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ARCOM Declaration:

The papers in these proceedings were double refereed by members of the scientific committee in a process that involved, detailed reading of the papers, reporting of comments to authors, modifications of papers by authors and re-evaluation of re-submitted papers to ensure quality of content.

FOREWORD

Welcome to the 30th annual Association of Researchers in Construction Management (ARCOM) conference; an occasion to celebrate construction management research.

ARCOM has developed into a popular and professional research association; our conference is attracting ever increasing number of research students, lecturers, prolific researchers and practitioners internationally. This year our delegates come from 28 countries with diverse range of backgrounds, interests and expertise.

In these proceedings we present the rich variety of contributions to the conference. Project management, building information modelling and sustainability continue to draw a large number of submissions. Health and safety and wellbeing, and construction management education and learning also feature as important themes in the conference together with procurement and information management. Policy research emerges as a new area of interest. In addition to our construction management papers, ARCOM is pleased to host the CIB W113 Law and Dispute Resolution Working Commission as a specialist stream of the conference this year.

We present to you 146 papers that were accepted for publication. This is the result of an intense three-stage review process through which we have been able to maintain high quality standards. Our initial call led to an astonishing 457 abstracts and 235 full papers being submitted. The Scientific Committee have worked very hard to select the final papers for presentation. If your paper is included in these proceedings then you should feel very proud of your achievement!

In addition to the research papers we welcome to the conference Tim Broyd (University College London) and Libby Schweber (University of Reading), our keynote speakers, and Martin Löwstedt (Chalmers University of Technology) who will deliver the Langford Lecture. Tim Broyd and Libby Schweber will join Christine Räisänen (Chalmers University of Technology), Mark Addis (Birmingham City University) and Stuart Green (University of Reading) as panellists on our debate: 'Do we need to have a method in order for us to be or become a community of construction management researchers?' The 30th ARCOM conference is a timely opportunity for an academic debate; time for reflection on the nature of research in construction management and discussion whether a method is central to our development as a community of researchers.

Putting together the academic programme for the conference is a collective effort, and we thank the ARCOM committee and wider Scientific Committee for their voluntary contribution to making the conference such a success year after year. Paul Chan, Andrew Dainty, Chris Harty, Scott Fernie and Simon Smith in particular have been instrumental in supporting us throughout the planning and managing of the conference over the past eight months.

We wish you an enjoyable and inspiring three days in Portsmouth; enjoy the diversity of research presented at the conference and proceedings and make the most of the many networking events. We hope that you will engage in critical reflection and discussions during the conference and afterwards through our web resources and workshops, and thus support our ongoing aim to further the advancement of knowledge in all aspects of management in construction.

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EXPLORING ESCALATION OF COMMITMENT IN CONSTRUCTION PROJECT MANAGEMENT: CASE STUDY OF THE SCOTTISH PARLIAMENT PROJECT

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Successfully managing large construction projects within defined budget and time constraints has always been a major challenge largely because crucial decisions about the project's ultimate fate have to be made within an environment of significant uncertainty at the beginning of the project. It is not surprising that cost and time overruns are commonplace on construction projects. Existing literature often suggests economical, technical, political or managerial roots to this phenomenon. A less explored possible cause within construction management framework is the escalation of commitment to a course of action. This theory, grounded in social psychology and organisational behaviour, suggests the tendency of people and organisations to become 'locked-in' and 'entrapped' in a particular course of action and thereby 'throw good money after bad' to make the venture succeed. This defies conventional rationality behind subjective expected utility theory. Through a critical analysis of the literature, we identify different frequently cited enablers of escalation of commitment. Using a hindsight constructivist approach, we then demonstrate references to some of these enablers on the Scottish Parliament project. We found strong evidence in support of possible strategic misrepresentation, confirmation bias, self-justification and optimism bias. We highlight the importance of setting realistic time and budget constraints to circumvent escalation and make several recommendations to attenuate unwarranted escalation of commitment, including the use of an objective outsider to evaluate responses to disconfirming information and the structuring of incentive systems that do not punish for inconsistency in order to curb the effects of self-justification and reputation management.

Keywords: cost overruns, confirmation bias, escalation of commitment, self-justification, strategic misrepresentation.

INTRODUCTION

Literature in social psychology and organisational behaviour suggests that after investing time, money, energy and other resources in a chosen course of action, individuals and decision makers often become "locked-in" or "entrapped" in that course of action, sometimes even if the venture is failing. Staw's (1976, 1981) seminal work on escalation of commitment seeks to explain why decision makers sometimes embark on a questionable course of action and then persist with them above and beyond what the objective facts suggest. The thesis of his work suggests that negative feedback on a previous decision often tends to rouse the feeling of self-justification and regret of that particular decision, thereby resulting in a reinforcement of additional

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resources (money, time or effort) to try and make the course of action pay off.

Consider the following situations:

1. A representative of an equity firm makes a decision to invest £5 million in a new IT start-up that is expected to take about 3 years to develop and implement. It emerges after two years that the IT firm is having liquidity issues and that the product might require additional funds of £2.5 million and a year's extension. The equity firm must decide whether to write-off the initial £5 million investment or commit the additional funds to give the project a chance of success. Should they cut their losses now, risk losing a total £7.5 million, or stake their chance at gaining much more should the project eventually succeed?
2. A Government proposes an grand project that will represent the essence and ideals of a people and be a symbol of devolution and national distinctiveness at £40 million. Two years later, it becomes obvious that it is impossible to complete the project at that cost and a new estimate was set at £119 million, with legislators imposing a cap of £195 million in the third year. By the 4th year, cost had increased to £241 million, rising twice in the 5th year to £295 million amidst several controversies. By the 6th year the cost reaches £376 million before project completion at £431 million in the 7th year.

Although each of the cases above presents different decision making situations, they both have a common trait - sequential decision patterns with one decision being made based on a previous. In each case also, a considerable amount of time, money and effort has already been committed to the venture and the results do not seem to be going as initially intended. Arkes and Blumer (1985) suggested that investment of resources often sets in motion non-rational sequential decision making process, with one form of commitment begetting further commitment. They further suggest that the more responsibility a person has for the outcome of an initial decision, the greater is the inertia towards further commitment. This tendency however, as noted by Bazerman and Moore (2008) defies the conventional rationality behind subjective expected utility theory which suggests that sunk costs or past losses should not enter into decisions regarding future gain (Bazerman and Moore 2008).

Using the theoretical framework described in the discourse above, this paper will explore the sources of escalation of commitment using the case study of the Scottish Parliament project. We examine official government publications and documentary evidence from the public enquiry that followed the controversies surrounding the project using a hindsight constructivist research approach. We focus on the events before and during the construction that created an environment for escalation and how these possibly led to the inevitable cost and duration overrun on the project. The next section of the paper explores the theory of escalation more closely, before we examine the Holyrood project for evidence of the locked-in syndrome. We then reveal some lessons learnt from the case study for construction project management with recommendations on how to attenuate unwarranted escalation tendencies.

THEORETICAL FRAMEWORK: ESCALATION OF COMMITMENT

Decision making experiments have provided a lot of evidence that individuals have a systematic bias towards escalation of commitment. Some of the reasons provided include a failure to treat previous investments as sunk cost (Arkes and Blumer 1985), self-justification (Staw 1981) and anticipated regret (Sarangee *et al.* 2013). Kahneman (1994) suggests that some decision makers use escalation of investments as opportunity to redeem a previous sub-optimal choice whiles Brockner (1992) posits that escalation tendencies may be buoyed by personal responsibility for negative

consequences. Traditional economic decision making models suggest that people are rational and would make decisions in an attempt to maximise expected utility. Sunk costs (past investments) must essentially therefore be considered as historical and irrecoverable, thus should not be considered in decisions regarding future course of action (Bazerman and Moore 2008). However, Barnes' (1984) work supports the supposition that decision making is often biased in favour of retrospective rationality-the sunk cost effect.

Organisations also demonstrate escalation tendencies, albeit in a more complex manner, according to Guler (2007). The presence of multiple members for decision making in organisations normally should increase the likelihood of recognising the irrationality of escalating commitment to a failing course of action. Bazerman *et al* (1984) thus found that groups are less likely than individuals to escalate commitment. They however added that where groups do escalate, they tend to do so to a greater degree than individuals, possibly because group dynamics tends to increase the level of justification to continue to support an initial venture. We refer to this here as the *strength in numbers* effect.

A tale of two schools

There are essentially two schools of thought on escalation phenomenon. Decision error theorists, after Staw (1976), maintain that escalation is a result of a systematic bias in decision making where people, especially those that have personal responsibility for the outcome of the project or have a vested interest in the project, interpret feedback to support their point of view (Caldwell and O'Reilly 1982). According to Nickerson (1998), this can either be intentional or that the decision maker unknowingly falls to the curse of a confirmation bias - the seeking and interpretation of feedback in ways that are partial to existing beliefs or expectations.

Decision dilemma theorists, after Bowen (1987), however point to uncertainty of information and argue that feedback is often equivocal and that it is impossible to accurately predict how any venture will eventually turn out. Hantula and DeNicolis Bragger (1999) posit that these uncertainties could explain why it may be a prudent, at least at the time of making the decision, to continue to give the project a chance. Whether the project eventually fails or succeed is not necessarily a result of one wrong decision to rectify a previous sub-optimal choice, but simply a decision made amongst many alternatives in an environment of uncertainty.

Sequential investment and escalation

Sequential investment projects are particular susceptible to escalation tendencies because the venture does not generate intermediate financial payoffs until its complete. There is also some level of uncertainty over the amount and timing of the investment that will be required over the life of the project. Each investment stage therefore presents more opportunity cost as well as a milestone to either escalate commitment or pursue an alternative course of action. As found by Shepherd and Cardon (2009) however, terminating unsuccessful projects often comes with negative attending consequences including loss of job or losing face within an organisation. Decision makers often thus attempt to keep projects running by using end-gaming and using future-perfect strategies (Clegg *et al.* 2006). Strategic misrepresentation, the deliberate distortion or misstatement of the amount of time or resources necessary to complete the venture is not an uncommon tactic either (see Jones and Euske 1991).

Table 1 summarises some of the factors that create an environment that enabling escalation of commitment. These factors will be expanded upon in latter sections of the paper with supporting evidence from the Holyrood Project.

Table 1: Escalation enablers

	Category	Description	Sources
1	Sunk-cost effects	Tendency to continue an endeavour because some amount of money, time or effort has already been invested in it. Investment begetting more investment.	Arkes and Blumer (1985), Brockner <i>et al</i> (1986)
2	Optimism bias	Overestimating the likelihood of positive events while downplaying the occurrence or severity of negative events.	Tversky and Kahneman (1974), Flyvbjerg (2008)
3	Future-perfect strategies (End-gaming)	Forward looking projection of ends with a visualisation of the means by which that projected future may be accomplished	Weick and Kiesler (1979) , Clegg <i>et al</i> (2006)
4	Strategic Misrepresentation	Deliberate distortion or misstatement of the amount of resources or time necessary to achieve an aim	Jones and Euske (1991), Flyvbjerg (2008)
5	Confirmation bias	Tendency to seek or interpret information in ways that are partial to existing beliefs or expectations	Cadwell and O'Reilly (1982)
6	Norms of consistency	Consistent and decisive leaders are often viewed as better leaders. Decisions makers tend to stick to their initial decisions to main this consistency.	Staw and Ross (1980), Wellen <i>et al</i> (1998)
7	Image/Reputation Management	Not wanting to appear indecisive or incompetent. Usually driven by feelings of personal responsibility	Smith and Terry (2003), Shepherd and Cardon (2009)
8	Self-justification	Unwillingness to admit to oneself, and/or others that a previous decision was sub-optimal or wrong.	Festinger (1962), Brockner (1992)
9	Organisational & Political influences	Coercive and normative pressures using institutional power or authority	Pfeffer (1992), Guler (2007)

Construction projects normally involve a series of sequential decisions before actual construction begins. Most projects will go through long feasibility and gestation periods before project approval and eventual delivery. These phases involve an iterative process of information acquisition and incremental commitment over a period of time, presenting a conducive environment for escalation of commitment. Where a project has commercial interest and is subject to sequential investment, the project often tends to be perceived as an end in itself according to Winch (2013), and therefore must be completed, no matter what, in order to recoup any initial investments.

RESEARCH APPROACH

Winch (2013) explored the three-pronged effects of future perfect strategising, strategic misrepresentation and escalation of commitment on the Channel Fixed Link project in an attempt to develop a broader organisational perspective on cost escalation in major projects. He proposed a hindsight constructivist or historical approach as research method to help fully comprehend the organisational complexities that led to overruns. Winch suggests that this approach will help comprehend the idiosyncratic embeddedness of major construction. We adopt a similar approach in this paper as it best helps for sense-making of the political and social construct of our case study, the Scottish Parliament building (Holyrood Project). We explore escalation of commitment using official documentary evidence from the government commissioned public enquiry that followed the controversies surrounding the construction of the Holyrood project (Fraser 2004). We also examine the Auditor General's reports (2000, 2004) and the Spencely Report (2000) submitted to the Scottish Parliamentary Corporate Body.

CASE STUDY: HOLYROOD PROJECT

Completed 3 years late in 2004, at a cost of £431million, The Holyrood Building in Edinburgh houses the Members of the Scottish Parliament (MSPs). Its final cost is approximately ten times more than the headline final cost of £40million announced in the Government's devolution White Paper, Scotland's Parliament (1997). The Government commissioned the Spencely Report (2000) to investigate cost and time overruns on the project. This was followed by two major probes by the Auditor General (2000, 2004) before the defining public enquiry, chaired by Lord Fraser of Carmyllie (2004) after project hand-over to investigate key decisions undertaken throughout the project delivery. There were 66 witnesses and more than 13,000 documents examined for the Public Enquiry (PE) alone. A full transcript of the transactions at the enquiry can be found at www.holyroodinquiry.org. These reports, as well as minutes of parliamentary proceedings, provide a rich source of documentary evidence to support the empirical analysis conducted in this paper.

The Act of Union of 1707 merged the Parliaments of Scotland and England into the Parliament of Great Britain, housed in the Palace of Westminster in London. Scotland was now effectively directly governed from London as a result (Colley 1992). However, in September 1979, the people of Scotland voted "Yes" in a referendum that would see the creation of the first Scottish Parliament in almost 300 years. Donald Dewar was appointed Secretary of State with the mandate to oversee the construction of a the parliament house. He became the main project champion, a key player and driver of what was to represent Scottish identity and aspirations. But the euphoria surrounding the referendum at this time led to many ill-considered decisions that created a conducive environment for escalation.

Optimism bias

First was the unrealistic cost ceiling of £40million. This turned out to be a rather optimistic estimate, or better still, a guesstimate of final cost of the project by non-construction professionals. Recall that a central theme of escalation theory is the increase in resources devoted to a venture in an attempt to redeem a previous sub-optimal choice. A member of the Scottish Parliament Corporate Body, Andrew Welsh MSP, stated that *"right from the very start, the budgets were totally unrealistic. The original budgets we inherited were for a fictional building"* [11 February 2004]. Russell Hillhouse, former Permanent Under-Secretary at the Scottish Office and a member of the team that estimated the cost of the project at £40million said *"we couldn't possibly have done a thorough job, and this was very difficult because it was a time when people were working extremely hard on other aspects of the White Paper"* [PE 30th October 2003]². Sam Galbraith, former Under-Secretary of State at the Scottish Office also told the public enquiry, *"the figure of £40million in the white document, was never for Holyrood. That was for a bog-standard building on a greenfield site."* [PE 28 October 2003]. When asked how he knew the figure was not for Holyrood project, he responded *"That's what Donald [Dewar] told me"* suggesting that the project champion at this stage may have been aware that the cost of the project announced to the public was unrealistic.

Self-justification, Reputation management and Norms of Consistency

Another sub-optimal decision that was made at the beginning of the project was the unrealistic completion date imposed on the project. Speed to build was priority for the project promoters who wanted the project completed within two years. This was

² Abbreviations: PE- Public Enquiry; MS/SE - Documentary evidences submitted to the public enquiry

strongly criticised by the opposition leaders. In a letter to all MSPs, Donald Gorrie MSP criticised the decision of the Scottish Office and the Secretary of State, Donald Dewer, writing *"There is no need for this haste...There has been widespread informed criticism of the fast timetable, for which there is no need. Professionals and organisations favouring the Holyrood site, favour a delay while the plans, timescale and budget are revised"* [MS/16/042 - 043]. Alex Salmond MSP also insisted that there was no need to try and deliver the project within such a short duration. He wrote to Donald Dewer, *"...it is quite impossible to have any new debating chamber of quality... ready by the time of the elections to the Scottish Parliament in 1999"* [MS/1/071 – 079]. Ignoring these warnings, however, the project sponsors still proceeded with the 2 year duration.

At least three enablers of escalation might have been at play at this stage - political reputation management, self-justification and maintaining norms of consistency. Negative feedback on a past decisions calls the validity of the original decision into question and is dissonant with a decision maker's natural desire to see himself as competent. Many decision makers would often escalate commitment to their previous decision in order to prove that the initial decision was valid. In the case of the promoters of the Holyrood project, choosing a fast track delivery method suddenly became very appealing if they had to meet 2 year deadline. Construction management procurement method was thus chosen as it has the advantage of allowing both design and project construction to occur concurrently. Using conventional construction methods of design before building would have added an extra 18months to the duration, according to William Armstrong, the Project Manager [PE 3 December 2003]. However, using construction management may well have been the single most important decision that was largely responsible for the cost and time overrun experienced on the Holyrood project. The client bears all financial risks associated with delays and design changes and final cost of the project could not be realistically known until all designs were completed. In addition, there is little incentive for the design team to keep cost low when such a method is used. Paul Grice, Clerk and Chief Executive of the Scottish Parliament told the public enquiry *'It is a fact of construction management - until you let the last tender, and settled the last claim, you can't know the final amount'* [PE 10 February 2004]. Robert Brown MSP, a member of the Scottish Parliament Corporate Body that was in charge of the project at one point aptly explains the source of the problems on the project. He noted, *"the signature design, the contractual method, and the process of developing the design detail, I increasingly came to the view that most of our difficulties [experienced on the project] were in a sense inevitable once the button was pressed at the beginning by the Scottish Office when they let the contract in the first place."*

Strategic misrepresentation

There was evidence of strategic misrepresentation, the deliberate distortion or misstatement of the amount of time and resources necessary to achieve an aim, at many stages during the procurement of the project. Five weeks after their election 1999, the new MSPs had to vote on whether or not to continue the project. At this stage, Alex Salmond MSP, leader of the main opposition party wrote to Sir David Steel MSP, the Presiding Officer of the Scottish Parliament, requesting that the project be suspended and that an estimate of possible cancellation cost be produced *"in order to properly debate the future of the Holyrood project or other alternatives"* (MS/1/083). He further wrote in a follow-up letter, *"It is now possible that we may have to consider cancelling the Holyrood project; in the circumstances it is essential*

that no further actions should be taken which would add to the cost of cancellation if this were the decision which Parliament reached." [MS/1/084]

Faced with the dire prospect of possible project cancellation, civil servants in the Scottish Office, led by Barbara Doig, the Project Sponsor, decided to hide the fact that costs were going to be significantly higher than what the MSPs were to vote upon. In a classic example of strategic misrepresentation, the Project Sponsor did not include an extra £27million for risk in the estimates submitted to the MSPs. She later insisted that she was *'confident the £27million could be managed out'* and therefore was not to be included in the information given to the members of the Scottish Parliament

The proposed vote for an amendment urging a termination of the project was defeated by only three votes. Alex Salmond MSP, later told the public enquiry that the vote was based on false information, adding, *"it is inconceivable that had the proper information been given to the members of the Scottish Parliament, that there wouldn't have been at least a delay for taking stock and reassessment... the figures, the facts, the timeline shows that when the Parliament were told they were inheriting a project of £109 million, it was actually well over £200 million and was totally out of control... Parliamentarians being misled and misinformed is a very serious issue indeed."* [PE 13 November 2003]

Lord Fraser himself makes a strong case for strategic misrepresentation on the Holyrood Project by stating *"As at the point of hand-over, where there is a very tight vote in the Parliament on whether to proceed with this particular project or not, that figure was specifically kept away from them. It looks rather as though, those who were involved in this were determined to keep the figure down as low as possible, even to the point of concealing it from the Parliament, in the hope that the project would go ahead."*

Political end-gaming and future-perfecting strategies

There was a lot of evidence supporting political end-gaming and future-perfecting strategies in the early stages of the project as well. Donald Dewar and the project team seem to have capitalised on the newly found nationalistic sentiments and euphoria around the referendum. The project was continuously presented to the public as one that will represent the essence of Scottish devolution and be an *"important symbol for Scotland"* that will *"pay tribute to the country's past achievements and signal its future aspirations"* (Scotland's Parliament 1997). Riding on these sentiments, Donald Dewar probably felt the need to build momentum and get the project started quickly. Consensus regarding some key decisions was ignored as he bypassed the consent of MSPs at many strategic stages, including the choosing of a site of the project [See MS/1/071 – 079]. It emerged during the public enquiry that he felt he had to 'endow' the MSPs with the new building and that if the decision of location of the building was not made quickly enough, the MSPs will never get around to doing it themselves. He probably also was aware that once the first concrete was poured, the project would become like a moving train that could not be stopped.

Confirmation bias

Confirmation bias, the tendency to seek or interpret information in ways that are partial to existing beliefs or expectations, played a key role in escalation on the Holyrood project. William Armstrong, an experienced project professional was the First Project Manager for the Holyrood Project at the Scottish Office. He resigned from his role because of frustrations he experienced regarding the spiralling cost and time delays. He was critical of the performance and commitment of the Architect,

Enrique Miralles writing to Project Sponsor, Barbara Doig, "*There is no indication that Miralles [can] remedy the deficiencies in time, cost and design to meet the programme.*" [PE SE-4-044]. His resignation letter prophesied that if measures were not quickly taken to properly control and manage the project, the "*programme will drift, the cost will increase, the design team will make claims, the contractors will make claims, and the project will become a disaster*" [PE SE-4-044]. As indicated by Caldwell and O'Reilly (1982) and Kahneman (2011), confirmation bias leads a decision maker to underplay, and in some cases, even ignore disconfirming feedback on performance of any venture. William Armstrong's strong warnings were blatantly ignored by the project sponsor, who later stated that "*I was comfortable that a great deal was being done to ensure that we continue to be on program, that we got the cost sorted out and that we got the design to the quality required*" [PE 4 December, 2003]. She decided instead that it was better that William Armstrong be removed from his post. He resigned before he could be fired.

Political and organisational influences

There were very strong political and organisational influences at many stages of the project as well. For example, opposition MSPs requested a two month delay in the project to examine the whole project more closely and explore other possible options. Margo MacDonald MSP insisted during a parliamentary debate that "*too many questions are unanswered at this stage, and we plead with you [Donald Dewar] for the time to find adequate answers*" [17 June 1999]. As is usually the case, those responsible for the negative outcome of a particular decision tend to maintain the norms of consistency in order not to appear indecisive or appear politically weak. Donald Dewar thus responded that such a delays requested by the opposition parties would "*cost more than £3million in contract penalties*". He added, "*this Parliament would look like a laughing stock*" if the opposition party got its way during the debate in Parliament. When it became apparent that the opposition might be fighting a lost cause, Donald Gorrie MSP said in reference to Donald Dewar, "*it is a despotism, we have one man says what happens and we all obediently follow him*" [17 June 1999]).

There were other sources of problems on the Holyrood project including significant scope changes, the death of the architect Enric Miralles, shortly followed by the death of project champion Donald Dewar. However, we have only concerned ourselves with some of the factors that may have contributed to escalation of commitment with its attending significant cost and time overruns.

CONCLUSIONS

The present study concerns the escalation of commitment to a particular course of action in decision making. We identified different enablers of escalation from the literature including sunk costs, self-justification, confirmation bias and strategic misrepresentation. We then examined official documentary evidence on the Holyrood project using a hindsight constructivist approach for possible causes of escalation that ultimately resulted in the cost and time overruns experienced on the project. We found overwhelming evidence in support of the use of strategic misrepresentation, self-justification and reputation management during the project. The study also revealed evidence of optimism bias on the part of project sponsors in defining the budget and time constraints for the project.

The case study suggests that escalation of commitment is a complex phenomenon with additive causes from different sources. We also highlight the importance of the early stages of a project, as decisions taken at this stage become increasingly difficult to

reverse. In general, it is important for project sponsors and decision makers to be aware of the fact that their decisions will tend to be biased by previous decisions, and that we all tend to have a natural inertia towards escalation of commitment, particularly after receiving negative feedback.

RECOMMENDATIONS

Knowing why and when escalation occurs can help managers avoid this common decision bias. However, as escalation may not always be readily obvious, it is important to put in place organisational structures that will help attenuate unwarranted escalation. The use of an objective outsider to evaluate our responses to disconfirming information, especially in situations of sequential decision making can be helpful in reducing escalation tendencies. It might be helpful to structure incentives so that decision makers are not punished for supposed inconsistency in order to curb the effect of self-justification. Increased monitoring, accountability, budget controls and scrutiny might also be helpful especially on large and complex projects.

While this paper deals with the sources of escalation and how it might be curbed, it is important to mention that escalation should not necessarily be considered as a negative tendency. There are situations where it might be economically rational to escalate commitment to keep options open or maintain personal and future business relationships. On cursory examination, this might sound divergent to the core of the foregone discussions in this paper. However, what is proposed in this paper instead is that decision makers should be aware of the difficulty of separating initial decisions from related future decisions. It might be prudent to actively search for disconfirming information to provide a balanced perspective on confirming information that we are more likely to intuitively seek.

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OPTIMISM BIAS, PATHOGENS AND COST OVERRUN: THE CASE OF AN RTS PROJECT IN SOUTH AFRICA

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The demand for electricity in South Africa is on the upward trend. To meet the demand, a state own enterprise embarked upon major infrastructure projects, which have been plagued with cost and schedule overrun. The overrun is particularly severe with return-to-service power projects. The aim of the study was to find ways of understanding latent factors that promoted overrun in such projects. Thus, with the use of a case study, the paper presents the contributing factors to cost overruns, which were overlooked at project inception. Major stakeholders with planning and implementation responsibilities were interviewed on the case project. A clear trend that was observable by all the interviewees was the inability to address cost and time overrun that was encountered on the project due to the presence of 'optimism bias and pathogens' in the project environment. Rather, the urgent electricity demand provided a platform for the implantation of optimism bias and planning fallacy, which stimulated pathogens. The practice, industry, task and circumstance related pathogens thus influenced the scale of the cost overrun that has been reported on the case project. The notable insight provided by the exploratory study is that resident pathogens in a complex project environment can work in unison with optimism bias and planning fallacy to engender cost overrun.

Keywords: cost overrun, major projects, South Africa

INTRODUCTION

Cost overrun is a barrier to the proliferation of infrastructure projects in developing countries (Flyvbjerg *et al.*, 2003). The literature has established that cost overrun is associated with major projects (Priemus *et al.*, 2008). For instance, it has been reported that project cost estimates may be wrong when compared to actual development cost (Altshuler and Luberoff, 2003). Understanding cost overruns in infrastructure projects in the broader construction context requires an assessment of many factors such as competitive tendering, which shows causes, frequency and severity (Park and Papadopoulou, 2012). These factors and its dynamics give credence to the reported assertion that a positive correlation exists between contract value and cost overrun (Love, 2011). In this regard, the paper presents the preliminary findings of a study aimed at gaining additional understanding of cost overruns in South Africa. Although return-to-service (RTS) projects are done for socio-economic reasons, their cost should not constitute a burden to tax payers. Based on the South Africa experience, a major feature of RTS projects at completion is cost overruns, and a reason pertains to the competition for the resources, commodities and manufacturing

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capacity needed for the design and construction of power projects (Schlissel and Biewald, 2008). In other words, project complexity is a major factor for the occurrence of overrun (Flyvbjerg, 2011a). The objective of the study was to identify mitigation decisions by understanding latent factors that promote overruns in major infrastructure projects. The objective is underpinned by the premise that RTS projects suffer overruns due to planning and implementation mechanisms in South Africa.

AN EXPOSITION ON RTS PROJECTS IN SOUTH AFRICA

In response to high demand for electricity in South Africa, a State Owned Enterprise (SOE) embarked on new and RTS power projects. The reason for the RTS of the old mothballed stations is because it seems to be a quicker option to generate electricity. Some of these RTS stations were mothballed for almost 20 years. In RTS projects, most contracts are structured to allow escalation after a year. The longer the delay on the project, the higher inflation costs, especially contract price adjustment. As an illustration, in a case where items are manufactured and have not yet been installed due to delays in the plant, the items would have to be stored in a safe place. In the case of specialised equipment such as the Switchgear for a power plant, it can only be stored at the manufacturer's storage facilities and if the delays are for a long period, the cost commitments would rise. This explanation is crucial because most of the items manufactured outside South Africa come into the country by air or sea freight and could take 5 weeks to 18 months. As a result of the aforesaid, there is a need to pay attention to either overestimation or underestimation of deliverables of RTS projects.

In the case of lack of experience in contract works, the non-prevalence of RTS project is a factor. Project experience is scarce when it comes to RTS projects. The knowledge and experience element inform the broadness of project information, which are in relation to the strength of project team (Wang and Yuan, 2011). Having these required attributes could be the difference between failure and success in a typical major project. For instance, request for information that often delay activities would emanate from incomplete drawings due to a lack of knowledge of what needs to be done, or insufficient time to ensure the drawings are complete and checked thoroughly, or incompetence. In RTS projects, equipment is not purchased new - they are refurbished equipment. This makes it very difficult to estimate the cost to refurbish as no two equipment is exactly the same. This is the reason why RTS projects mainly use historical data to determine the estimates. This can be a simple method of estimating, but could also be very inaccurate because without cautious utilization of post bid data, this practice will lead to an inaccurate estimate (Chou, 2009).

Inflation and currency fluctuations have serious impact on the cost of construction, especially if the project involves importation of materials from another country (Emuze and Kadangwe, 2014). Forecasting the trend of inflation in Sub-Saharan African countries is particularly very difficult, and as such, the impact is felt on procurement, purchasing decisions, collective bargaining agreements with local unions and overall cash flow management (Gunhan and Arditi, 2005). Schedule delays and implementation mechanism could also lead to cost overruns. There are many possible triggers: (1) the scope could have been underestimated or increased because of customer requests; (2) customers can request changes in the design or project requirements during the course of a project which cause completed work to require rework; (3) the original plan may not be practicable (for example, too aggressively scheduled, or failing to take rework into account); or (4) other risks

might have occurred, such as lack of staff due to hiring delays or delayed completion of upstream projects (Ford *et al.*, 2007).

A RELATIONAL OUTLOOK ON OPTIMISM BIAS, PATHOGENS AND COST OVERRUN

Infrastructure development projects are infamous for over-running cost and schedule budgets (Flyvbjerg *et al.*, 2003; Matta and Ashkenas, 2003; Love, 2011), and such overruns increases construction cost on a daily basis (Flyvbjerg, 2005). Notable reasons for these overruns include material price fluctuations, contractor delays in deliverables, changes in specifications and scope, inflation, design changes, funding problems, among others (Enshassi *et al.*, 2009). In addition, major projects are often exposed to performance problems with origins in upstream project activities where multi-factor decisions are embedded (Morris *et al.*, 2011). The case of poor estimating at the beginning of the project serves as an example. Cost estimation is very important in project management as it has a huge influence on decisions. When the estimate is based on insufficient information in the form of uncertainties, it is generally incorrect. Beside uncertainties, optimism bias and strategic misrepresentation constitute reasons for cost overruns in major infrastructure projects (Flyvbjerg, 2008).

Optimism bias is an inclination to estimate items more confidently without a reality check; and strategic misrepresentation is about purposely under-estimating cost and time for political and strategic reasons (Giezen, 2012). The reason for under-estimating could relate to the need for the project to proceed based on the initial estimate. Optimism bias occurs when decision makers were over-optimistic about the outcome of their planning endeavours (Flyvbjerg, 2008). This entails over-estimating the likelihood of positive events and under-estimating risk and loss (Love, 2011). However, the actions of strategic misrepresentation and optimism bias could stimulate pathogens in the project implementation environment. Citing the work of Busby and Hughes (2004), pathogens has been likened by Love (2011) to latent conditions that lay dormant within a system until they are triggered by an error. The fact that they are latent means pathogens could reside within a system for a considerable length of time and become an integral part of work practices in a firm. These pathogens contribute to errors in different forms, which include the deliberate practices of people, the nature of work / task to be performed, the circumstance in which the project is embedded, the structure and operation of an enterprise, the system of an organisation, and the technical features of the tool / tools employed in a process (Busby and Hughes, 2004 cited by Love, 2011).

Recent discourses have also shown that misrepresentation, optimism bias and pathogens can work in unison or independently to produce excessive cost and schedule deviation in a major project. The cost overruns associated with major projects are influenced by multi-factor decisions at the early stages of procurement. The degree of complexities in a particular project thus determines the proneness of such project to cost overrun due to changes in scope, specifications, material prices, and cost estimates, to mention a few. The exposition on RTS projects extends the literature on project complexity. A keen look at RTS projects reveals that such projects are characterised with complexity, non-linearity, and dynamism, which often exist on the edge of chaos (Bertelsen, 2003). The construction industry is struggling to cope with the increasing complexity of major projects because complexity, inter-alia, determine planning, co-ordination and control requirements in a project; influences the selection of expertise and experience requirements of human resources; influence

the selection of suitable procurement arrangements; and determine project performance in terms of cost, quality, time and other considerations (Baccarini, 1996).

Thus, managing RTS projects within a complex environment mandate the ability to take cognizance of systems from varying perspectives so as to apply a range of tools and methodologies that suits the needs of a prevailing situation (Remington and Pollack, 2008).

METHODOLOGY

A case study approach is used to examine the underlying dynamics that are contributing to cost overrun. The case study, which is based on interviews and relies on verbal reports, is exploratory in nature (Flyvbjerg, 2011b). The single case was chosen because it represents a typical example of a more general problem related to cost overrun in South Africa (Flick, 2014). From a methodological perspective, this single case study detailed a single project through interviews and documents so as to provide insights and ideas in the early stages of investigating cost overrun in South Africa (Fellows and Liu, 2008). The research design focuses on preconstruction decisions and actions. Therefore scope creep, change orders, the relationship between cost overrun and value for money and other elements of complexities, which are synonymous with major projects were not interrogated. Interviews were conducted with participants from the SOE that does RTS projects in South Africa. This refurbishment project started off with a budget of R4.3 billion after contract negotiations and at R14.6 billion, completion is yet far away. A protocol was developed for the interviews, which were based on a purposive sample (Flick, 2014). The protocol was guided by three research questions. Interviews were conducted among professionals who are experienced in the phenomenon under study. In depth interviews were conducted, over a period of four weeks, at the project offices of the interviewees. The interviewees were all part of the management structures of the project. The face-to-face interviews were approximately 40 minutes long, and the interviews were digitally recorded prior to transcription. The interviewees were four male and one female, and held different portfolio within the project team. The five interviewees were chosen as they are currently addressing cost matters in the case project. The selection of the interviewees was influenced by their current job profile and experiences in the specific project. The interviewees have background training and experience in engineering and project management. Descriptive narrative, which is noted with single cases (Tracy, 2013), is used to present the findings in the next section.

RESEARCH FINDINGS - THE CASE STUDY

How does the SOE compile the scope of RTS projects before the commencement of the works?

In response to the above question, the interviewees and the analysed company documents show that the client (the SOE) base the scope of RTS projects on previous work that has been done as well as visual inspections carried out in the power station through life extension studies, which included checking the conditions of equipment and their components. Sometimes, it is not easy to open every component in the plant, so samples were taken to determine the scope of work for items such as vessels and pumps.

Participant 1 elaborated that she will base the scope of the work done on other RTS projects so that lessons learnt can be used to avoid past mistakes. She mentioned that

she is not certain that proper feasibility studies were done, and if it was done, specialists and engineers should be held accountable where necessary. However, Participant 2 stated that he will base the scope on a full site inspection, although it was very expensive. The participant noted that if a proper inspection was not done, the extent of repair, replacement and new built cannot be accurately determined. He contends that it is prudent to spend slightly more on inspections so as to ensure a more accurate scope of works is determined. In the same context, Participant 3 says he would also base scope of RTS works on inspections, but the inspections will have to be done in detail and make sure all items are covered. By doing more detailed plant inspections, the SOE would be able to get a better understanding of the condition of the plant, and, would have an idea of whether it is better to replace the components or refurbish them. According to the participant, most of the mothballed stations were built around 50 years ago. Some of the plant items are in a state where it cannot be refurbished and need to be replaced. The technology used 50 years ago is not the same as today. So a detailed inspection would be the best option. Where it is difficult to get an investigation done, then he would look at similar work done previously and see what the scope was and use such information. However, there appear to be a cautionary tone with the latter perspective. Looking at other stations that were refurbished may also not be very accurate as the stations were built in different time and locations. If a station was built in 1950 and has 9 generating units, there is a chance that the first unit was built in 1950 and the ninth unit was built 5 years later. This would mean that the condition of the first and the last unit would not be the same. So basing the scope on other refurbished stations would be the last option of this participant.

In contrast to the opinion of the first participant, Participant 4 stated that feasibility studies were done before decisions to proceed were made with the RTS projects. The time it takes to build a new plant is assumed to be more than the project duration for the refurbishment an old plant. Thus, refurbishment appears to be an attractive option for a firm in urgent need of power generation capability. This is where feasibility studies become relevant. The participant noted that by doing a feasibility study, the SOE was able to see that it is feasible to refurbish the old plant than build a new one. The participant equally mentioned that although it is feasible to refurbish an old plant, it should also be priced more accurately. Similarly, Participant 5 mentioned that risk assessments were done, although with hindsight, it appears that the assessment were not exhaustive enough. The participant conceded that risk assessment was done, but the extent of which it is done only covers upstream activities and thus, it assisted to a limited extent. From this participant view, the risk assessments have probably helped to reduce cost overruns, but not to a huge extent as the RTS project still encountered cost overrun. In the exact words of the participant, *“maybe they never allowed enough time to be able to work around the risks”*. It can be observed that insufficient time to undertake proper assessment is a factor in relation to RTS projects.

What is the magnitude of cost overruns that are experienced on RTS projects in the SOE?

In general terms, the participants of the study observe that the magnitude of cost overruns on RTS projects is huge. The participants were experiencing huge cost overrun on the specific RTS project in which they were engaged. In terms of the specific project, all the participants mentioned poor planning as a major cause of the situation. The participant noted that cost overrun impact taxpayers in South Africa negatively as the main source of project fund is the national treasury. The effect of the

cost overrun on the SOE is negative in terms of budgeting, cash flow and image. According to Participant 1, cost estimates should have been more effective, and, it should have taken realistic market considerations into account, in addition to a 10-20% premium on top of the estimates in the form of contingency. The second participant was more focus on planning. The participant opined that he would spend more time on planning, and he would do the life extension studies properly and not partially; he would need to know if there is potential improvement and what can be reused and what cannot be reused and that needs time, and that in particular is *“what we don't really do”*. Furthermore, the transcribed data show that Participant 3 concurs with Participant 2. The third participant mentioned that he would make sure that *“we plan properly”*. The participant noted that the SOE should have examined and used lessons learned in similar projects. The participant concluded that he would rather spend much more time planning instead of rushing to the execution phase of the RTS project. The perception of Participant 4 and 5 were not different from the planning related views.

What can be done to prevent scope induced cost overruns on future RTS projects in the SOE?

All participants were in agreement that unclear scope and inadequate planning influenced the encountered cost overrun on the case RTS project. If the scope has been clearly defined in the beginning, it would have closed all procurement / purchase related loop holes. It would eliminate suppliers coming with ridiculous prices and would minimize compensation events. The first participant summarise her view by saying *“a typical RTS project is where the station is old and one does not really know what exactly needs to be done in detail, so when the scope is poorly defined, there is a high chance that you would hit cost overruns. Unclear scope means you are not too sure what you need to do. When you are not sure what you need to do then you find unexpected expenses along the way.”* The participant further suggests that in order to control costs, there is a need to involve all the disciplines (engineers and financial experts) in the planning process from the onset. The project leaders also need to ensure that the costs are market related. A realistic picture of the project should be compiled alongside adequate contingencies. The nature of the contract or the structure of the contract will also affect cost control, so the correct type of contract should be placed to make sure the client does not incur losses. Participant 1 also mention that expert advice on good cost control measures that can be used in order to make sure value for money is attained, must be sought. In this regard, the participant advocates the placement of cost monitoring system from the start of each RTS project.

According to the second participant, the scope of each RTS project must be drawn up by experienced persons who have a valid knowledge of the particular project in order to minimize cost overruns. In the South African construction environment, there must be collaboration where lessons learned can be shared. The participant also highlights the fact that experienced professionals should place RTS contracts so as to ensure adequate accountability. On the one hand, Participant 4 stated that people involved in placing contracts put their own interests first instead of the business interests. Once people start putting the business interests before theirs, then we would see the extent of cost overruns reducing in South Africa. On the other hand, Participant 3 reason that the SOE overspend is because of poor management and inexperienced people that handle projects, especially in Government. Verbatim, the participant says *“in these days we tend to give contracts to people that are inexperienced and know almost*

nothing, instead of giving this work to people or companies that have been doing this kind of work for many years.”

The interviews show that scope, planning and inspection were highlighted as aspects that may have contributed significantly to the cost of the RTS project (Table 1). All the interviewees noted the interdependence of these aspects and their ability to alter the cost of an RTS project. In essence, the perceptions of the interviewees suggest that the RTS project may have fallen victim to 'planning fallacy'. When planning fallacy takes root in a project, managers make decisions based on optimism rather than on a rational weighting of gains, losses, and probabilities - risks (Flyvbjerg, 2011a). Manager tend to overestimate benefits and underestimate project performance parameters by projecting forecasts of success without paying adequate attention to potential for mistakes and miscalculations.

Table 1: Overview of major perceptions of the interviewees

Aspect	Comments
Scope	Scope is determined through the input of life extension studies
	Scope is influenced by the advice of experts
Planning	Planning is affected by upstream / executive decisions
	Ineffective cost estimate and measures is a feature of poor planning
	The experience and expertise of project actors affect planning outcomes
Inspection	RTS project scope and planning depend on life extension studies
	Inspection is a determinant of repair and replace decisions
	Inspection is dependent on expert knowledge

DISCUSSION

Although a consensus about the management decisions that should have been made to ensure that the project was delivered as initially envisaged was not discernable from the study participants, the narrative in the findings shows that optimism bias and pathogens may have combined to produce the cost overrun in the RTS project. The optimism bias occurred through the decisions of the project sponsors based on the theoretical assumption that it is cheaper and quicker to fix an old power station in the South African construction environment that have been challenged by performance problems (Valentin and Vorster, 2012). The bias was fuelled by the need to limit load shedding and power cuts in the country. The recognition of the complexities and latent dynamics related to RTS projects shows that the optimism bias led to a series of events, which mirror the attributes of pathogens. The work of the project was started using tentative information where design and construction activities overlapped so as to meet the shortest delivery time. In this situation, individuals may repeat inappropriate practices, such as taking short cuts and not following due processes (Love, 2011), especially in relation to life extension studies, inspections, and cost estimation. The lack of quality management during the planning process is evident from the opinions of the interviewees. The planning gaps therefore made variation orders, request for information, site instructions, and non-conformances, constant features of the RTS project. The pathogens that eventuate in the project pertain to practise, circumstance, industry, and task. For example, the haste in project

commencement led to inadequate assessment of risks and poor estimation of cost, which in turn opens the floodgate for huge compensation events that is fairly in tandem with the practice of the industry. The nature of the task is also a factor in that the refurbishment of old equipment is not a guarantee of expected performance in operation. Most importantly, a pathogen that seems to pervade the entire industry is the lack of needed expertise, especially when specialist knowledge is a requirement for the achievement of project objectives.

The examined case project supports the argument that the processes that have the greatest impact on project success in the construction sector are activity definition and project plan development. Leaders of this project appear not to have invested enough effort in this regard. Thus, the improvement of project performance at the planning phase of a project should concentrate more on the accurate identification of all project activities; and ensure that a high-quality project plan is approved by key stakeholders (Zwikael, 2009).

The analysis of Love *et al.* (2012) supports the findings of this single case as the circumstance of an optimistic feasibility and life extension studies was used to produce the construction work packages due to surging electricity demand in South Africa. The organisation and industry nature introduced knowledge and skills related issues that affected the compilation of the planning documents (task), which failed to circumvent problems at the implementation stage. Through underestimation of cost and time, and overestimation of benefits (Buehler *et al.*, 1994), the case RTS project can be assumed to be a victim of planning fallacy as mentioned earlier. Koole and Spijker (2000) noted that people would underestimate task-completion times when planning fallacy is not addressed. In other words, the conventional planning method, which relies on insider view, should be replaced with better forecasting method that depends on outside view (Flyvbjerg, 2011a). A better forecasting method in this context could be the "*reference class forecasting*", which identifies a relevant reference class of past projects; establish a probability distribution for the selected reference class; and then compare the specific project with the reference class distribution so as to determine the most likely outcome for the specific project (Flyvbjerg, 2011a).

CONCLUSIONS

The need and worth of infrastructure projects is not disputed, but their final cost is a concern. The reported innate features of major projects – project complexity and cost overrun, are evident in this project. The case study shows that the approach to planning, which was laden with hasty decisions constitutes the major reason for the runaway costs of the project. The face-to-face interviews of five key project participant in the case RTS project that have exceeded its initial budget significantly show that improper estimation of ‘what must be done’ at the planning stage influenced the magnitude of cost overrun encountered on the project. The informants contend that the urgency of the RTS projects may have influenced the decision to go ahead with construction without a realistic estimation of the required activities. The urgency was the fertile ground for the implantation of optimism bias, which effectively stimulates pathogens, and then, confirms the symptoms of planning fallacy. The practice, industry, task and circumstance based pathogens thus influenced the magnitude of the cost overrun that has been reported on the RTS project. The notable insight provided by the exploratory study is that resident pathogens in a complex project environment can work in unison with optimism bias to engender cost overrun.

The case points to the fact that in order to curtail cost overrun on RTS projects, informed decisions should be promoted at the planning stage. This can be achieved by ensuring that life extension studies and risk assessment are compiled without haste before project implementation. Such a mechanism should promote quality management in the design and all pre-construction activities. Provision for adequate planning time should be made by the project sponsors that are not relying on 'strategic misrepresentation / optimism biases' for the commencement of the projects. All key parties to the project should also get involved in the planning processes and inputs from each discipline should receive recognised considerations. The use of a better forecasting method should equally be advocated. However, additional research is required to establish the exact mechanism that would address excessive optimism in planning and pathogens on an RTS project environment. Although this particular case project focused directly on the topic and has been insightful from the client perspective, the single case is a precursor to further multiple studies related to cost overruns in the South African infrastructure sector. It is imperative to conduct further studies so as to eliminate bias and reflexivity errors from interventions that will begin to address the problem in the sector. Future studies would also consider the inputs of other members of the construction supply chain.

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AN ASSESSMENT OF CRITICAL SUCCESS FACTORS FOR THE REDUCTION OF THE COST OF POOR QUALITY FROM CONSTRUCTION PROJECTS IN SOUTH AFRICA

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The cost of poor quality (COPQ) in the construction industry are cost associated with the prevention, discovery, and resolving of defects. These are caused due to failure in preventing defects and wastages during construction work. They arise whether the product is at design stages, manufacturing plants, or in the customer's hand. The main purpose of this research is to identify the critical success factors (CSF) which have the potentials to reduce the COPQ during planning and execution stages of construction projects in South Africa. This study is descriptively designed to obtain the views of construction professionals in regard to the CSF for the reduction of the COPQ in construction projects. A structured questionnaire survey was conducted amongst 60 construction professional to identify the CSF for the reduction of the COPQ in construction projects. This study identified 10 CSF for the reduction of COPQ in construction projects from a list of 41 different CSF classified under five themes. The ten most important CSF were: defining quality objectives (standards and specifications); providing effective leadership; defining quality control mechanism; team development and deploying skilled work force; team work; providing effective leadership; fulfilling health and safety requirements; measuring performance of activities on critical path; improving the productivity of resources and initiating accountability process. The study contributes to the body of knowledge on the subject of the CSF for the reduction of COPQ in construction project in South Africa.

Keywords: cost of poor quality, critical success factors, South Africa

INTRODUCTION

The problem of projects poor quality in the construction industry is a global phenomenon and the South Africa construction industry is no exception. Despite the legislated policies assuring quality products from construction firms by the South Africa Council for the Built Environment (CBE) and other associated quality control bodies to prevent this global construction industry problem, this problem is still very much present. The goal of construction stakeholders in either the public or private sector is to successfully complete the project on schedule, within planned budget, in the safest manner and with the highest quality. Construction projects are frequently influenced by either success factors that help project parties reach their goal as planned- such as attainment of the minimum level of quality required, or poor quality problems that stifle or postpone project completion.

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Over time, scholars (see Morris and Hough, 1987; Pinto and Slevin, 1989) have investigated factors which aid successful completion of projects without any effect on the cost, particularly those which affect project quality success more than others. The concept of success in a construction project can, according to some researchers be evaluated only when the evaluation dimensions are adequately defined (Morris and Hough, 1987). Generally, in any project the evaluation dimensions correspond to the traditional constraints of time, cost, and quality parameters. Ashley *et al.* (1987) defined project success as results better than expected or normally observed in terms of cost, schedule, quality, safety, and participant satisfaction. Therefore, when the results obtained during and after completion of construction projects result in significant cost discrepancies due to poor quality for example, then the project is deemed not successful. Thus, this necessitates the studies of CSF for the reduction of construction projects poor quality in order to achieve results better than expected.

Quality is one of the most important competitive strategic tools which many organizations and national states have used as a key to develop products and services in supporting continuing success. Quality management systems in all industries, are designed to set a clear view for organization to follow, enabling understanding and involvement of employees proceeding towards common goal. In the cycle of never ending improvement which is required in the construction industry as client demand value for money spent in line with the construction professionals mandate and training, quality measurement plays an important role in the assessment and assurance of project successes. The assessment of the CSF for the reduction of the cost of poor quality (COPQ) is considered as a trigger for the improvement of construction project quality, and its associated problems such as rework, disputes, time overruns amongst others. Moreover, no improvement in the associated poor quality issues can be achieved when the CSF to mitigate against the COPQ are not studied to assist in identifying opportunities for improvement. There are many success factors, if addressed effectively can reduce COPQ from construction projects. It is these factors that the current study aims to assess in order to enable the South Africa construction industry address effectively one of the many difficulties faced by construction industries worldwide. As there have not been any known study which has addressed this subject in South Africa.

However, the problems facing the construction industry in South Africa are significantly more fundamental, more serious and more complex. In South Africa, these difficulties and challenges sit alongside the general situation of socioeconomic and political issues which are/were underpinned by the previous apartheid regime of segregation; thus polarising the construction section with various problems. Whilst in all countries, the construction industry faces conditions of uncertainty and risk which are totally different from the causes in South Africa. The sources of such problems in South Africa are even more severe because of the dwindling tax base and other areas demanding attention for spending. Therefore, the objective of the current study is to identify the critical success factors (CSF) which have the potentials to reduce the COPQ during planning and execution stages of construction project in South Africa. The identification of CSF for reduction of COPQ would be helpful for the construction industry in South Africa, as it would present an opportunity for the construction industry stakeholders to concentrate on the identified CSF to reduce COPQ from projects. This will enhance profitability, productivity, compatibility and quality which increases the sustainability of national economic growth, strength and performance of the construction industry. The study is descriptively designed to obtain

the views of construction professionals in regards to the CSF for the reduction of the COPQ in construction projects.

COST OF POOR QUALITY

Quality in the construction industry, according to Goetsch and Devis (2006) is a dynamic state associated with products, services, people, processes and environment that meets or exceeds customer expectations and contract requirements/standards. Whilst Crosby (1979) in his work "*Quality is Free*", states that quality is the conformance to the standards and fitness for purpose. Likewise, ISO 9000 defined quality as "*the degree to which a set of inherent characteristics fulfils requirements*". Similarly, FIDIC (2004) defines quality as that quality (excellence), which meets or exceeds the requirements of the employer, as specified in the contract documents, whilst complying with law, codes, standards and regulatory policy, which apply to the contract. Hu (2004) posits that quality is the symbol of human civilization, and with the progress of human civilization, quality control plays an incomparable role in the mandates of businesses. The definition of Hu (2004) bears resemblance to that of Crosby (1979) which informs that quality must conform to standard and fitness for purpose. Also, Duncan, Thorpe and Summer (1990) posit that quality refers to standards and the ways and means by which those standards are achieved, maintained and improved upon. Whilst quality is key in construction products, it does not necessarily refer to their prestigious attributes, but to the fitness of purpose of the construction projects to the clients and meeting of customer's requirements (Crosby, 1979; Hu; 2004). Harris and McCaffer (1995) emphasize that quality is meeting the requirements of the customer. The benefits of construction quality improvement have long been emphasised by quality management experts and researchers (Love and Li, 2000). Improving construction quality through reducing poor quality activities brings several advantages such as: increased productivity improved morale and increased adaptability in the process of change. Construction quality improvements increase the chance of significant profits to be gained by providing better production quality, which translates into higher expected utility for the customer.

COQ approach was pioneered by Juran (Venters, 2004) as the "*Cost of Poor Quality*" in his "*Quality Control Hand book*" in 1951. In his work, Juran argues that quality issues need to be conveyed in financial terms for executives to really understand and take notice. Subsequently, Feigenbaum (1951) derived the classification called the Prevention, Appraisal, and Failure (PAF) model of cost. In this model, quality costs were divided into prevention, appraisal and failure costs. Furthermore, Crosby (1979) redefined the cost of quality as the sum of "*Price of Conformance and Price of Non-Conformance*". A number of articles published on quality related costs in construction refer to these traditional classifications at least at some level (Love and Li, 2000). However, there are categories of costs which need to be considered during the conception of projects. These include: appraisal costs (costs incurred to determine the degree of conformance to quality requirements), prevention costs (costs incurred to keep failure and appraisal costs to a minimum), internal failure costs (costs associated with defects found before the customer receives the product or service), and external failure costs (costs associated with defects found after the customer receives the product or service). COPQ in the construction industry, is the cost faced due to the production of poor quality products and services. The COPQ are easily traced or identified from the existing accounting reports and auditing system as they are obvious whenever they occur. For instance, Schiffauerova and Thomson (2006) informs that 6-15% of construction cost is found to be wasted due to rework of

defective components detected late during construction, while a further 5% of construction cost is wasted due to rework of defective components detected during maintenance. Also, Chapalkar (2011) states that the nature of poor works/ errors are quite diverse estimating that 20-40% of all construction project poor quality have their roots in errors arising during the construction phase, and a whopping 54% of all construction poor quality defects can be attributed to human factors like unskilled workers or insufficient supervision of construction work. These observations suggest that a thorough quality management of construction activities is needed and that current construction project quality management approaches need to be improved through the assessment of the CSF's that have the potentials to reduce the COPQ in construction projects.

METHOD

The data used in this paper were derived from both primary and secondary sources. The primary data was obtained through the survey method, while the secondary data was derived from the review of literature and archival records. The primary data was obtained through the use of a structured questionnaire aimed at 60 construction professional in Johannesburg to meet the research objectives. The professionals were randomly selected amongst their peers. Survey participants included architects, quantity surveyors, civil engineers, construction and project managers; excluding construction clients and contractors. A list of construction professional who works within the greater Johannesburg Metropolitan Municipality was obtained from the respective professional council and the Council for the Built Environment- the watchdog of professionals in the country via the various professional councils. This approach concurs with the work of Swan and Khalfan (2007) who advise that the inclusion of all construction professionals, is essential for successful project delivery- which applies to the current study. Random sampling was used to select the professionals. According to Kombo and Tromp (2006) random sampling is the probability whereby people, place or things are randomly selected. From the list of construction professionals, 60 were randomly selected. This yardstick was considered vital for the survey in order to have a true assessment of the critical success factors which have the potentials to reduce the COPQ during planning and execution stages of construction project in South Africa. Because all professionals as contained on the list had an equal chance to be drawn and participate in the survey. Out of the 60 questionnaires sent out, 58 were received back representing a 96.7% response rate. This was considered satisfactory for the analysis based on the assertion by Moser and Kalton (1971) that the result of a survey could be considered as biased and of little value if the return rate was lower than 30% to 40%. Because the sample size for this study was relatively small, all groups of respondents were lumped together in the analysis in order to obtain significant results. The data were analysed by calculating frequencies and the mean item score (MIS) of the rated CSF. Although the empirical study is based on a relatively small sample of 60 construction professionals, the findings provide an insight into the general perception of the COPQ in Johannesburg construction projects. The calculation of the MIS is explained in the next section. The research was conducted between the months of July to October, 2013. The questionnaire was designed based on the information gathered during the literature review and does not form part of an existing survey instrument.

Mean Item Score (MIS)

A five point Likert scale was used to determine the CSF which have the potentials to reduce the COPQ during planning and execution stages of construction project in South Africa with regards to the identified factors from the extant review of literature. The adopted scale was as follows: (1) = Strongly disagree; (2) = Disagree; (3) = Neutral; (4) = Agree; and (5) = Strongly agree. The five-point Likert scale scores were transformed to an MIS for each of the CSF as scored by the respondents. The indices were then used to determine the rank of each item. These rankings made it possible to cross compare the relative importance of the items as perceived by the respondents. The computation of the MIS was calculated from the total of all weighted responses and then relating it to the total responses on a particular aspect. This was based on the principle that respondents' scores on all the selected criteria, considered together, are the empirically determined indices of relative importance. The index of MIS of a particular factor is the sum of the respondents' actual scores (on the 5-point scale) given by all the respondents' as a proportion of the sum of all maximum possible scores on the 5-point scale that all the respondents could give to that criterion. Weighting were assigned to each responses ranging from one to five for the responses of 'strongly disagree' to 'strongly agree'. This is expressed mathematically below in Equation 1.0. The relative index for each item was calculated for each item as follows, after Lim and Alum (1995):

$$MIS = \frac{1n_1 + 2n_2 + 3n_3 + 4n_4 + 5n_5}{\sum N} \quad \text{Equation 1.0}$$

Where; n_1 = Number of respondents for strongly disagree; n_2 = Number of respondents for disagree; n_3 = Number of respondents for neutral; n_4 = Number of respondents for agree; n_5 = Number of respondents for strongly agree; N = Total number of respondents. Following the mathematical computations, the criteria were then ranked in descending order of their relative importance index (from the highest to the lowest). The next section of the article presents the findings of the survey and some discussion.

RESULTS AND DISCUSSION

Demographical specifics

From the structure questionnaire survey, it was found that the surveyed professionals' composition were: 10.0% architects, 25.0% quantity surveyors, 20.0% civil structural engineers, and 25.0% construction managers and 20.0% project managers. It was also found that the respondents' are currently handling construction projects ranging from residential, road construction, and civil engineering related projects.

Further findings revealed that 59.0% of the respondents were male while 41.0% were female. This finding thus shows that the orientation of a male dominated construction industry is gradually being revolutionised in South Africa, into an industry where a significant numbers of females are now participating. Howbeit, 80.0% of the reported 25.0% quantity surveyors in the study were females. Also, findings relating to the respondents' ethnic background reveals that Black Africans were 80.0%, while 15.0% were Whites, 2.0% where Indians / Asians and 3.0% were Coloured people of South Africa. The respondents' educational qualification reveals that 53.0% have post-diploma degrees, 27.0% have an equivalent of B-degree and 20.0% with a post graduate degree as their highest qualification. A survey of the respondents' professional registration revealed that 35.0% of the respondents where professionally

registered with different built environment professions, while 65.0% were registered as under the candidate category of their professional route to formal registration as professionals. Also, it was found that 87.0% of the respondents have been working in Johannesburg for more than 10 years, while 13.0% have worked in Johannesburg for a period of less than 5 years. Findings also shows that 45.0% of the respondents work for construction consultant firms while 20.0% of the respondents' works for public sector client (government), while a further 35.% works for contractors. These finding thus reveals that the respondents have a working knowledge of the construction industry/ projects and activities in Johannesburg; hence their opinions on the study objective will be deemed credible. The following sections present the result of the survey findings on the CSF which have the potentials to reduce the COPQ during planning and execution stages of construction project in South Africa with regards to the identified factors from the extant review of literature.

Critical Success Factors for the Reduction of the COPQ

Based on the ranking (R) of the weighted averages, the mean item scores (MIS) for the listed CSF which have the potentials to reduce the COPQ in South Africa construction projects were identified (Table 1-5). The survey findings revealed the ten (10) most CSF from a list of 41 CSF classified under five themes that have the potentials to reduce the COPQ on construction projects in Johannesburg. The most important CSF identified under the planning stage CSF were: defining quality objectives- standards and specifications (MIS = 4.39); providing effective leadership (MIS = 4.20); and team development and deploying of skilled workforce (MIS = 4.13) as shown in Table 1.

Table 1: Planning Stage CSF for the reduction of the COPQ

Planning stage CSF		MIS	RANK (R)
Planning stage	Defining quality objectives (standards and specifications)	4.39	1.00
	Providing effective leadership	4.20	2.00
	Team development and deploying skilled work force	4.13	3.00
	Clearly defining the project objectives (scope, time and cost)	4.12	4.00
	Identification of processes and skills for activities	4.08	5.00
	Identifying technology requirement for processes	4.03	6.00
	Cash flow planning	3.85	7.00
	Defining measurement and testing procedures	3.34	8.00

The CSF scores of the COPQ reduction for the organising stage of project construction were: defining quality control mechanism (MIS = 4.12); team development and deploying skilled work force (MIS = 4.12) and providing effective project management process (MIS = 4.02). Other CSF's include: defining the decision making process and empowerment, use of appropriate technology amongst others as shown in Table 2.

Table 2: Organizing Stage CSF for the reduction of the COPQ

Organizing stage CSF		MIS	RANK (R)
Organizing stage	Defining quality control mechanism	4.12	1.00
	Team development and deploying skilled work force	4.10	2.00
	Providing effective project management process	4.02	3.00
	Defining the decision making process and empowerment	3.76	4.00
	Usage of appropriate technology	3.88	4.00
	Defining organizational structure	3.78	5.00
	Use of integrated procurement systems	3.71	6.00
	Training, development and quality awareness of HR	3.68	7.00

Furthermore, the findings relating to the execution stage as classified include: team work (MIS = 4.32); providing effective leadership (MIS = 4.20) and the optimum use of resources (MIS = 4.05). Others findings include- fulfilling contractual obligations, fulfilling health and safety requirements, employee's involvement amongst others as shown in Table 3.

Table 3: Executing Stage CSF for the reduction of the COPQ

Executing stage CSF		MIS	RANK (R)
Executing stage	Team work	4.32	1.00
	Providing effective leadership	4.20	2.00
	Optimum use of resources	4.05	3.00
	Fulfilling contractual obligations	3.93	4.00
	Fulfilling health and safety requirements	3.87	5.00
	Employee involvement	3.71	6.00
	Fulfilling environmental protection requirements	3.66	7.00
	Exercising transparency in procurement process and transactions	3.63	8.00
	Protecting stakeholder rights	3.51	9.00

The most CSF finding for COPQ reduction relating to the monitoring stages were found to include: fulfilling health and safety requirements (MIS = 4.10); measuring performance of activities on critical path (MIS = 3.93); and measurement of executed works (3.85) as shown in Table 4.

Table 4: Monitoring Stage CSF for the reduction of the COPQ

Monitoring stage CSF		MIS	RANK (R)
Monitoring stage	Fulfilling health and safety requirements	4.10	1.00
	Measuring performance of activities on critical path	3.93	2.00
	Measurement of executed works	3.85	3.00
	Measurement of wastage and reworks (COPQ)	3.80	4.00
	Audit of expenditure and procurement process	3.70	5.00
	Fulfilling environmental protection requirements	3.68	6.00
	Testing of executed works	3.68	6.00
	Measurement of productivity of resources	3.68	6.00
	Measure Variation in planned and actual resource utilization	3.61	7.00

Lastly, the most CSF for the reduction of COPQ at the controlling stage of construction include: improving the productivity of resources (MIS = 4.05); initiating accountability process (MIS = 4.05) and improving the quality of input materials and resources (MIS = 3.98).

Table 5: Controlling Stage CSF for the reduction of the COPQ

Controlling stage COPQ		MIS	RANK (R)
Controlling stage	Improving the productivity of resources	4.05	1.00
	Initiating accountability process	4.05	1.00
	Improving the quality of input materials and resources	3.98	2.00
	Reducing the gap in planned and actual schedule	3.85	3.00
	Reducing the gap in planned and actual cost	3.83	4.00
	Reducing the gap in planned and actual scope	3.73	5.00
	Reducing the gap in planned and actual resource utilization	3.49	6.00

The research findings are not significantly different from findings of other cultural contexts. However, they are peculiar the South Africa construction industry because of the extent of regulation via policies and the various government legislated professional bodies and councils. The ten most important CSF as identified from the above five classification (1) defining quality objectives (standards and specifications); (2) providing effective leadership; (3) defining quality control mechanism; (4) team development and deploying skilled work force; (5) team work; (6) providing effective leadership; (7) fulfilling health and safety requirements; (8) measuring performance of activities on critical path; (9) improving the productivity of resources and (10) initiating accountability process are the topical issues the various regulatory professional councils/ bodies such as the South Africa Construction Industry Development Board (cidb) have been mandated to address since inception. For instance, on the CSF for the provision of effective leadership- the various professional bodies such as the South Africa Council of Quantity surveying Profession (SACQSP) and the Construction Project Management Council have organiser series of leadership training which contribute to the registered professional Continuous Professional Development (CPD) training. Besides, in order to create health and safety leadership, the Construction Project Management Council through the order of the Minister of Public Works have create a separate registration route for professional health and safety managers who will be responsible for leadership in this aspect.

Furthermore, the survey results concurs with the findings of the study of Jha and Iyer (2006), where it was found that defining quality objectives (standards and specifications); providing effective leadership; and team development and deploying skilled work force as factors which could mitigate against the COPQ in construction projects. Also, the findings from the current work concurs with the study of Mahmood, Shahrukh and Sajid (2012) when they found that team work; providing effective leadership; fulfilling health and safety requirements; measuring performance of activities on critical path; improving the productivity of resources and initiating accountability process are CSF for the reduction of the COPQ in construction projects in the Pakistani construction industry. Moreover, Newton (2005) states that resource plan has to be adequately developed and distributed to every section involved in any project in order to ensure the successful delivery of the project, thus avoiding the incidences of cost overruns. In addition, Johnson, Scholes and Whittington (2006) stresses the importance of adequate funding throughout the project which is also highlighted in the current finding. This they informed will ensure that no activity is hampered, due to funding shortages. The importance of contract documentation was highlighted by Kerzner (2006), who suggests that, if no contract is signed, it would be difficult to ensure performance of the necessary activities. This seldom happens, but where there is no adequate leadership to ensure the coordination of construction activities, this can occur. Likewise, the ground breaking work of Ashley *et al.* (1987) on CSF construction project also concurs partially with the current findings. Ashley *et al.* (1987) found that management, organisation and communication; scope and

planning; controls; environmental, economic, political and social; and construction technical are typical CSF's for the reduction of the COPQ in construction projects. Based on the results of studies conducted in other geographical regions such as Pakistan and Brunei, the current results seem to be more or less the same; however, it is the first of its kind in South Africa. These results are important for future research studies in order to observe trends and shifts with regard to the CSF which have the potentials to reduce the COPQ on construction projects in South Africa, using the Johannesburg construction industry as a case study. This study provides a baseline for further studies in South Africa to enable researchers to monitor the CSF which will reduce the COPQ in construction projects.

CONCLUSIONS

The study investigated the CSF which have the potentials to reduce the COPQ in construction projects in the South Africa construction industry, a case Johannesburg. This study identified 10 CSF for the reduction of COPQ in construction projects from a list of 41 different CSF classified under five themes. The ten most important CSF as identified in from the study were: defining quality objectives (standards and specifications); providing effective leadership; defining quality control mechanism; team development and deploying skilled work force; team work; providing effective leadership; fulfilling health and safety requirements; measuring performance of activities on critical path; improving the productivity of resources and initiating accountability process.

The study concludes that there are a number of factors which have the potentials to reduce the COPQ in construction projects in South Africa of which when properly implemented will give the industry an advantage to meaningfully enhance profitability, productivity, compatibility and quality delivery of construction jobs which will boost the sustainability of the South Africa national economic growth and strength and performance of the construction industry. Hence, it is therefore recommended that adequate and effective monitoring of construction projects and provision of feedback by the project team, adequately planning and coordination of construction activities, timely issuing of information, and sound project management skills and periodic quality audit of construction projects should be the main focus of the parties in project construction process. It is believed that the results of this study can be of immense assistance to the construction stakeholders (clients, contractors and consultants) and construction industry academics. The stakeholders can better understand the changing aspects of construction project management and they will be able to make concerted efforts to reduce the incidents of construction poor quality thus avoiding cost discrepancies which can result to dispute and other problems. In addition, the construction industry academics can conduct similar studies in other parts of South Africa and identify the CSF for the reduction of COPQ and the cost of reworks amongst others.

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BARRIERS TO LIFE CYCLE COSTING USAGE

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Life Cycle Costing (LCC) is widely recognized amongst practitioners and academics as a valuable tool in assessing the economic efficiency of constructed facilities. Clients now want buildings that demonstrate value for money over a long term, and are not interested simply in the design solution which is the least expensive. This change has led to and highlighted the importance of LCC approaches to the design, construction and operation of buildings. However, the majority of building designs are still currently produced unsullied by thoughts of maintenance implications, life expectancy or energy consumption. In a forward looking approach, the paper attempts to provide some recommendations that should facilitate and enhance the implementation of LCC in the UK. A questionnaire was distributed to two group samples of 80 practitioners; the quantity surveyors and builders with a total of 70 practitioners (35 aside) completing the survey. The key findings of the statistical analysis indicated that builders ranked the lack of data as the most prevalent problem while quantity surveyors felt it was the lack of a universal framework. The results suggest that there are different opinions and perplexity on issues relating to LCC application. This research will be of interest to industry practitioners and academic researchers with an interest in life cycle costing

Keywords: barriers, life cycle costing, techniques.

INTRODUCTION

Several studies (Pelzeter, 2007; Olubodun *et al.* 2010; Opoku, 2013) have strongly advocated the need to consider the long-term cost of design decisions. Recent guidance for projects procured using the Private Finance Initiative (PFI) or Public-Private Partnership (PPP) routes advocates the use of life cycle costing techniques specifically as they provide an assessment of the long-term cost effectiveness of a project. It can be used as a means of comparing options and their associated costs over a period of time (Cuéllar and Azapagic, 2014) or as a tool for assessing the long term costs of ownership in existing buildings through stochastic modelling and key performance indicators (Kirkham and Boussabaine, 2000a).

Given the capacity of LCC to capture essential information associated with the management of an organisation's assets and the enhancements in decision making competence which it offers, it is rather disappointing that these benefits are not replicated in reality where there is an obvious lack of attention paid to LCC (TRADA Technology, 2008).

Undeniably, numerous studies and in particular Olubodun *et al.* (2010) and Arja *et al.* (2009) all recognised a significant absence of LCC implementation in construction

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operations. Subsequently, several researchers have sought to determine the barriers of life cycle costing methodology (Glucha and Baumannb, 2003; Kishk *et al.* 2005; Swaffield and McDonald, 2008). However, no research has simultaneously enquired about the views from Quantity Surveyors and Builders on the likely barriers of LCC application.

The advantages of using life cycle costs are undeniable. Bouachera, Kishk and Power (2007) in their research project concluded that it enables practitioners and researchers to evaluate long-term effects on different construction schemes. This paper therefore evaluates the barriers in LCC applications in the UK and suggests how the usages can be improved. It also discusses a survey with Quantity Surveyors and Builders, majority of who have worked in the construction industry for over 5 years.

DATA COLLECTION

A survey utilizing a questionnaire was distributed electronically by email to a random sample of 80 practitioners (Quantity Surveyors and Builders) in the UK. The questionnaire comprised three main sections (tables 1-3) each exploring different parts of the research question.

The first section sought information on the respondent's profile as shown in tables 1 and 2. The second section included questions primarily addressing the application of LCC as shown in (see table 3). The third section ranked 13 key challenges identified from the literature. The questionnaire responses were assigned numerical codes and the data was analysed using descriptive and inferential statistics methods in Stata version 12.0

ANALYSIS AND DISCUSSION OF RESULTS

Respondents' profiles

Table 1 show that 50% of the respondents are either Quantity Surveyors or Builders. And that 8 out of 35 Builders have between 0-5 years construction experience, 19 have 6-10 years and 8 respondents with over 11 years' experience.

Table 1: Respondent's response rate and years of experience

Background	Freq	Percent	Cum	0-5	6-10	11 and above
Builders	35	50	50	8	19	8
QSY	35	50	100	14	7	14
Total	70	100		22	26	22

Table 2 below shows that all respondents had a degree in construction related courses while 16 builders and 17 quantity surveyors had a Post-graduate degree although none had a Doctor of Philosophy (PhD). Similarly, 54 professionals (25 builders and 29 QS) were members of the Royal Institution of Chartered Surveyors (RICS), 31 respondents (18 builders and 13 QS) were members of the British Institute of Facilities Management (BIFM) while 59 respondents (32 builders and 27 QS) were members of the Chartered Institute of Building (CIOB). This means that all respondents are suitable to proffer answers to the objectives of the study.

Table 2: Respondent's Academic and Professional Qualifications

Background	BSc		MSc		PhD		RICS		BIFM		CIOB		Total
	0	1	0	1	0	1	No	Yes	No	Yes	No	Yes	
Builders		35	16	19	35	-	10	25	17	18	3	32	35
QSY		35	17	18	35	-	6	29	22	13	8	27	35
Total		70	33	37	70		16	54	39	31	11	59	70

Application of LCC

Table 3 noted that all respondents were aware of LCC application. Most of them (34 builders and 33 QS) were directly involved in LCC application. 67 respondents (33 builders and 34 QS) have used LCC less than 20 times while 2 respondents (1 builder and 1 QSV) have used it between 21 and 40 times, no respondent has used LCC more than 40 times. This shows the limited understanding and restricted usage of LCC. This could be ascribed to the barriers associated with LCC implementation earlier mentioned in this paper.

Table 3: Application of LCC

Background	Often used			Total
	Less than 20	Btw 21 and 40	More than 40	
Builders	33	1	0	35
QSY	34	1	0	35
Total	67	2	0	70

Background	Direct use		Total
	No	Yes	
Builders	34	1	35
QSY	33	2	35
Total	3	67	70

Barriers to LCC

Lack of reliable data

In this survey, the builders stated that lack of readily available and reliable LCC data as the most significant barrier that inhibits the successful practical implementation of LCC (table 4). This factor is ranked second based on the Quantity Surveyors' opinions (table 5). This concurs with the findings by Swaffield and McDonald, (2008) on their research on LCC used by contractor's quantity surveyors on PFI projects and Pelzeter, (2007) who sought the views of real estate professionals on use of LCC in Germany and Sterner, (2000) on their surveys of stakeholders on LCC applications in the construction industry in Sweden.

Lack of common and standard method

Quantity Surveyors as shown on table 5 cited lack of a common method as the major limitation of LCC and one of the key problems that exist in LCC is the lack of an

acknowledged methodology for carrying out an LCC procedure. This factor is ranked second based on the builders' opinions (table 4). The journey towards a standardised method has been muted by practitioners since 1970. However, the construction industry is yet to develop a framework for LCC that is not only universally acceptable, but more importantly dynamic in use as most clients now want buildings that demonstrate value for money over a long term. Subsequently, several researchers have sought to use different methods to deliver effective solutions to the problems of uncertainty quantification (Kelly and Hunter, 2009; Kirkham, 2002; Choong, *et al*, 2002; Kirkham, Boussabaine and Kirkham, 2002). However, there is still no real credible user friendly method in place as the existing frameworks do not enable researchers to forecast future operational and maintenance costs before integrating quantitative risk assessment measures (Creedy, 2006).

Type of investor/user

Most developers are concerned with the initial costs as they do not manage the buildings when completed. This result in a lack of long-term interest in the building operating and maintenance costs and similarly, the lack of capital and the high financial costs and prevailing interest rates can limit investors on advanced investment to cut the operating costs.

Dealing with intangible factors

Dealing with intangible factors is also a very important barrier as the design or component selection decisions can often be taken based on factors other than financial criteria. Most of these factors cannot be assessed in a strict LCC framework. This is mainly because either they are in conflict with the main LCC objective or because they are mostly 'non-financial' (Kishk, Al-Hajj and Pollock, 2001).

Table 4: Builder's level of agreement

Variable	Obs	Mean	Std Dev	Min	Max
Lack of reliable data	35	4.686	0.900	1	5
Lack of common standard	35	3.571	1.170	2	5
Type of investor	35	3.686	1.762	1	5
Dealing with intangibles	35	3.286	1.426	1	5
Lack of procurement award incentives	35	2.714	1.226	1	4
Lack of monitoring	35	2.914	1.222	2	5
Risk and Uncertainty	35	2.486	1.380	1	5
Lack of clarity of LCC principles	35	2.914	1.442	1	5
Lack of fiscal encouragement	35	2.765	1.372	1	5
The industry's relative lack of interest in LCC implications	35	2.171	1.150	1	5
Overabundance of cost models	35	2.229	1.060	1	4
Not required by Clients	35	1.800	0.933	1	4
Market Conditions and Assumptions	35	1.829	0.857	1	3

Market conditions

The prevalent market conditions have momentous influence on LCC. The future is unknown, but LCC encompasses a countless deal of forecasts and assumptions of the future. These include the maintenance and operating costs, rate of interests, inflation, material and component prices. But in truth, these factors tend to change when applied to different interest rates and different scales (Korpi and Ala-Risku, 2008). The uncertainty surrounding the variables used in any LCC model should be eliminated to improve the precision of the approximation.

Risk and uncertainty

It has been widely noted that concerns about using a LCC approach are based mainly on the risky nature of the assumptions on which the forecasts are modelled (Boussabaine and Kirkham, 2008). Whilst forecasting of future costs is to some extent not an inexact science, this should not dissuade analysts and managers from attempting to apply LCC principles (Kishk, Al-Hajj and Pollock, 2001).

Table 5: Quantity Surveyor's level of agreement

Variable	Obs	Mean	Std. Dev.	Min	Max
Lack of common standard	35	4.514	0.853	2	5
Lack of reliable data	35	4.743	0.443	4	5
Risk and uncertainty	35	3.971	1.175	1	5
Market conditions	35	1.800	1.132	1	5
Not required by clients	35	2.371	1.555	1	5
Dealing with intangibles	35	1.714	0.926	1	4
Type of user	35	2.371	1.190	1	5
Lack of fiscal encouragement	35	2.143	1.089	1	4
Lack of monitoring	35	2.629	1.395	1	5
Lack of procurement award incentives	35	2.914	1.442	1	5
Lack of clarity of LCC principles	35	3.114	1.451	1	5
The industry's relative lack of interest in LCC implications	35	3.029	1.485	1	5
Overabundance of cost models	35	2.143	1.216	1	5

Tables 6 to 9 show the Pearson's correlation that was applied to four random factors to determine if there was a significant difference in the opinions of the builders and quantity surveyors.

In the main majority of clients are ill informed about the benefits of a life cycle approach, which can lead to subjective decision-making. Moreover, clients may have

a limited foreseeable use for the building and different organisations may have different expectations of the constructed asset in the future. Therefore, it is critical to understand the expectations of different project participants throughout a project's life and consider the relevant factors which affect the implementation of LCC.

Table 6: Lack of reliable data

Background	Lacofreliabdata					Total
	1	2	3	4	5	
Builders	1	1	1	2	30	35
QSY	0	0	0	9	26	35
Total	1	1	1	11	56	70

Pearson $\chi^2(4) = 7.7403$ Pr = 0.102

This means that there is no significant difference in the opinion of either the builders or quantity surveyors

Table 7: Lack of common methodology

Background	Lacofcomonstd					Total
	1	2	3	4	5	
Builders	0	9	7	9	10	35
QSY	0	2	2	7	24	35
Total	0	11	9	16	34	70

Pearson $\chi^2(3) = 13.2470$
Pr=0.004

This means that there is no significant difference in the opinion of either the builders or quantity surveyors

Table 8: Risk and Uncertainty

RISK AND UNCERTAINTY						
Background						Total
	1	2	3	4	5	
Builders	15	0	9	10	1	35
QSY	2	1	9	7	16	35
Total	17	1	18	17	17	70

Pearson $\chi^2(4) = 24.7059$
Pr=0.000

Note: p-value = 0.000 indicates that the opinion of the builders is significantly different from those of the quantity surveyors.

Table 9: Not required by clients

NOT REQUIRED BY CLIENTS (Notrequiclient)						
Background	1	2	3	4	5	Total
Builders	17	10	6	2	0	35
QSY	15	7	5	1	7	35
Total	32	17	11	3	7	70
Pearson chi2(4) = 8.0787 Pr = 0.089						

Note: At p-value = 0.089, this implies the difference in the opinion of both builders and quantity surveyors is significantly different only 10 percent significant level.

The results from the table 6 to 9 suggest that there are different opinions and perplexity on issues relating to LCC application. Whilst the survey of the barriers of LCC abound, this is the first time a survey of builders and quantity surveyors has been carried out. Builders were selected in particular as there has been an exponential increase in the number of developers and self-build in recent years and most especially with the rapid increase in energy efficient buildings.

The majority of barriers are directly associated to the lack of adequate knowledge of LCC processes and mechanisms. They may also be due to lack of readiness from stakeholders to set up suitable mechanisms to resolve these issues. These and other issues need to be adequately tackled before a higher level of application of LCC can be established.

RECOMMENDATIONS AND CONCLUSION

As discussed above, there are many obstacles facing the practical implementation of LCC. This presents an interesting challenge on exploring new approach that would seek to spread the benefits of LCC and overcome some of the above barriers to LCC adoption. In response, a number of remedial actions have been suggested such as the development of a standardised LCC approach (British Standard Institute, 2008) and the introduction of more Building Cost Information Service (BCIS) cost data sets for life cycle cost analysis

These are also issues which could be addressed by a recognised organisation in the industry such as the RICS and the CIOB. These professional organisations could encourage increased LCC education for their members. It is also expedient to integrate risk and uncertainty in LCC calculations in order to improve the precision of forecasts. Failure to do this would result in not reaping the benefits of the LCC applications, as cost computations would be inexact. Applying these procedures and steps would augment the accuracy of cost forecasts, accelerating the integration into the examination of unanticipated happenings all through the life cycle of the building.

This paper has given an overview of the barriers of LCC application in the UK with suggestions on how its implementation can be improved. This has led to the identification of the most relevant barriers hindering its implementation. It also ranked the opinions of Quantity Surveyors and Builders. This would effectively allow

researchers to be more aware about the obstacles hindering the frequent application of LCC. It is hoped that as a consequence, the industry will make constructive strides towards application of LCC as a mechanism for considering the cradle to grave implications of their work.

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CONCEPTUALISING ORGANISATIONAL RESILIENCE: AN INVESTIGATION INTO PROJECT ORGANISING

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Organisational resilience is a capability which enables organisations to adjust to perturbation, moderate the effects of risk and uncertainty and take advantage of emergent opportunities. The concept of organisational resilience has in the main been developed and operationalized in relation to permanent and stable organisations. The concept is, however, far less applied to project-based forms of organisation, where the temporary, cross-functional and dispersed nature of delivery teams renders some of these concepts problematic. This paper identifies the challenges in applying the concept of organisational resilience to project organisations by systematically reviewing and relating the lines of literature on organisational resilience and project organising. For example, the temporary nature of project organisations hinders learning and knowledge sharing necessary to ensure a dynamic response to evolving threats and perturbations. Other inherent factors, such as the distributed locations of project personnel, also impede this development. This paper goes on to refine the research necessary to develop the concepts so as they respond to the challenges of project-based working.

Keywords: adaptive capacity, organisational resilience, project organising, risk.

INTRODUCTION

Organisations are complex entities which manage and maintain our infrastructure and contribute to the economy and the society as a whole (Seville *et al.* 2006). As such, organisations need to adjust to perturbations and take advantage of available opportunities and mitigate threats (Giezen 2013; Seville *et al.* 2006). Perturbations are major external or internal spikes in pressure beyond the normal range of variability in a system (Gallopín, 2006). The notion of resilience; ‘a functional capacity of a system to manage perturbations’ has been used to reflect the ability of organisations to moderate the effects of risk and uncertainty and take advantage of any available opportunities (Gunderson 2000; Luthans 2002; Folke 2006; Gallopín 2006). However, the notion of organisational resilience has in the main been developed and operationalized in relation to permanent and stable organisations (Luthans 2002; Vogus and Sutcliffe 2007; McManus 2008).

The current promotion of continual improvement and development of innovative ways (Emmitt 2010; Gareis 2010; BSI 2014) of executing an activity or endeavour in both permanent and temporal organisations has called for continual employment of personnel from diverse organisations with complementary skills to come together (Hodgson and Cicmil 2006; van Donk and Molloy 2008) to execute a project, thus,

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forming an unstable and temporary organisation; project organisation (Killen *et al.* 2012; Winch 2013). In a project based sectors such as construction, the employment of the notion of resilience has largely been infrastructure and asset-based focused (Bosher 2008; Boin and McConnell 2007) with minimal or no focus on the personnel who execute the works. However, authors such as Packendorff (1995), Söderlund (2004), Winch (2013) and Giezen (2013) have called for research into developing measures to strengthen these forms of organisations so as to continually withstand future possible perturbations.

Arguably, the temporary, cross-functional and dispersed nature of delivery teams renders employing the notion of organisational resilience in project-based forms of organisations problematic. This paper therefore identifies the specific challenges in applying the concept of resilience in project organising by systematically reviewing the lines of literature on organisational resilience and project organising. The review is divided into three parts comprising defining the notion of resilience and its dimensions in general and in organisations, the identification of the challenges in embedding resilience in project organising, and the suggestions as to the research that is necessary to develop the concept of resilience so as to respond to the specific challenges of project-based working.

DEFINING RESILIENCE

Evolution of the Construct

The first application of resilience in systems was in the 1800's in mechanics (physics) to describe the capacity of steel as a material to withstand stress (Pimm 1984; Alexander 2013). This capacity to 'absorb shocks and maintain function' has come to be known as engineering resilience (Pimm 1984; Holling 1973, 1996; Tilman and Downing 1994). Thus, the focus of engineering resilience is efficiency, stability, predictability and return time to normal functioning (Holling 1973; Walker *et al.* 2004; Folke 2006). The notion of engineering resilience was then employed in psychology in the 1950's to describe how children suffering from schizophrenia could withstand shock (Garmezy *et al.* 1984; Glantz and Johnson 1999).

Another definition of resilience emerged in ecology in the 1970's following Holling's (1973) seminal paper in which he introduced the notion of 'ecological resilience'. This notion captures resilience as 'the capacity for renewal, re-organisation and development' and, thus, focuses on persistence, change and flexibility (Holling 1973, 1996; Folke 2006; Gunderson 2000). Therefore, ecological resilience subsumes the concept of engineering resilience and emphasizes a dynamic adaptive response to change and higher and better levels of functioning (Holling 1996; Folke 2006; Klein *et al.* 1998).

An engineering resilience perspective, thus, implies a reactive focus on building in resistance to or developing response mechanisms for predictive perturbations (Bruneau *et al.* 2003; Rice and Sheffi 2005). In other words, engineering resilience primarily focuses on risk and usually involves the use of mathematical tools in assessing the likelihood and impact of each perturbation (Winkler 1996; cf. Knight, 1921). On the other hand, the ecological resilience perspective implies a proactive focus, on managing both risk and uncertainty; hence the emphasis on flexibility and dynamic and continual development of the system to sustain higher and better levels of functioning (Carpenter *et al.* 2001; Seville *et al.* 2006). In building on these engineering and ecological foundations of the construct and focusing on different targets and research domains, scholars have developed numerous definitions of the

resilience construct. These definitions of the resilience construct, which compete for primacy across numerous research domains stand in the way of a unified understanding of the theoretical dimensionality, antecedents and outcomes of the construct. These issues are discussed in the following subsections.

Review of definitions used in previous research

Growth in resilience research over the past few years has been marked. For example, a Google Scholar search conducted by the authors in April 2014 revealed that research in resilience increased by 10% from 1991 to 2002 and over 60% from 2002 to 2013. A comprehensive review of the studies on resilience reveals 35 emergent definitions of the construct from the engineering and ecological perspectives. The review shows that resilience is clearly a malleable and nebulous term that has been appropriated across a multiplicity of different application domains and blended with a range of other related concepts. Its malleability might explain the enduring utility of the term to account for so many natural, organisational and societal phenomena, including being: a process (Rutter; 1999; Coutu 2002); an outcome (Klein *et al.* 1998; Timmerman 1981); and 'circumstance dependent' (Carpenter *et al.* 2001; Bhamra *et al.* 2011; Gunderson 2000). However, the versatility of the resilience construct has also meant there is, as yet, no agreement on its theoretical dimensionality, antecedents and consequences (McCubbin 2001; Seville *et al.* 2006).

Table 1: Representative definitions of resilience

Author	Focus	Broad Perspective	
		Engineering	Ecological
Klein <i>et al.</i> (1998) p. 259	Coast	-	'The self-organising capacity of the coast to preserve actual and potential functions under changing hydraulic and morphological conditions'.
Bruneau <i>et al.</i> (2003) p.735	Community	-	'Ability of social units to mitigate, contain hazards and carry out recovery activities'.
Holling (1973) p.14	Ecological system	-	'A measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables'.
Bosher (2008) p.13	Infrastructure	'A quality of abuilt environment's capability (in physical, institutional, economic and social terms) to keep adapting to existing and emergent threats'.	
Coutu (2002) p.4.	Individual	-	'The ability to accept, have a strong belief that life is meaningful and that there is the need to improvise'.
Rutter (1999) p. 119;	Individual Child	'A process of relative resistance to psychosocial risk experiences'.	-
Bhamra <i>et al.</i> , (2011) p. 5587	Organisation	-	'Resilience is the emergent property of organisational systems that relates to the inherent and adaptive qualities and capabilities that enables an organisation's adaptive capacity during turbulent periods'.
Timmerman (1981) p. 21	Society	'The measure of a system's or part of a system's capacity to absorb and recover from the occurrence of a hazardous event'.	-
Walker <i>et al.</i> (2004) p. 2	Socio-ecological system	'The capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks'.	-
Pimm (1984) p. 322	Specie	'The speed with which a system returns to its original state following a perturbation'.	-
Rice & Sheffi (2005) p.41	Supply chain	-	'Ability to recover from disruption quickly by building redundancy and flexibility into its supply chain'.
Adger (2000) p. 347	Workgroup/ community	-	'The ability of groups or communities to cope with external stresses and disturbances as a result of social, political, and environmental change'.

Table 1 summarises the main definitions of the notion of resilience reviewed from the 35 emergent ecological and engineering resilience definitions. (Glantz and Johnson 1999; Adger 2000; Gunderson 2000; Rice and Sheffi 2005; Bhamra *et al.* 2011). From Table 1, it can be seen that the definitions of resilience from an engineering resilience perspective, such as those by Walker *et al.* (2004) and Rutter (1999), emphasize stability and resistance during perturbation and, thus, imply hardening the organisation against shocks through building in redundancy or by hardening systems. On the other hand, definitions of the resilience construct from an ecological perspective place emphasis on responding flexibly to perturbations, bouncing back to a stronger, more resilient states (Rice and Sheffi 2005).

There is also a lack of conceptual clarity on how resilience is different from related concepts such as vulnerability, adaptation, and transformation. For example, Janssen *et al.* (2006) define vulnerability as a characteristic of a system which makes it susceptible to possible future harm, a potential change or transformation when struck with a perturbation or stress. A meta-analytic review of definitions of vulnerability by Ionescu *et al.* (2009) identified the key concepts of exposure, sensitivity, coping, persistence, stability, and adaptive capacity as underpinning the dominant interpretations of the vulnerability construct. The concepts of persistence, stability and adaptive capacity are also employed in explaining the notion of resilience (Carpenter *et al.* 2001; Gallopin 2006; McManus 2008; Timmerman 1981). Gallopin (2006) defines adaptive capacity as the common attribute of a system which provides it with an ability to adjust to change, moderate potential damages, take advantage of opportunities and cope with consequences. This is the definition that has also been given to the concept of ‘coping ability’ (Cumming *et al.* 2005). Some authors use the term ‘adaptive capacity’ to refer to the capacity of response of organisations (Seville *et al.* 2006) and ‘adaptability’, for individuals’ capacity of response (Folke 2006) to perturbations; yet others use the terms the other way around (Luthans 2002; Coutu 2002).

The applications of the above dimensions are influenced by the context in which they are applied. For instance, Carpenter *et al.* (2001) points this out by explaining that, the system configuration and interested perturbation drives resilience, hence authors should begin by clearly defining resilience in terms of what to what.

ORGANISATIONAL RESILIENCE

Defining organisational resilience

The construct of organisational resilience suffers from the same conceptual-definitional issues with the general construct of resilience, as discussed above. For example, there is no agreement on what a resilient organisation is. According to Weick and Sutcliffe (2001), the notion of resilience in organisations seeks to promote competence, restore efficacy, and encourage growth through the behavioural processes of mindful organizing enacted by front-line employees; therefore, a resilient organisation is one that is able to do this on a sustainable basis. Mallak (1998) describes a resilient organisation as one which is able to design and implement effective actions to advance organisational development and ensure survival. These definitions, thus, seem to conflate the notion of organisational resilience with that of organisational competitiveness. One definition of a resilient organisation that has gained considerable traction in the literature is as a high reliability organisation (HRO; Weick and Sutcliffe 2001): an organisation which works in highly trying conditions, with few to no errors due to its very flexible systems. The HRO conceptualisation of

organisational resilience has been criticised for (McManus 2008): oversimplifying accidents, hence underestimating accidents and the vulnerability of an organisation to perturbations; prioritising, through its ‘culture of safety’ approach, risk management over uncertainty management. Also, there is as yet no agreement on the source of resilience in organisations: some authors argue that organisational resilience is dependent solely on the resilience of the individual (e.g. Mallak 1998); others argue that individual characteristics do not necessarily justify organisational resilience (e.g. Hone and Orr 1998); and some authors settle for the middle ground (e.g. Bhamra *et al.* 2011).

More crucially, the notion of organisational resilience has to date only been explored in relation to stable and permanent organisations (McManus 2008; Bhamra *et al.* 2011). Within this context, the literature identifies redundancy (i.e. time and resource buffers), organisational learning, co-location and continuity of employment, knowledge management, team development and managerial participation as being central to the development of adaptive capacity (McManus 2008), flexibility (Keong and Mei 2010), coping ability (Vogus and Sutcliffe 2007) and persistence (Hamel and Valikangas 2003); all fundamental tenets of organisational resilience.

However, not all organisations are permanent in nature; temporary organisations abound. Specifically, project-based organisations are used in diverse fields such as advertising (Grabher 2002a), construction (Emmitt 2010) and biotechnology (Powell *et al.* 1999). Winch (2013: 8) defines a project organisation as the “*configuration of permanent organisations coming together to form a temporary coalition to deliver a particular outcome*”. Indeed, it has been suggested that most permanent organisations use projects as the means for organising and executing organisational functions due to the beneficial consequences of this approach, such as innovation and continual improvement (Winch 2013; Emmitt 2010; Gareis 2010). Therefore, it is essential to create and develop resilience in all forms of organisations, specifically projects. However, there is a paucity of research on the theme of resilience in projects; for example, it is not clear what a resilient project is. In particular, the peculiarity of projects may pose significant challenges to the theoretical utility and substantive relevance of the organisational resilience construct in areas such as construction. These challenges are discussed next.

Challenges of employing resilience in projects

The diversity in the definition of the notion of resilience and its ‘circumstance dependent’ (Carpenter *et al.* 2001) nature poses challenges to employing resilience in project organising. For instance, for resilience in ecology, the more species that are available, the more the other species tend to be stable and adaptive in the environment due to contingencies (Gallopín 2006). However, this is not the case with personnel in project organising because Lundin and Soderholm (1995) reveal that, the more personnel from diverse organisations are made to make critical decisions on projects, the more inconsistent and unstable the project is and this is due to interpersonal conflict it creates. Hence, if this analogy is brought into project organising, it might rather impede on the development of resilience.

The most related concept of resilience that could be employed in project organising is the notion of organisational resilience. However, the antecedents which lead to the employment of this notion in organisations are absent in project organising. This is due to the temporary, cross-functional and dispersed nature of delivery teams in project organising (Emmitt 2010). Hence it is essential to explore these challenges and

identify whether the notion of organisational resilience can be embedded in project organising or new avenues should be explored in embedding resilience in project organising.

Concept building towards resilience in project organising

Since the first application of resilience (to describe the capacity of steel as a material to withstand stress) in systems in the 1800's (Pimm 1984; Alexander 2013), there has been a growing recognition of the concept within academic publications. Scholars have developed numerous varying definitions of the resilience construct, which compete for primacy across a number of research domains. These varying definitions of the concept of resilience stand in the way of a unified theoretical understanding of resilience in project organising. Researches such as Boshier (2008), Seville *et al.* (2006), Burnard (2013) and McManus (2008) have also mentioned within their review about the diversity and variation in the definition of the notion. As such, research into unlocking the definition of the notion of resilience and related dimensions (as stated under research agenda in table 2) will enable project-based organisations to attain a congruent understanding of the notion of resilience.

Authors of the notion of organisational resilience explain that, organisational resilience is dependent on fundamental tenets such as the organisational personnel's adaptive capacity (McManus 2008), flexibility (Keong and Mei 2010) and coping ability (Vogus and Sutcliffe 2007) hence, developing the organisational personnel in order to allow organisations to cultivate the essential capabilities is required. However, the time and resource constraint of project organising (Emmitt 2010) hinders the redundancy required to develop these fundamental tenets of resilience (Luthans *et al.* 2002; Braes and Brooks 2010 and Vogus and Sutcliffe 2007) as such, research outlined in table 2; into exploring the potential of redundancy in project organising will provide the awareness and avenues for the development of the fundamental tenets of resilience.

Organisational resilience is based the organisations ability to continually promote knowledge management, situational awareness and organisational learning in order to be able to adapt and take advantage in the face of potential opportunities and certain discontinuities so as to reduce the rate of ambiguity and uncertainty during a perturbation (Seville *et al.* 2006; Carpenter *et al.* 2001; McManus 2008). However, the dispersed, temporary and unique nature of projects hinders the continuity in communication and knowledge sharing required to continually keep project personnel up to date on perturbations. Hence research agenda outlined in table 2 about unveiling avenues for developing continuity amongst project personnel will aid project organisations to adequately manage and be abreast with perturbations.

The efficient employment of the notion of resilience in organisations as stated by Glantz and Johnson (1999), Bhamra *et al.* (2011) and Giezen (2013) is mainly driven by the development of a resilient culture. However, this culture is driven by the leaders and management team. However, swift change in project leaders (mainly influenced by type of project being executed) and the affiliation of project personnel to different parent organisations before, during and after the project hinders the commitment and collaboration (van Donk and Molloy 2008) required sustain and develop the resilient culture to withstand perturbations. Hence, investigating into resilient culture development (as stated under research agenda in table 2) during project execution will aid the efficient employment of the notion of resilience in project organising.

Below in table 2 presents identified issues in project-based forms of organisations which hinder organisational resilience as discussed above together with the emerged research agenda for the efficient and effective employment of the notion of resilience in project-based organisations.

Table 2: Summary of assumptions, issues and research agenda

Assumptions of resilience	Issues in project-based organisations which challenges organisational resilience	Research agenda
Resilience is a malleable and nebulous term	The diversity of definitions of resilience instigates important issues about any common understanding of this construct across research domains.	Unlock the theoretical definitions and the dimensions of resilience
Redundancy (i.e. time and resource buffers)	The time and resource scarcity hinders the development of adaptive capacity (McManus 2008), flexibility (Keong and Mei 2010), coping ability (Vogus & Sutcliffe 2007) and persistence (Hamel & Valikangas 2003); all fundamental tenets of resilience	Explore the potential of redundancy in project organising
Organisational continuity (i.e co-location, permanent, monotonous)	The dispersed, temporary and unique nature of projects hinders the continuity in learning and knowledge sharing required to continually keep project personnel up to date on perturbations	Unveil avenues for keeping up to date on perturbations in project organising
Resilient culture development (managerial participation, team development)	The affiliation of project personnel to parent organisation before, during and after project hinders the development of a resilient culture required to sustain commitment and collaboration amongst project team members during a time of perturbation.	Investigate into resilient culture development in project organising

The above listed research agenda provides a foundation for both theoretical and practical tendencies to embed resilience in project organising to be explored.

CONCLUDING REMARKS

In this paper, a synthesis of literature on resilience has been undertaken to explore the discourse and challenges of embedding resilience in project organising. It has been argued that the characteristic nature of project organising, diversity in resilience definition and circumstance dependent nature of resilience renders its employment in project organising problematic. As such it is essential to explore opportunities of resolving the research issues identified to employ the notion of organisational resilience in project-based organisations. Hence, the identified research agenda form the basis for future studies into developing strategies to facilitate effective resilience implementation in project organising.

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THE TRANSLATION OF POWER: A STUDY OF BOUNDARY OBJECTS IN PUBLIC ENGAGEMENT PROCESSES

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Public consultation and engagement processes have become an integral feature of infrastructure development projects in many parts of the world. Regardless of the drivers behind this trend, legislative or otherwise, a key objective of the process is to facilitate information exchange between affected parties. Somewhat simplified, the process is used by the project team to garner support, collect feedback and address grievances for the project, and by a multitude of stakeholders to voice complaints, lobby for change and secure benefits for themselves. It follows that the process, despite intentions otherwise, is commonly characterised by opposing interests and unequal power relationships that lead to antagonistic standoffs between participants. This paper focuses on what takes place within the engagement process and the format through which information is exchanged. In particular, focus is on the material artefacts that are used to facilitate the information exchange. When used effectively, these artefacts act as boundary objects between participants by allowing them to work together across a diverse range of issues. The paper draws on ongoing research that explores how boundary objects are used in the public engagement process in Hong Kong. The study utilises the Latour-Callon model of 'interessement' to trace how information is translated through boundary objects across a series of engagement events. An argument is put forward highlighting how boundary objects both affect and are affected by power struggles between social groups, and how this in turn affects decision making and goal alignment. In so doing, the notion of the boundary objects possessing inherent properties making them effective communication tools across events is rejected, and replaced by a view that puts more emphasis on how and why they are used by the participants.

Keywords: public engagement, power dynamics, materiality, boundary object, communication.

INTRODUCTION

The impact of any construction project extends far beyond the duration of the project itself. Typically, it may cause significant social and lifestyle changes for members of the local community. In the extreme case, it may adversely impact the livelihood of local inhabitants and irrevocably damage the surrounding ecological system. Because of these possible impacts, the concept of public engagement, which allows for the public community to be involved in the decision making process, has become prevalent around the world. In the case of Hong Kong, for example, demand for public engagement has steadily gained momentum over the past decade in response to societal pressures and growing concerns from civil society groups (Lee *et al.* 2013).

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Although there is no legislative requirement for public engagement, it has become a general expectation, such that nowadays all major public projects in Hong Kong undertake some form of public engagement throughout its planning and conceptual design stages (Cheung 2011).

It has been argued that for the public engagement process to be effective it should comprise of a combination of initiatives including public communication, public consultation and public participation (Rowe and Frewer 2005). In Hong Kong, this takes the form of information being communicated to the public through methods such as 'roving' exhibitions, road shows, and surveys; which are then followed up by participatory team processes including focus groups, workshops, and public forums. This is of course heavily context specific and the balance between communication, consultation and participation varies between countries. But the process can nonetheless be understood as being used by the project team to garner support, collect feedback and address grievances for the project; and concomitantly, by community members to voice complaints, lobby for change and negotiate benefits for themselves and those they represent.

It follows, that it is inherent to the process for individuals to have opposing views. Public engagement events are, as such, often filled with tension that leads to antagonistic standoffs between participants. Because of these complications, although establishing effective communication may be the espoused goal by government departments and agencies, such an outcome may not be easily achievable. Furthermore, at times it seemingly might not be desirable. In the example of Hong Kong, the government has in the past been criticised for manipulating the communication flow; if not the information itself then at the very least the message it represents to the public (cf. Cheung 2011). As well as, asking leading questions in their public surveys in order to obtain more favourable responses (*ibid.*). Together these issues highlight the unequal relationship between participants at these events, and illustrate how the struggle for power manifests in the ways information is handled and controlled.

In this paper we take as our point of departure that for urban development projects, the array of artefacts presented at public engagement events provides the most direct way for the public to scrutinise and comment on the design of a government proposal. Therefore, the extent to which they may be effectively used to convey project information to the public is worthy of deliberation and debate. We introduce the concepts of materiality and boundary objects, and go on to argue that certain artefacts presented at public engagement events may be considered as boundary objects. Attention is then turned to how the theoretical model for boundary objects may be extended to analyse situations where unequal power relations exist. Via two short vignettes we illustrate how studying the use of artefacts at public engagement enables the relationships that agents form with each other to be interpreted. Through the struggles and negotiations over the interpretation of a truth or fact, power relationships that are normally implicit are made explicit.

MATERIALITY AND BOUNDARY OBJECTS

In its broadest sense, materiality can be understood as incorporating both tangible objects such as furniture, documents and project management tools, as well as more intangible things such as social settings, job titles and brand names (Carlile 2006). It could even be argued to include the memory of physical objects that no longer exist,

apart from in memories of how it interacted with its surroundings (Walter and Styhre 2013).

Physical objects constitute a ubiquitous part of the construction process, since the end product of construction projects is a physical artefact. Models, drawings, schedules and claims, reports and even the final constructed building itself, plays an active role in the overall goal seeking, goal formulating and decision making processes. It is ironic therefore, especially when considering decision making as a socially negotiated process, that materiality has been relatively neglected (Tryggestad *et al.* 2010). There is, however, a small but growing body of literature that explores the relationship between actors, objects, and communities of practice in construction (cf. Bresnen and Harty 2010). Relevant examples to the research presented here include papers on how designers formulate their understanding of a design scheme through interaction with various design objects (Luck 2010), how artistic sketches, drawings, photos and models actively mediate the transforming ambitions of a building design (Tryggestad *et al.* 2010), and how office hierarchy and managerial controls play out across embedded and material registers (Sage and Dainty 2012).

To understand how interactions between participants and the material artefacts used in public engagement can facilitate communication across knowledge domains, we examine the concept of ‘boundary objects’. First coined by Star and Griesemer in 1989, ‘boundary objects’ describe objects that intersect multiple social worlds. Multiple agents negotiate different interests with each other through interactions with a series of objects. From this perspective, boundary objects allow agents to create meaning along the margins of their overlapping social worlds. Thus, boundary objects facilitate generalisation across domains by being flexible enough to be able to hold different meanings to different people. Hence, they are “*weakly structured in common use, and become strongly structured in individual site use*” (Star and Griesemer 1989: 393).

Since the original article in 1989, boundary objects have gained impetus within the broader organisational management literature. Objects and tools that have been analysed as boundary objects include timelines (Yakura 2002), product design drawings (Carlile 2002), and project management tools (Sapsed and Salter 2004). Four characteristics have been identified that allows an object to function across boundaries: firstly, the development of a syntactic capacity based on a common lexicon that allows transferring of domain-specific knowledge; secondly, a semantic capacity that creates common meanings for identifying novel differences and dependences and translating domain-specific knowledge; thirdly, a pragmatic capacity that allows for a common interest for trade-off and transforming of domain-specific knowledge; and lastly, a system that supports an iterative approach where actors can develop common knowledge over time (Carlile 2004).

It is important to note that merely being an object used in communications between two social worlds does not automatically make it a boundary object. Objects may embody the relevant capabilities to function as boundary objects, but it is the process it supports for actors to collaborate across boundaries that is of importance (Carlile 2006). The property of things are not inherent to artefacts themselves; instead, they emerge from the network of associations within which they are positioned (Lainer-Vos 2013).

FACILITATING INFORMATION EXCHANGE AT PUBLIC ENGAGEMENT EVENTS

A wide range of material artefacts are used in public engagement programs to facilitate information exchange. These include technical reports, drawings and models; promotional leaflets, posters and videos; design digests; powerpoint presentations; and press releases. Likewise, feedback from the public is captured using another set of material artefacts, namely meeting minutes; discussion summaries written by invited panel members; comment sheets and questionnaires; and video recordings.

The above artefacts, or objects, can be grouped into two main categories: the main design preparation; and a supporting system to allow the design information to be consumed by the targeted audience at the event. The first category, design preparation, can in turn be further subdivided into three stages: (i) the design as a collaborative and evolving conceptual object; (ii) the documentation of that object using the conventional techniques of the professionals in charge; and (iii) the production of a design package that allows the design to be distributed to a large audience.

The design concept is an internal boundary object that is not shown to the public. The public nonetheless has an influence on its development. As design ideas are suggested within the project team, their knowledge and perception of existing powerful lobby groups and influential stakeholders will affect the way information is put together and design decisions are made. As the design concept lays the foundation for the subsequent documentation and distribution processes, relatively small changes to the design at this stage may prove to have significant impact on the final object that is presented at an event. There are multiple ways in which raw design may be documented, and the choice is often informed by the target audience and the message the project team wishes to convey. For example, an architectural vision for a new town center may be documented as a series of masterplan drawings, a 3-D physical model, or architectural perspective drawings (or indeed, a combination of all three). Finally, the way information is packaged also has an impact on how it can be used by participants. For example, brochures and design booklets are designed to be easily portable and are ideal for distribution to the masses; whereas the large size format of posters can better accommodate scaled drawings to be read legibly and for multiple parties to gather around to discuss ideas. Separating the design concepts in their raw form, from the way they are documented and packaged, is necessary because the various ways of documenting or packaging the same design concept may be understood differently and illicit different reactions by the viewer. Furthermore, each stage has distinct features that in turn address communication complexities at syntactic, semantic, and pragmatic levels (Carlile 2004).

While crucial for information exchange at the event, the design package comprises only a fraction of the repertoire of objects that participants will interact with. Indeed, an array of objects are used during events to facilitate exchange of ideas and information, as well as for the purposes of maintaining order and control within what can be considered a fair process. This second category – the support system – consists of two stages (iv) the nexus/meeting point, and (v) the reception and feedback mechanism. Together, they provide the venue and physical locality of the event, and the objects needed to follow established procedures. The impact of the support system is as such extremely varied. For a start, the venue has clear implications for who will be able to attend, as well as its duration and content. As a case in point, ‘roving

exhibitions' consisting of panels showing the design proposal are commonly displayed in an area of high pedestrian traffic flow. Community workshops that aim to allow time for in-depth discussion of issues arising from the design proposal are commonly held in local school halls or other public meeting places that are easily accessible by public transport. At a more detailed level, objects such as the ballot box, feedback sheets, AV equipment and portable interpreter headsets all aid in the process of information exchange. For example, the feedback from participants are collected in open floor sessions where feedback forms completed by participants are entered into a ballot box and drawn out at random, and those that are selected by this format will be given a chance to stand up and voice their views.

Table 1 summarises the progression of stages that various material artefacts need to go through to enable public engagement events to function. Stages (i) – (iii) describe the design objects from conception through documentation to package and distribution, and are a commonplace evolution for design development; while stages (iv) and (v) are specific to public engagement processes. As this paper will show, each stage is equally important to the overall process.

Table 1: Chronological hierarchy of objects used to facilitate information exchange

Procedure	Description of boundary object(s)
(i) Design	Conceptual information in raw or digital form; these objects remain in internal circulation and provide a basis for design development and discussion among the design team.
(ii) Documentation	Presentation of the design, in adherence to the conventions of the professions creating the documents, whether they be technical drawings, maps, textual information, physical models, or 3D perspective sketches
(iii) Package and distribution	The documentation is edited and packaged into brochures, powerpoints, videos, and posters for ease of wide distribution. They may also be incorporated, in part or in whole, into media releases and consultant reports.
(iv) Nexus (meeting point)	Physical attributes of the event, including the time and venue; and technical support such as an AV system to showcase the digitised information, and systems for multi-lingual interpretation.
(v) Reception and feedback	A commonly agreed system that allow participants to express their views and exchange ideas in a fair, orderly, and manageable fashion. The materials used to facilitate this include a ballot system to determine who may speak, and feedback sheets collected at the end of the event.

THE TRANSLATION OF POWER

In an ideal setting, the boundary objects should facilitate effective communication and information exchange between parties. They should, in accordance with Star and Griesemer's (1989) model, also allow parties to interact and achieve a common goal. However, since conflicting interests of participants is inherent to public engagement processes, the common goal will be contested and seldom be readily identifiable. As pointed out by Carlile, "*developing an adequate common knowledge is a political process of negotiating and defining common interests*" (Carlile 2004: 559). It follows that for boundary objects to work effectively in the public engagement setting, they will be required to cross not only knowledge boundaries, but boundaries across

unequal power relationships as well. The fact that the system for public engagement is orchestrated by the government, from the type of information shown to the level of feedback it chooses to note down (Cheung 2011), highlights the power they have over the process. Likewise, the power yielded by certain interest groups and their potential ability to bring proceedings to a halt, should not be underestimated. In short, the way events are enacted demonstrates a system of power (Clegg 1989).

Indeed, each of the stages of information exchange detailed in the previous section is not only developed with a temporal insight of significant past and potentially significant future events; they are actively translated from one stage to the next with input from influential parties. The way boundary objects develop through a process of translation highlights the intimate connection power has over the control of information. This idea of translation of power is advocated by Latour, who argues that the exercise of power should be treated as an effect rather than as a cause. He points out the paradoxical notion that *“when you simply have power – in potentia – nothing happens and you are powerless; when you exert power – in actu – others are performing the action and not you”* (Latour 1986: 264-5). To study power as an effect, Latour proposes following actors around to trace the associations established as various actors conduct tasks to achieve their goals, and through these associations, arrive at a network of actors that, due to their interactions, form a society or a community. In short, such an approach endeavours to understand the social world by tracing the associations that creates such a world (Latour 1987, 2005). Callon (1986) applies this perspective to identify a series of translations where agents form associations and alliances with each other. During this process, certain entities control others, and form the foundations of power relationships. Alliances are formed in a series of ‘interessement’ events. Roughly translating to ‘inter-positioned’ in French, ‘interessement’ describes a group of actions by which one group of entities use their influence to impose or dictate the actions of other entities in order to conform to the way a situation has been framed in their minds (Callon 1986).

The distinguishing characteristic of ‘interessement’ events are ‘obligatory passage points’, which are crucial points that bring entities together to form a system of alliances or associations (see also Law 1986). Clegg (1989) interprets an obligatory passage point as an avenue for each of the three categories in his power circuits framework (‘episodic’, ‘dispositional’ and ‘facilitative’), to interact with each other. It is at these obligatory passage points where entities have the chance to become empowered or disempowered (Clegg 1989). A public engagement event may be seen as an ‘episode’ where a ‘dispositional’ system of power network is made explicit through the mobilisation of a ritualised procedure. During these episodes opportunities exists where, through the process of working with objects, an actor can use an object as leverage to become empowered or conversely, have certain objects used against them and become disempowered.

The idea of ‘interessement’ is something that, although prominent in Star and Griesemer’s original work on boundary objects, has disappeared into the background in later adaptations in the broader management literature. Focus has instead been on the property of the objects and how a physical ‘organisational object’ crosses knowledge boundaries (Lainer-Vos 2013). The alternative approach, and the one that we advocate here, is to instead focus on the process of translation through ‘interessement’ events. This approach focuses on how actors form alliances with each other to guide or alter the trajectory of an object’s development. Doing so allows us to take power relationships between the actors into consideration.

The progression of ‘interessement’ in the public engagement process begins at the inception of the design concept and continues throughout its evolution and development to influence how the information may be digested by the target audience. At every stage of design development, consideration of how it will be perceived by the public will be taken into account, effectively ‘interesting’ the design process. Although the control of information flow resides exclusively with the project team up until the nexus/meeting point, the influences of powerful stakeholders are forever present in the background. These implicit relationships are exposed and made explicit during the event when parties finally meet. Each group of participants who attend this event has an agenda based on their own self-interest, which involves a distinctive set of goals and obstacles. The successful attainment of a group’s goal may be hindered by either conflict with project goals or conflict with the goals of another group. These goals are, in part, progressed through ‘interessement’ events that involve actors interacting with boundary objects. Furthermore, decisions are made through an iterative process in which recurrent actions are taken up and carried through by adaptive actors (Macy 1997). The challenge for boundary objects in this instance is, as previously noted, the need for them to be able to satisfy the needs of divergent sets of goals as determined by individual participants.

DISCUSSION

To illustrate how boundary objects may be conceptualised, how their meaning is influenced and shaped based on the circumstance of their use, and how their usage constitute ‘interessement’ events that highlight power *in actu*, we draw on two small vignettes extracted from an ongoing multi-case study research.

VIGNETTE: COMMUNITY WORKSHOP

At the audience feedback session conducted towards the end of a community workshop, some participants expressed considerable criticism towards the way in which the planning scheme was presented during meetings – the schemes were presented as standard zoning plans, accompanied by architectural site cross sections and some artists’ renditions. The criticism was that:

“We cannot understand the blobs and the squiggles of this so-called zoning plan; it doesn’t show the height or the real impact, so why don’t you come back with a 3D perspective and then we can have an honest discussion.”

The frustration voiced by this participant highlights the difficulty of communicating technical drawings and design information through any representational medium to laypersons. It also implicitly demonstrates the power that is associated with the control of information. Whether intentional or not, the method of representation directly influences an actor’s ability to use the object. A similar argument can be found in the results of a focus group study conducted by Woodcock *et al.* (2012), which gauged the reaction of local residents to different types of architectural representations. The study found that, if buildings are represented as solid blocks with little architectural details, the laypersons will likely misinterpret the height and bulk of the proposed development. Yet, if they are shown an architectural 3D rendering, they are likely to conclude that they are being misled by developers, that the built reality will not reflect the version shown to them in the focus group, and that the drawings are used to seduce and manipulate them into agreeing to a scheme they may later regret.

What our vignette and the findings of Woodcock *et al.* (2012) have in common is that they both illustrate instances where actors fail to use the objects to convey technical project-specific information. The barrier to knowledge exchange at the documentation level has effectively obstructed communication at the design concept level.

VIGNETTE: PUBLIC FORUM

During the Q&A section of a public forum, speakers voiced their concern that the completed development will not match the images shown in the video, and that the numbers published in the socio-economic study were incorrect. When these technical details could not be agreed upon, hostility began to be directed towards the format of the forum, personal attacks were made on the mental capacity of the facilitator, and the legitimacy of the ballot box was questioned. At this event the AV technicians controlled the use of the microphone and were able to switch it off after the allocated time, if the member of audience refused to stop speaking. This ‘privilege’ was used increasingly frequently as the event progressed and speakers in the audience began to ignore the 3 minute rule. This display of *power in actu* demonstrates how one technician’s relatively minor supporting role may have a major impact on the flow of information. Following the incident with the microphone, some of the other boundary-objects-in-use began to lose the ability to sustain a set of ‘common lexicon’ (Carlile 2004) deemed necessary for knowledge transfer. For example, a few participants declared that the ballot was unfair because the ballot box was somehow rigged, despite the fact that the box was made of clear plastic and completely transparent.

In the above description, the focus is shifted from the design information to items that symbolise the event: the format (which was predetermined by the project team); the facilitator; and the ballot box. Hence, the boundary objects include both artefacts (eg. the ballot box) and systems of organisation (eg. the microphone system) that allowed information to be conveyed at different levels. These systems for communication are especially important since the information is not the only artefact that the participants will interact with at the event. In such a regimented environment, numerous forms of materiality play a role in the task of communicating between parties, effectively qualifying them as boundary objects. Each of the boundary objects used in the above ‘episode’ of power struggle were manipulated by the user to empower themselves while simultaneously disempowering their opposition.

CONCLUDING REMARKS

By systematically categorising the types of boundary objects used during public engagement processes and by drawing attention to the interaction between agents and artefacts, we have sought to define and conceptualise how systems of objects and material artefacts contribute to the formulation of information exchange in public engagement processes. We have illustrated that merely being a material artefact that is used for communication between two social worlds does not automatically make the artefact a boundary object. The willingness of the participants to interact with the artefacts, and the identities they give to them, has a decisive role in determining how effectively the artefact will be able to cross knowledge boundaries. When agreement cannot be reached on the meaning of a boundary object, they cease to be effective communication tools, and might be turned into a ‘bludgeoning tool’ instead (Carlile 2002: 452). This is not dependent on any inherent characteristics of the artefact, which may be controlled, but rather on the interactions between artefacts and agents, which cannot be controlled and is built upon a dynamic relationship between artefacts, its creators, and its targeted audience. Thus, we argue that to study boundary objects

necessarily involves studying the creation and transformation of the object over time and identifying ‘interessement’ events throughout this evolution. The influence that participant groups have on a project will in turn influence the formulation of these artefacts. It follows that there is a need to trace how decisions are made in the public engagement process, by studying the active involvement of boundary objects.

We have argued that the dynamics of information exchange and goal formation changes and is adapted depending on the circumstances surrounding its discussion, and that material artefacts play an active role as boundary objects in facilitating the dialogue between parties. Although we have progressed the argument that power struggles between parties may hinder the process of information exchange, it is important to remember that power struggles should not be seen as an antithesis to the goal of information exchange. Instead, we view the process of information exchange as a socially negotiated process that is heavily dependent on the quality of interaction between participants, and argue that power dynamics is one such contributing factor that may play a role in manipulating or influencing the outcome of decisions.

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RECASTING COORDINATION: A THEORETICAL REVIEW IN THE CONTEXT OF DESIGN-BUILD PROJECT ORGANISATIONS

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Coordination, and the lack of it, is frequently ascribed as a key role in successful and less successful building processes. Over the last four decades, the understanding of coordination has shifted from emphasizing formal structures to emphasizing informal mechanisms. A review of four articles shows this development as well as how the formal and informal structures and mechanisms relate. The review is done from a perspective of a large design-build project in Denmark. The review indicates, that formal and informal coordination mechanisms alone are not sufficient to explain coordination in practice. The main coordination mechanisms discussed are mutual adjustment, direct supervision, standardization, relational coordination, adaptive capacity, and IT as a tool to accomplish task and impose a chronological rhythm and schedule on the work processes. From this point of departure a new set of coordination mechanisms for practice is developed rooted in current institutional theory. The mechanisms are internal building of an institution and external building of relationships between a number of institutions. The conclusion is that existing literature on coordination does not fully describe the complexity of coordination in an institutionalised design-build organisation and that a new set of coordination mechanisms rooted in institutional theory contributes to our understanding of complex coordination.

Keywords: coordination, Mintzberg, relational coordination, institutional logic, institutional work.

INTRODUCTION

Coordination is central to design build processes in construction (Apelgren *et al.* 2005, Hemphill 2010, Jones and Lichtenstein 2008). Early discussions of coordination included formal mechanisms such as standardization of work processes, skills, knowledge, and products; direct supervision and informal mechanisms such as mutual adjustment (Mintzberg 1979). While these theorizations appeared useful to a functionalist perspective of large organisations in the manufacturing industry, they were more problematic when applied to volatile project organisations, such as a design-build contractor. A design-build organisation is characterized by temporary project teams made up of actors from different organisations each representing different professions, norms, values and responsibilities (Jones and Lichtenstein 2008, Kadefors 1995). In that light, coordination is the interactions and structures that bring together related, yet spatially, socially and/or temporally separated, work elements. In the following we review four contributions on coordination including Mintzberg

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(1979) (1983) who studied coordination in manufacturing organisations, Melin & Axelsson (2005), who studied AutoCAD's role in coordination in a building firm, Gittel (2008) who studied relational coordination in nursing homes and Hemphill (2010) who studied coordination in a project organisation in civil engineering. Recent contributions to the field of institutional theory emphasize how most organisations are affected by a number of norms or institutional pressures to which they must relate (for example Greenwood *et al* 2011, Smets & Jarzabkowski 2013). However, where literature on coordination falls short on sufficiently including the impacts of organisational institutional environments, institutional theory appears short of explicitly addressing organisational coordination mechanisms.

The aim of this paper is to contribute to a framework for coordination in project based organisations embedded in complex institutional environments.

The paper's main contribution is a qualified set of coordination mechanisms that go beyond the formal, informal, and actor centered understanding of coordination and embeds coordination into institutional theory. Also, the paper contributes with a discussion emphasizing the complexity of the relationship between coordination and management.

METHOD

The literature review presented in this paper forms part of a Ph.D. study by the first author also involving a case study of a design-build project and the development of an institutional framework of understanding (Urup 2014). The presentation in this paper is a preliminary version of the still ongoing review (Bryman 2008) guided by the also ongoing study of design built processes and institutional theory. The literature review is selective and preliminary and takes its starting point in Mintzberg's extensive work on coordination mechanisms in management and organisations. Through snowballing (Jahali and Wohlin 2012) and database searches pieces of literature on coordination were found, including the key articles by Gittel (2008), Melin and Axelsson (2005) and the dissertation by Hemphill (2010). Together these represent qualitatively interesting contributions important in this context, rather than providing breadth and depth in any comprehensive way. In the following section we review the literature based on a set of criteria (Hart 2009) that are interpreted to be important in the light of extending our understanding of coordination in an institutional theoretical framework within a design build context. The limitations of the present contribution are the use of a few central sources for the literature review rather than a more comprehensive literature search and review (see Maclure 2005 for a discussion). More specifically we have chosen to disregard quantitative and economically oriented concepts such as social network analysis (Hossain 2009), as well as social action and social embeddedness (Jones & Lichtenstein 2008) as it require too much space to give the differences and similarities to an institutional approach justice (Suddaby and Greenwood 2009).

FRAMEWORK OF UNDERSTANDING

In the following we develop our framework of the main characteristics that we review in the literature on coordination (Hart 2009). The framework consists of the following dimensions: definition of coordination; paradigmatic position; agency; coordination mechanisms; relation to institutions; project based organisations; management/leadership; and IT.

First, the definition of coordination is important. There are several closely related concepts aiming at describing interaction involved in carrying out work. These include, apart from coordination, also collaboration, communication, cooperation and management (see for example Dewulf and Kadefors 2012, Hossain 2009). Hence, it is important to position a definition of coordination. One can find coordination aspects in many building project activities. Previous reviews, such as Jha (2004), find more than fifty types of coordination activities and De Saram & Ahmed (2001) more than sixty. However, we contend that such broad definitions are at risk of losing explanatory strength.

Second, and in addition to the definition, it is important to scrutinize the theoretical positioning of coordination. A particular theoretical positioning would often ontologically concern the issue of internal and extra organisational context, while epistemologically it would often concern the issues of understanding the relationship between structure and agency (Burrell and Morgan 1977). The paradigmatic embeddedness of the reviewed literature may be weak or strong and this offers the opportunity to carefully consider how a particular coordination mechanism may be translated in an institutional theoretic framework (see below).

Third, the understanding of agency is important. As coordination focuses on interaction, it is central to ask between whom and/or what the coordination occurs. Some would understand coordination as interpersonal (methodological individualist, Emirbauer & Mische 2007), others would perceive it is at a combination of structural and agency oriented elements (Mintzberg 1986). Others again might argue for interaction between both social and material elements and understand agency as centered in networks (Callon 1986) or as embedded in social relations (Jones and Lichtenstein 2008).

Fourth, the coordination mechanisms themselves are of course central. In reviewing the literature, we note that it is more common to provide a concrete set of mechanisms for coordination, like Mintzberg's (1986) five, which structures his entire argument. Across the reviewed literature there appears to be no limitations to the types of mechanisms (see also Jha 2004, De Saram and Ahmed 2001). However, as with the definition of coordination, the broader the conceptualization of coordination mechanisms, the weaker the concept's analytical power. Furthermore, the level of empirical support may weaken or strengthen a particular contribution's identified coordination mechanism.

Fifth, the relation to institutions is relevant. An institution, can be defined as a 'more-or-less taken-for-granted repetitive social behaviour that is underpinned by normative systems and cognitive understandings that give meaning to social exchange and thus enable self-reproducing social order.' (Greenwood *et al.* 2008, pp. 4–5). The recent development of institutional theory includes institutional work (Lawrence *et al.* 2009), institutional complexity (Greenwood *et al.* 2011) and institutional logic (Lounsbury & Boxenbaum 2013a, b, Thornton *et al.* 2012). These contributions have reopened a discussion of agency: some liberating it from its earlier institutional embeddedness; others convening structure and agency as structuration (Thornton *et al.* 2012). In this discussion, there appears to be a possibility to translate previous concepts of coordination into an institutional framework. This framework may provide a new understanding of organisation and organisational processes suitable for the analysis of a design build project organisation.

Sixth, considering the contributions related to project based organisations is important. Coordination in project-based organisations is here assumed to, first to, occur internally within each of the projects which is both intra- and interorganisational. Secondly, coordination occurs externally between projects in the each of the individual organisations that are part of a building project set up. This need for coordination is due to the fragmentation of competences and contradictory dynamics within the individual organisation and the in the project organisations (Koch and Bendixen 2005). Besides, we are also interested in the longer-term coordination between projects, completed as well as concurrent, as well as between projects and the established departments of a project based organisation.

Seventh, management and leadership can frame, enable and constrain, the acts of coordination. Kotter (1996) characteristically distinguish between management and leadership by pointing at two types of management: leadership is concerned with driving change, whereas management is concerned with administering existing organisations. Coordination would play a role in both.

Eight, IT would usually embody standardised routines which enable efficient coordination when the IT-routines mirrors the actually practices. Also, IT facilitates coordination through change of the organisational routines by providing new ones embedded in software. Communication supporting IT would enable linking separated work elements in time and space. More specifically in a design build context, building information models enable identification of collisions between collaborators design and transfer of complex information among others (Guo *et al.* 2013).

RESULTS

In the following we present a table summarizing the findings of the literature review.

Table 1: Findings of the literature review

	Mintzberg	Gitell	Hemphill.	Melin & Axelsson
Definition of Coordination	No explicit definition. The structure of an organisation is the division of tasks and coordination between them.	Coordination is management of interdependencies between tasks.	Coordination is the organisation of different elements of a complex body or activity so as to enable them to work together effectively.	No explicit definition developed.
Paradigmatic Positioning	Functionalist view with assumptions of given management prerogatives. Focus on structure.	Phenomenological approach. Focus on agency.	Social constructivist approach. Focus on agency.	Interpretive social constructivist approach. Focus on agency and structure.
Agency	Human individual. Dominant agency is management	Collective human. At management and operational level.	Individual human and non-human. At all organisational levels.	Non-human. At all organisational levels.
Coordination Mechanisms	Mutual adjustment. Direct supervision. Standardisation of output, skills, norms.	Frequent, timely and accurate communication. Shared goals, knowledge. Mutual respect.	Adaptive capacity: perspective-taking, communication, shared objects, affect, and multi-membership.	IT provides: tool to accomplish tasks, rhythm to work processes, technical vocabularies.
Relation to Institutions	Structure focus fits classic institutional theory	No structure, no explicit relationship. Implicit, institutional entrepreneurship.	No structure, no explicit relationship.	Combined structure and agency fits institutional logics and work.
Relation to Management & Leadership	Managers and leaders privileges to some degree free of structure.	Managers and leaders free of social structures.	Managers and leaders free of social structure.	IT results in structure which affects managers.

The compilation of the results in a brief table like this one drives simplification as several of the authors incorporate nuances and ambiguity into the very center of the argument and conceptualization. Some notable results of the review (entered in the table 1) are that definitions of coordination are not precise, or even absent, that paradigmatic positioning and understanding of agency differ considerably. Whether project based organisations encompasses special coordination forms are not dealt with and therefore asks for a conceptualization. Only Melin and Axelsson is providing an understanding of the coordination role of IT, an understanding that can be expanded

from their main example of CAD into projectmanagement software and in principle also other types of IT.

A number of coordination mechanisms are identified that is further discussed below. Some of them overlap like Hemphill understanding of shared object and Melin and Axelssons understanding of IT. Also the relationship to management and to institutions is dealt with below.

DISCUSSION

Coordination and institutional theory

The aim of the literature review is to position coordination in an institutional framework. While Mintzberg doesn't explicitly develop a definition, his understanding of organisation as structure would sit well with classic institutional theory. Contrasting Mintzberg, Gittel's definition of coordination and understanding of organisation is human-agency-centred and would sit well with institutional entrepreneur/agency theory. Hemphill's definition of coordination and understanding of organisation is very broad not indicating any limitation to who or what can coordinate. This paradigmatic positioning is complicated from an institutional point of view given its broad approach to agency and lack of recognition of structure. Therefore, these three texts do not explicitly contribute much to the development of a current institutional understanding of coordination. However, if we decouple each of the coordination mechanisms from their respective paradigms, they may be able to inform an institutional understanding of coordination after all. In that light, we would contend that both structural and agency oriented coordination mechanisms would sit well with a structuration oriented understanding of institutional work and logics (Lawrence *et al.* 2009, Thornton *et al.* 2012). This means that routines, standardisation of process and products, relational coordination and adaptive capacity could be included in institutional structures, ie. the organisational norms. Melin and Axelsson (2005) do offer some preliminary considerations as to how structure and agency may be combined in a coordination context that sits well with institutional work. They call for a more sophisticated development of Mintzberg's notion 'Mutual Adjustment', and thus his understanding of informal communication, and discuss how informal communication relates to formal structures imposed by IT (CAD). Further, they implicitly offer an understanding of coordination that sits well with a broader current institutional framework including both institutional work and logics: "*If an information system or an organization contains a coordination logic, principle or pattern not harmonious with each other, competing forces, for example, can be a part of human actors' use of information systems.*" (Melin & Axelsson, 2005: 9). However, Melin and Axelsson do not explicitly define coordination, implicitly they offer a definition by referring to Mintzberg. Also, with a focus entirely on a particular IT application Melin and Axelsson's understanding of coordination fails to capture the entire complexity that characterizes coordination in organization influenced by many institutional logics. In a complex institutional context the issue of interactions bringing different institutions together in various relationships is central. These relationships could be characterised by either conflict, enabling compromises or more profound mergers of different institutions (Lawrence *et al.* 2009 Thornton *et al.* 2012, all of which would imply different coordination mechanisms.

Coordination and design-build project organisations

If we consider an institutional understanding of coordination in the context of design build projects, we see that Mintzberg's understanding of project based organisations as "*merely*" being dominating by adhocracy and mutual adjustment underestimates institutional complexity of project based organisations (Urup 2014). Design-build project based organisations would, despite their label, often imply a hybridisation between vertical organisational hierarchies including for example centralisation of certain tasks, networks of professionals and temporary projects teams for specific tasks, such as discussed by Hemphill (2010), Koch & Bendixen (2005) and Urup (2014). The reviewed literature therefore does not adequately address the complexity and specific kind of coordination between projects and the organisations (ie. the hierarchy of the headquarter).

Furthermore, Mintzberg's "*mutual adjustment*" appears to assume an equal power base. This presents another underestimation of the complexity of coordination. Also, Mintzberg's conceptualization of standardization would require a less complicated pattern of institutions and more stable organization. Gittel's position appears to be that collective human agency can exercise relational coordination free of any pre- or coexisting norms and this falls short of appreciating the full complexity of design-build projects. Hemphill may recognize the complex nature of negotiation and compromise in practice, but removes it from considerations regarding structure.

We content, that there is a need to expand the concept of coordination in order to capture the complexity that characterizes a complex institutionalized design-build organization. A definition of coordination positioned in a complex institutional context would be: coordination is the interactions and structures that bring together related, yet potentially spatially, socially and temporally separated, work elements.

Fundamental to our definition of coordination is the understanding that coordination occurs through agency and structure, thus expanding Okhuysen and Bechky (2009; 908) review summarizing definitions of coordination into three common elements: people work collectively, the work is interdependent; and a goal, task, or piece of work is achieved. And also appreciation a shift in focus to the combination of process and structure, or coordinating and coordination, expanding Jarzabskowski *et al* (2012) and other one sided views. Our notion of agency is oriented towards negotiation and mutual adjustment, in an expanded version that includes relational coordinating and adaptive capacity, while structure is oriented towards material means such as routines, standards, and IT. As such we end up with a composite concept for agency and structure respectively. Agency is characterised by networking or interaction in dynamic webs, while structures are constituted both materially and immaterially.

Based on this definition we may consider a number of new coordinating mechanisms that relates to institutional work and institutional logics and we propose the following two mechanisms: the internal building of an institutional logic or an institution in the making; and external building of institutions by establishing relations between a two or more institutional logics or institutions. A decoupled mutual adjustment concept would fit with the external blending of logics/institutions and could also encompass a view of the role of mutual respect. IT artefacts (CAD and project management software) can introduce concerted rhythm to work processes and act as a shared meaning artefact which would at a time contribute to internal consolidation of a logics as well as work as cross logic integrative mechanism.. Standardisation of output, skills, norms would be instrumental for internal building for an institutional logic, but

would in many project contexts collide with the fragmented multi logic constellation. Further conceptualisation of institution building coordination can be done. The building of complex institutional logics is institutional work and requires a consideration of how the role of organisational managers and leaders is connected to coordination. The relationship between coordination and management is often unclear in the reviewed contributions, most explicitly when Mintzberg (1986) proposes direct control as a coordination mechanism, and when Gittel (2008) defines coordination as the management of interaction. Rather than suggesting and aiming at definitional purism we tend to accept this unclear relation, which also refers to our understanding of coordination as occasionally inbuilt in other entities such as routines, structures and IT. However, we contend that a conscious distinction between coordination and management/leadership may be useful in order to clarify their definitions respectively. But it is beyond the scope of this paper to develop a new definition of management and leadership, perhaps we could extend a call for future research to consider this study.

CONCLUSION

Our review of four pieces of literature on coordination showed that the complexity of coordination has been downplayed either by a too narrow focus on either structures or agency. One article acknowledged the interplay between structure and agency, but downplayed the complexity of coordination by only considering IT as structure in relation to agency. Our main contribution here is a new definition of coordination that is rooted in current institutional theory and acknowledges the complexity of a complex institutional organisation such as a design-build organisation. It understands coordination as related to internal building of (new) institutions or maintaining them as well as bonding two or more institutions to each other. We extended our definition to develop these two new coordination mechanisms that include both the internal building of a particular institutional logic/ institution and the building of a constellation of institutions constituted by a number of institutional logics/institutions.

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ALLOCATING PROJECT MANAGERS TO PROJECTS IN A MULTI-PROJECT ENVIRONMENT

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A recent empirical study demonstrated that the process of allocating project managers to projects (PM2P) in multi-project environments of Botswana was not effective. This inspired the authors to seek to understand the structure of the PM2P process with a view of proposing improvements to increase effectiveness. A conceptual model was developed and used in this study, which focusses on using the developed model as a theoretical lens to study the process in a large company, using the case study method. Via an enumeration, qualitative and quantitative data were collected from four project directors and eleven senior level executives through in-depth semi-structured interviews. The analysis of the quantitative data (using univariate descriptive analysis) and qualitative data (using content and thematic analysis) revealed weaknesses in the existing PM2P process demonstrated in five ways namely: (1) absence of documented and specific competencies required of project managers in various roles, (2) lack of management tools and techniques to match project managers to projects, (3) prevalence of ad-hoc projects, (4) lack of consideration of a comprehensive list of inputs and (5) lack of accountability for outputs. The strengths in existing PM2P process were demonstrated in two ways namely: (1) use of management tools and techniques at strategic level to forecast project implementation costs for projects in the pipeline, and (2) managers' recognition of some important criteria to be considered in the PM2P process. The findings provide a strong basis upon which a decision support system can be developed to facilitate a more effective approach to allocating project managers to projects in the multi-project environment of the case study in question. Other companies that undertake business in a multi-project context may benefit from this work.

Keywords: allocation, decision making, project manager, multi-project environment.

INTRODUCTION

Seboni *et al* (2013) identified the problem of lack of effective PM2P allocation processes, and the impact on Botswana's private and public sector organizations' performance. The outcome of that previous empirical study was that the PM2P processes were informal, not objective, not comprehensive and lacked a good match between project managers and projects. The link between these practices to certain performance variables (e.g., project manager performance, project success, project manager rewards) was also established in terms of positive and statistically significant correlations. These findings pertain to 12 out of 15 eligible project based companies in Botswana, which included the Case study in question as regards the current study. The term 'effective' is used in the context of improving the quality of the PM2P allocation process, leading to improved company performance (Jugdev and Muller 2005). The

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basis of the research problem was the author's anecdotal observation regarding a lack of effective PM2P approaches in a specific company based in Botswana. This was strengthened by a critical appraisal of the limited literature specific to PM2P allocations in multi-project settings, majority of which were predominantly focussed in USA high-tech industry and specific to new product development projects (Patanakul 2004, Patanakul *et al* 2004). The empirical study conducted in Botswana (Seboni *et al* 2013) also confirmed the author's anecdotal observation. This currently underexplored area was broadened by drawing from well-supported management and organizational theories. For example, the universal theory of resource management (Owusu *et al* 2007), which encapsulates other theories such as resource planning, scheduling and allocation (PMI 2008).

A conceptual model for understanding the PM2P allocation process was developed (Seboni and Tutesigensi 2014) by modifying existing models, incorporating broader reviews of cognate fields of inquiry to address gaps in existing PM2P allocation models e.g., inclusion of some significant additions in terms of criteria to be considered and feedback loops between the model components. The model was used in this study to examine the PMP2 allocation process of a large company in the context of Botswana, as part of building on existing framework to include a different contextual perspective as regards a different country, industry and project types.

Given that research must be done within a certain context that suits the research problem, justification for using Botswana as the contextual basis for this study are: (1) strong empirical evidence from a previous study (Seboni *et al* 2013) that validated the existence of the research problem across 12 out of 15 eligible private and public companies, (2) the need to extend existing framework to other countries, (3) the author's familiarity with Botswana as regards reducing the challenges of data collection, (4) the need to give back to Botswana, since the research funding comes entirely from Botswana. Empirical studies on PM2P allocation models, applicable to multi-project environments (the principal focus of this study), are currently limited and focussed predominantly on one country and industry (Patanakul 2004). For example, six empirical studies that directly propose PM2P allocation models were conducted in USA high-tech industry alone, published between 2003 and 2009. The closest to these six studies are four studies conducted in Israel (Hadad *et al* 2013), Iran (Sebt *et al* 2010), Thailand (Ogunlana *et al* 2002) and Egypt (El-Sabaa 2001), in the context of the construction industry, but not explicit to multi-project environments.

Notwithstanding this currently underexplored area, this is an important topic because of the significant impact of the PM2P allocation decisions on company strategic value, particularly in view of the link between projects and strategy (Olsson 2008), directly visible in a multi-project environment and in the realm of senior management's attention. The term 'multi-project environment' is used in relation to: number of concurrent projects to be implemented as a vehicle to deliver the company's strategic goals, presence of clear links between projects and company goals, and degree of investment involved with the projects in question. Management in many project-based companies make PM2P allocation decisions informally in practice, on the basis of intuition (Patanakul *et al* 2007, Seboni *et al* 2013), despite this decision being among the critical project success factors (Pinto and Slevin 1988, Brown and Eisenhardt 1995, Seboni *et al* 2013, Hadad *et al* 2013). Some of the key reasons for this practice are attributed to lack of management tools and techniques to objectively match project managers to projects, lack of sufficient information and time (Kabli 2009). This implies that a project can fail or succeed, based on PM2P allocation effectiveness. The

importance of this study, which is among the first to empirically examine the PM2P allocation practices of a large multi-project company in Botswana, is even more crucial because of the significant contribution of the chosen company's project types to national Gross Domestic Product (GDP). The word 'large' is used in the context of project budgets and annual revenue generated by the company's projects, relative to global value of mineral resources. Revenue from these projects contributes approximately 30% to national GDP, in the context of the economy of Botswana (DeBeers 2012). It therefore, becomes critical that the right project managers are allocated to the right projects.

Conceptual model for understanding the PM2P allocation process

The conceptual model used in this study is shown in Figure 1.

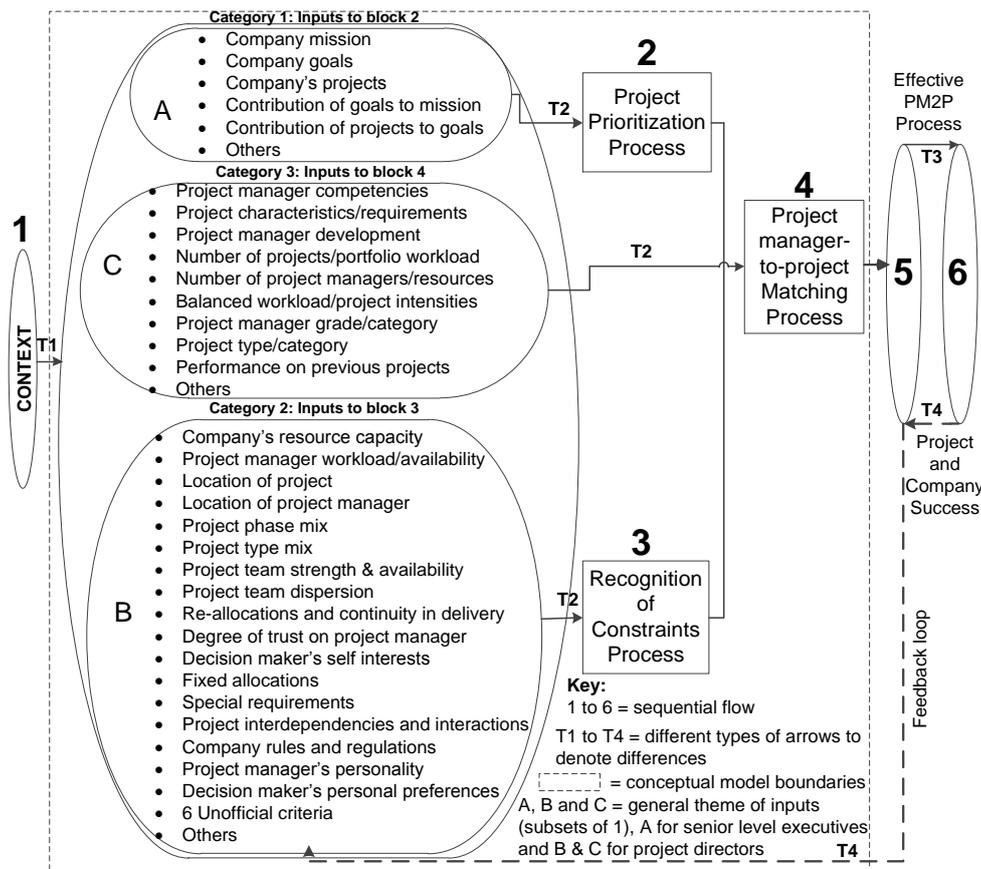


Figure 1 Conceptual model for PM2P process - Source: Seboni and Tutesigensi (2014)

This conceptual model was developed from: (1) critical appraisal of specific literature concerning PM2P allocation models (which included empirical studies as secondary data) and broader theories surrounding the PM2P allocation process, (2) industry expert reviews from USA, UK and Botswana, in relation to validating the generic nature of the model structure and content, as part of complimenting the evidence from literature with industry practice. The model was developed for use by project management practitioners and researchers to guide the PM2P allocation process, applicable to multi-project environments. It contains a total of thirty-seven criteria considered to be important for consideration in effective PM2P processes. The word others, under each category of inputs (Figure 1) was used to appreciate scope for inclusion of additional criteria that may emerge from data collection. The context (labelled 1) influences the general theme of inputs in blocks A, B and C. These inputs

are used in processes labelled 2, 3 and 4, leading to performance related outcomes labelled 5 and 6. The six unofficial criteria in block B are: project manager's age, gender, religious beliefs, marital status, health condition and nationality. Details of how the contents of this conceptual model were translated into a research instrument for this study are discussed under research method.

Research aim and questions

The aim of this study was to use the developed conceptual model (Seboni and Tutesigensi 2014) to empirically examine the PM2P allocation practices of a specific company, with a view to obtain a complete understanding of the participating company's PM2P approach in relation to strengths and weaknesses. Two research questions were constructed to focus on different aspects of this process. These research questions were: (1) to what extent do managers consider the list of thirty-seven criteria in the conceptual model in their PM2P allocation practices? and (2) what are the strengths and weaknesses of their current practices on the basis of the conceptual model? The developed conceptual model, described briefly in terms of its contents and not its development and verification (which is outside the scope of this study) was used as a lens through which gaps and strengths could be identified, from complementary analysis of each data type (such that new insights could be uncovered from equal treatment of each data type). The work is classified as quantitative research, on the basis of building on existing theory by using a developed conceptual model that has been validated from both literature and industry.

RESEARCH METHOD

A case study of the chosen company (major unit of analysis) was considered appropriate to address the research aim for two reasons. Firstly, the need to obtain in-depth descriptions of the PM2P allocation process and not generalizations, and secondly, the complexity of the unit of analysis in terms of the large number of variables involved, including the different qualitative aspects of the issues surrounding the PM2P process to be studied through an in-depth semi-structured interview survey of two groups of informants (embedded unit of analysis) in different organizational levels. The participating company was selected on the basis of its eagerness to be used as a case for the current study, including commitment and timely participation and cooperation demonstrated in a previous study involving 12 companies (Seboni *et al* 2013) aimed at validating the existence and nature of the research problem. The chosen company views the outcome of the entire study (which includes the current study) as critical in the pursuit of improved performance. Whilst there was consistent evidence of a lack of effective PM2P practices for the specific context of Botswana's public and private sector, the case in question stood out since it had a project management office in three locations, compared to the other 11 companies, which had one or two project management offices and fewer relevant informants.

The case organization is a global leader in the mining industry in terms of annual value and quality of minerals produced. Its core activities in relation to projects are underground mineral explorations involving geotechnical drilling, blasting, hauling and processing of the extracted minerals to world class finished products. The portfolio of projects implemented per year is typically 34 to 47 and range in budget and duration from £1 m to over £4 m and 12 to 48 months respectively. It has three project management offices in different locations, with a total of 18 project managers, each managing between 1 to 2 projects (large projects) and 1 to 5 projects (small projects). Typical large projects include strategic expansion projects such as building a

new mining plant or increasing the capacity of an existing plant. Typical small projects include resource evaluation to sustain existing mine business and give confidence to the investment community regarding the types of mineral resources being mined in terms of changes in volumes and grades as depth of mining increases.

Senior level executives were required to provide detailed information about five criteria pertaining to the company's project prioritization process, while project directors were required to provide detailed information about thirty-two criteria that pertain to the PM2P matching process. Both qualitative and quantitative data were required from different informants within the hierarchy of the unit of analysis (including company documents as additional data sources) in a complementary manner that treats both data types equally, to uncover a complete understanding of the PM2P allocation process of the entire case. A relevant population of 15 informants was identified on the basis of eligibility to provide the required data relating to the PM2P process. This population was enumerated (no sampling), given its manageable size in terms of the required time and resources to conduct interviews. All 15 informants, who represent the entire population in the context of the participating company, were interviewed. The issue of data quality was addressed by careful selection (Fellows and Liu 2008) of company documents, which were reviewed to complement interviews as regards substantiating the constructs being studied.

Using the case study method, the contents of the conceptual model were translated into an in-depth semi-structured interview protocol (research instrument), containing both quantitative and qualitative questions about different aspects of the PM2P allocation process. The questions were structured into four main themes. Theme 1 was concerned with measuring the importance score for each of the thirty-seven criterion contained in the conceptual model using a 1 to 9 Likert scale (1 = not important, 5 = average importance, and 9 = very important). Theme 2 focussed on a reflection of the given importance scores to determine how each criterion was taken into account in the actual (real-life context) PM2P decision making process (Yin 1984). Theme 3 explored the outputs to the decision making process (Figure 1). Theme 4 examined how the output to each process was used in reality. These four themes represent different aspects of the issues surrounding the PM2P allocation process. The research questions warrant a mixture of quantitative and qualitative questions, informed by a pragmatist philosophical perspective, which was adopted on the basis that it is suited to this type of design (Cresswell and Clark 2011). The importance of this approach lies in the need to fully address the research questions, with a view to provide a complete understanding of how managers make PM2P allocation decisions.

DATA COLLECTION AND ANALYSIS

Following pilot testing of the research instrument on a group of people not directly involved with the study, feedback was used to refine the instrument. The refined instrument was used to collect both quantitative and qualitative data from all four project directors (responsible for PM2P allocation decisions) and all eleven senior level executives (responsible for company strategic decisions that impact PM2P approach), in relation to different aspects of the PM2P allocation process. The research instrument contained questions that were complementary, some of which were quantitative and others qualitative. The quantitative data involved univariate descriptive statistics (Blaikie 2003) representing one layer of analysis in terms of importance scores for the thirty-seven criteria. Analysis of the quantitative data, in terms of the extent to which the managers consider the list of thirty-seven criteria that

theory suggests to be important in effective PM2P processes, was used to identify strengths and gaps. The qualitative data involved thematic (Ritchie and Lewis 2003) and content analysis (Krippendorff 2004) of the open ended responses, representing another layer of analysis to uncover words and phrases that are indicative of strengths and weaknesses (Figure 2).

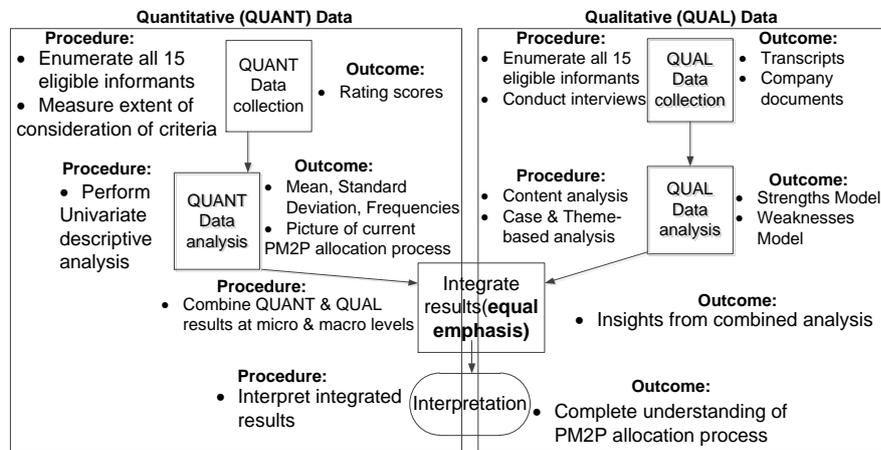


Figure 2 Approach for data collection and analysis

SPSS version 21 was used for analysis of quantitative data in relation to measures of central tendencies (e.g., mean). NVivo version 10 was used to facilitate management and analysis of the qualitative data (Bazeley and Jackson 2013), in relation to exploring different themes associated with the PM2P allocation process. The two strands were analysed independently, as a starting point to reduce bias. The findings from quantitative data analysis were intellectualized to examine the extent to which the managers consider the list of thirty-seven criteria. The findings from qualitative data analysis were intellectualized using models built from both case and theme-based analysis of the whole data, to demonstrate the strengths and gaps of PM2P allocation practices of the case study in question.

Following a review of several analytic strategies for integrating the two strands during analysis rather than when making conclusions, the appropriate analytic strategy, proposed by Brewer and Hunter (2006) and supported by Green (2007), Cresswell and Clark (2011), was adopted for further integration of the outcomes of each analysis (Figure 2). This integration, concerned with combining different aspects of the issues surrounding the PM2P allocation process, rather than data comparisons appropriate for similar aspects to determine concordances and discordances, was chosen because it is consistent with the purpose of this study. The integration was performed at micro-level (each individual criterion in the conceptual model) and macro-level (summaries of the findings). This integration, performed during analysis rather than conclusions (Brewer and Hunter 2006), revealed new insights discussed in the next section.

RESULTS AND DISCUSSION

Table 1 is an illustration of a typical result for integration at micro-level. The quantitative data (left-hand side of Table 1) show typical results for three variables measured on the 1 to 9 Likert scale from four project directors, in terms of mean scores. The qualitative data (right-hand side) display the open ended responses from the project directors (only one response per variable shown for illustration) as regards the issues surrounding each variable.

Table 1: Typical result from project director's data set for integration at micro-level

Quantitative strand		Qualitative strand
Variables (N=4)	Mean	Description
Project manager's gender	1.5	"1. It doesn't matter. We haven't got female project managers..."
Project manager's age	1.5	"3. For me it's not about age but competence "
Project manager's health condition	2.5	"1. That's not an issue since all employees will have gone through the company's requirements regarding a full medical examination ..."

The integrated results from both strands revealed no additions to the developed conceptual model (another evidence for model validation) but new insights regarding three categories of criteria as follows:

- Category 1: four criteria (gender, age, health condition and marital status) were not considered important on the basis of context. For example, project manager's gender was rated relatively low because it was not applicable to the conditions of the case being studied (see Table 1). Whilst the absence of female project managers was attributed to a "*hostile mining environment*", the interpretation from the findings, in relation to these four criteria, is that context (country, industry, company and nature of projects) plays a role in determining important criteria to be considered in the PM2P approach, as supported by a similar study of the important factors to be considered in matching project managers to construction projects in Thailand (Ogunlana *et al* 2002).
- Category 2: eleven criteria were not given sufficient attention by the managers, in terms of extent of consideration, despite their importance. These criteria were: contribution of projects to goals, location of project, location of project manager, team dispersion, self interests of decision maker and project manager, nationality of project manager, organization's rules and regulations, contribution of each limitation, number of project managers and projects. This is despite evidence from literature (Patanakul *et al* 2007, Hadad *et al* 2013) which suggests that these issues are important contributors to effective PM2P allocation decisions.
- Category 3: five criteria were rated highly (quantitative measures) but their importance were not reflected in the qualitative descriptions of the issues surrounding those criteria. These criteria were: project manager competencies, organizational goals, organization's projects, contribution of projects to goals and contribution of goals to organization's mission.

Items 2 and 3 were used as a basis for identification of weaknesses in the current PM2P allocation process. The next section is a summary of the strengths and weaknesses that emerged from integrated analysis of both strands.

Strengths and weaknesses

The strengths in PM2P practices were demonstrated in two main ways. Firstly, the use of management tools at strategic level to forecast project implementation costs. Secondly, the informants recognized some important criteria to be considered in the PM2P allocation process. For example, the importance of allocating project managers with relatively high competency levels to projects which make the biggest impact on company goals and mission. This finding concurs with empirical studies conducted in USA (Patanakul 2004) and Thailand (Ogunlana *et al* 2002).

The weaknesses in existing PM2P allocation processes were found to be as follows:

- Absence of documented and specific competencies required of project managers in various roles – the results reveal that the job profiles for all project management related roles contain a total of 8 identified competencies, which are generic and not specific to each role.
- Lack of management tools and techniques to match project managers to projects – the managers rely on intuition and do not have objective tools, as part of a structured approach to aid decision making. This may explain evidence of mismatches in PM2P allocations. This finding concurs with empirical studies conducted in USA (Patanakul *et al* 2007), in relation to reliance on managerial intuition, considered ineffectiveness when majority of the decision making variables are known (Shapiro and Spence 1997).
- The results indicate the presence of ad hoc projects and the ad hoc manner in which these projects are introduced, as a result of changes in business dynamics, caused by changing business priorities due to unanticipated events in the global mining industry.
- Lack of consideration of a comprehensive list of criteria that theory suggests should be considered as inputs to effective PM2P allocation processes.
- Lack of accountability for outputs – the managers could not account for differences in given scores to certain criteria in their qualitative descriptions of the issues surrounding those criteria, from analysis of both data types.

Implications

The results provide a strong basis upon which a decision support system (DSS) can be developed to facilitate a more effective PM2P approach, applicable to the multi-project environment of the case study company. A DSS will help to provide decision makers with readily available information required to make objective and systematic resource allocations (which include resource planning and scheduling) while saving time (particularly for large project based companies with teams of project managers), as well as the need to occasionally reshuffle the PM2P allocations due to incoming projects (Patanakul *et al* 2007). A critical discussion of the theme of a DSS is beyond the scope of the current study.

The implications of these findings highlight potential cost savings that could be made by implementing a DSS to optimize the PM2P allocation process, linked directly to the participating company's strategic intent of moving towards better performance. Other companies that undertake business in a multi-project context may benefit from this study, in the context of two potential benefits namely: (1) improved PM2P allocation processes in terms of objective consideration of a comprehensive list of criteria contained in the developed conceptual model (whose deployment verified the model content since it did not result in significant structural modifications), including use of formalized tools such as a DSS (to complement managerial intuition in terms of effective decision making) to promote increased levels of match between project managers and projects, leading to increased project manager motivation and performance, and (2) reduction in human resource expenditure - a number of authors assert that the increasing global market competitiveness facing companies that compete for the same pool of human resources leads to a steep increase in human resource expenditure, which calls for these companies to manage their human resourcing activities efficiently and utilize their workforce effectively to avoid project failures (Srouf *et al* 2006), particularly in industries such as mining, where there are scarce resources with the required capabilities.

CONCLUSIONS AND FUTURE RESEARCH

The aim of this study was to use a conceptual model to empirically study how managers make PM2P allocation decisions, using a specific case in Botswana. This led to identification of strengths and gaps in PM2P processes, demonstrated in several ways as outlined under 'results and discussion'. The following conclusions can be drawn: (1) analysis of both quantitative and qualitative data revealed gaps in the PM2P process of the case study in question, on the basis of five criteria that were rated highly by the informants but not accounted for in the relevant qualitative descriptions, (2) eleven criteria contained in the conceptual model were not given sufficient attention by the informants, despite their importance in the PM2P process, (3) it is evident that there are areas for improvement in view of an effective PM2P approach, which presents an opportunity to address identified gaps.

Next steps

The next step is to develop a DSS with a view to facilitate a more effective approach to the PM2P decision making problem, applicable to the multi-project environment of the case study in question.

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COMMUNICATION RISK AND TRUST IN CONSTRUCTION PROJECTS: A FRAMEWORK FOR INTERDISCIPLINARY RESEARCH

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Communication risk is one of the most important types of risk that occur in construction projects, and trust is one of the most effective ways to minimise it. Interest in communication risk and trust spans economics, sociology and psychology. These social sciences are most relevant for the understanding of different dimensions of trust investigated in the framework of the principal-agent theory. In construction projects, this applies to inter-firm, intra-firm and interpersonal relationships between the project parties. The project owner, contractor, and their respective project managers are among the key parties involved in every construction project. This conceptual paper is based both on empirical research that has evolved in four stages, and on extensive literature review that has developed through three stages. Using the principal-agent theory, this paper offers a framework for interdisciplinary research into communication risk and trust spanning economics, sociology, and psychology. This framework rests on firm theoretical foundations concerning inter-firm, intra-firm, and interpersonal relationships characteristic of construction projects, all of which depend on trust between project parties.

Keywords: principal-agent theory, trust, risk, communication.

INTRODUCTION

Interest in trust spans a number of social sciences relevant to the field of management. This applies especially to economics, sociology, and psychology. According to Rousseau *et al.* (1998:393), economists tend to find trust as either calculative or institutional; sociologists commonly view trust in socially embedded properties of relationships between people; and psychologists tend to view trust in terms of attributes of those who trust or are trusted, as well as focus upon these personal attributes of individuals. As will be shown in this paper, all of these perspectives are relevant to the understanding of different dimensions of trust as it pertains to project management in construction (Ceric, 2012c). The principal-agent theory framework includes inter-firm, intra-firm, and interpersonal relationships, and it thus brings together the three social sciences above in a coherent and comprehensive manner.

Most theorists agree that trust is intimately associated with risk, and that trust and risk can be thought of as "*mirror images*" of each other (Das and Teng, 1998:503). Also, trust requires communication, for cooperative relationships tend to suffer without proper communication (Das and Teng, 1998:504). Communication can be thought of

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as a route to trust and collaborative working (Dainty *et al.*, 2006:230). Related to this, trust has a time dimension, for it can change as a cooperative relationship develops or declines (Gill and Butler, 1996; Schoorman *et al.*, 2007:346). The fourth edition of the Project Management Body of Knowledge recognises that trust plays a part in the successful management of projects (Brewer and Strahorn, 2012). A wide variety of perspectives on trust recognise that risk is required for trust to influence choice and behaviour (Doney *et al.*, 1998). Williamson (1993) thus argues that trust is a calculated risk assessment in an economic exchange. However, Bresnen and Marshall (2000:590-591) argue that financial incentives may reinforce "*calculative trust*", but that they are limited in their ability to generate "*more intense*" forms of trust at the group or individual level. At these levels, trust is an ethical construct whose qualities identified in the literature include integrity, honesty, truthfulness, reliability, dependability, openness, and respect for the other's autonomy and fairness (Wood *et al.*, 2002:5). Indeed, the view of trust as a foundation for social order spans many disciplines (Lewicki *et al.*, 1998:438). Although the principal-agent theory offers a useful framework for organisational research, researchers of organisational behaviour are thus well advised to look beyond economics (Eisenhardt, 1989:72). As argued by Chiles and McMackin (1996:85), this applies especially to trust, the many qualities of which point to other social sciences, including sociology and psychology.

Focussing on professionals as agents, Sharma (1997) introduces the notion of knowledge asymmetry that favours them to principals in many business interactions. Among commonplace business interactions involving professionals as agents, Sharma (1997:762) lists those of attorney-client, builder-owner, and doctor-patient, in that order. In such situations, Sharma (1997:764) argues that professionals are better trusted than controlled by principals on account of the underlying asymmetry in expertise. In intra-firm relationships, factors such as altruism, peer pressure, and specialised bureaucratic controls are especially pertinent (Sharma, 1997:793).

This paper opens with a brief presentation of the principal-agent theory concerning construction projects. It continues by succinctly presenting the previous empirical research applying this theory, which has evolved in four distinct stages (Ceric, 2012a,b,c,d). This is followed by a discussion of the literature review concerning trust, as well as two previous literature reviews leading up to the present paper (Ceric, 2013, 2014c). Next, the main part of the paper discusses trust at all three levels characteristic of the relationships between project parties in construction projects: inter-firm, intra-firm, and interpersonal. The paper concludes by providing a framework for interdisciplinary research in this promising field.

THE PRINCIPAL-AGENT THEORY

The principal-agent theory offers a useful representation of many types of relationships between economic parties, including construction projects. For their work on the theory, George Akerlof, Michael Spence, and Joseph Stiglitz shared a Nobel prize in economics in 2001. It provides one of the best known applications of information asymmetry in economics, which is the situation in which one of the two parties is better informed than the other, in which they do not share the same interests, and in which both parties are motivated by self interest (e.g., Eisenhardt, 1989; Sharma, 1997; Jensen, 2000). Among other fields, the theory has so far been applied to project management, where the focus has initially been on the relationship between the project owner and the project manager engaged for a particular project (e.g., Turner and Müller, 2004; Müller and Turner, 2005). However, it has also been

extended to other agents, such as contractors, sub-contractors, designers, and consultants.

Specifically, three types of information asymmetry apply for acting parties: hidden characteristics, hidden information, and hidden intention (Jäger, 2008). These generate the following risks: adverse selection, moral hazard, and hold-up. Adverse selection occurs when the principal does not have the exact information about the agent before the contract between them is signed. Moral hazard occurs after the contract is signed and the agent does not perform in accordance with it without knowledge of the principal. Hold-up occurs after the contract is signed and the principal makes large investments because of the trusty relationship with the agent, but these investments come into jeopardy because the agent acts uncooperatively. The ways to minimise risks that arise from information asymmetry are known as agency costs. These include screening and monitoring costs. Screening refers to the principal's effort to gather information about the agent's qualifications before the contract between them is signed. It helps reduce the adverse selection risk. Similarly, monitoring refers to the principal's effort to ascertain whether or not the agent is behaving in accordance with the contract after it is signed. It helps reduce moral hazard and hold-up risks.

Now, trust reduces agency costs both before and after the contract is signed between the principal and the agent. Alternatively, mistrust comes at a cost (Zeghloul and Hartman, 2003). Screening is typically conducted on the inter-firm level, but it is also relevant on the intra-firm level. However, monitoring typically happens on the intra-firm and interpersonal levels. The reduction of agency costs thus requires different kinds of trust between project parties.

As will be argued in the next section, monitoring is most important in the construction phase of a project. This is where trust is crucial in the relationship between project parties. However, the key relationship in question involves the principal's and the contractor's project managers, and their communication during the construction phase is central to the fostering of their trust. The empirical research on which the present paper is largely based has therefore focused on the two project managers.

EMPIRICAL BACKGROUND

The empirical research that provides the background for this paper has evolved in four stages, which will be briefly outlined below. The principal-agent theory has formed the core of the endeavour throughout. In this theoretical framework, the principal delegates a particular task to the agent. In simplest construction projects, the project owner is the principal and the contractor is the agent. This relationship is extended by adding project managers as agents of both the project owner and contractor, as is shown in Figure 1 (Ceric, 2012a,b). For a more complex project organisation involving the designer and designer's project manager, see Ceric (2012d, 2014b). As agents, the project managers are in a non-contractual relationship, while the other project parties are in contractual relationships.

The first stage of empirical research was based on an exploratory survey of project managers, in which it was found that the project owner's and contractor's project managers played the key role in the construction phase of a project (Ceric, 2012a). The Delphi method was employed in the second stage. A panel of experts in project management confirmed the previous finding (Ceric, 2012b). The third stage involved another exploratory survey of project managers to establish the relative importance of communication-risk minimisation strategies in construction projects, which were

established by Schieg (2008). They are bureaucratic control (contracts), information systems, incentives (bonuses), corporate culture, reputation, and trust. Trust was found to be the most important risk-minimisation strategy, which was reflected in the following comments by two respondents to the survey: "trust takes time to develop between the parties, and it is very fragile, but once developed it outshines all the other strategies in terms of project control and risk minimisation," argued one, while another pointed out that "the most important document is the contract, but the trust between the parties is as important as the contract" (Ceric, 2012c). The fourth stage concerned the impact of knowledge and experience on project managers' conception of risk (Ceric, 2014a). Again, trust came foremost as a risk-minimisation strategy. This finding is insensitive to all the three dimensions of project managers' knowledge and experience considered in the survey - years of experience, largest project worked on, and number of countries worked in. This research led to a further conceptual investigation of trust in the context of the principal-agent theory. It was found that trust is the only viable way forward because non-contractual relationships between project parties tend to dominate contractual relationships as projects grow in size and complexity (Ceric, 2014b). Without trust between project parties, large projects would be in jeopardy.

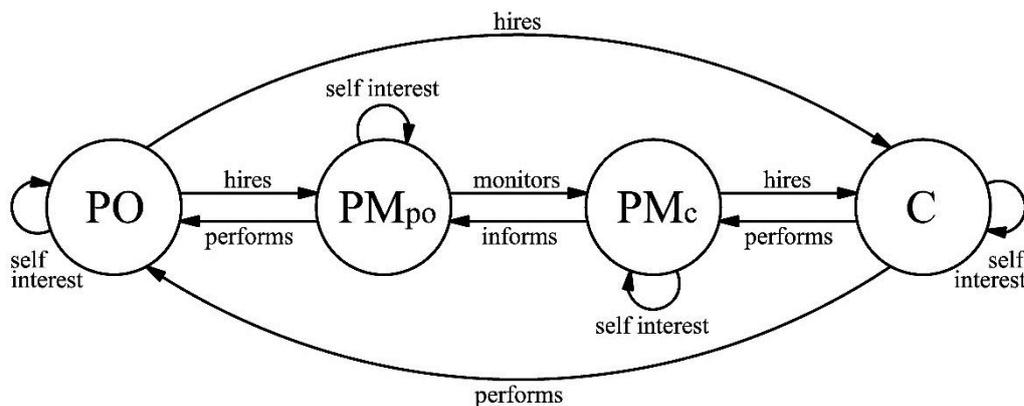


Figure 1: Principal-agent theory framework for construction projects (PO: Project owner, C: Contractor, PM_{po}: Project owner's project manager, PM_c: Contractor's project manager)

The principal-agent theory framework in Figure 1 displays three different types of relationship. That between the project owner and the contractor can be either an inter-firm or intra-firm relationship, but it is typically of an inter-firm type. The relationship between the project owner and project owner's project manager can be either an intra-firm or inter-firm relationship, but it is typically of an intra-firm type. The same holds for the relationship between the contractor and the contractor's project manager. Finally, the relationship between the project owner's and contractor's project managers can be either an interpersonal or an inter-firm relationship, but it is typically of an interpersonal type. Inter-firm and interpersonal relationships involved in construction projects are typically one-off, whereas intra-firm relationships are typically long-term. All three dimensions of trust introduced are consequently involved in the principal-agent theory framework. Therefore, they fall into domains of economics, sociology, and psychology, the three social sciences relevant to project management in construction.

Interestingly, the above analysis is supported by the empirical research summarised here. When asked about trust, project managers surveyed reported all three types of relationship discussed here: inter-firm, intra-firm, and interpersonal (Ceric, 2012c,

2014a). However, trust relevant for the relationship between the project owner's and contractor's project managers was always of the interpersonal type. As has been pointed out in the previous section, this relationship is central during the construction phase of a project.

The key distinguishing characteristic of all relationships investigated here is whether they are one-off or repeating. Most construction projects are one-off, however. In other words, construction projects tend to be undertaken by a combination of firms and individuals most of whom will not have worked together before and are not likely to work together again (Dainty *et al.*, 2007:7). Relationships between project owners and contractors are typically one-off, and so are relationships between project owner's and contractor's project managers. Only relationships between project owners and their project managers, as well as those between contractors and their project managers, are typically repeating. In this case, they are guided by employment contracts.

LITERATURE REVIEW

In addition to the empirical background discussed above, this paper is based on an extensive review of the literature concerning trust. The review, which has developed in three stages, covers both construction management literature and literature concerning management in general. Also, this review is based on two previous reviews of the construction management literature - the first concerning the principal agent theory (Ceric, 2013), and the second concerning the New Institutional Economics, which brings together the principal-agent and transaction cost theories (Ceric, 2014c). The first review concluded that the main interest of researchers in construction management associated with the principal-agent theory is a combination of contracts and risk management to limit the principal's exposure. The second review found that the key concepts from New Institutional Economics used by construction management researchers point at the self-interest of all parties engaged in the exchange of goods and services related to construction. The concept of trust appeared only in the first review, but its place was marginal.

The present literature review is not limited to the principal agent or transaction cost theories, however. Spanning both management in general and construction management, its aim was to capture the seminal papers concerned with trust, as exemplified by their titles and keywords used. A wide variety of theoretical frameworks are therefore represented in the papers identified.

To date, much research has been dedicated to the study of inter-firm trust in construction, most of which concerns partnerships and alliances (e.g., Gulati, 1995; Gill and Butler, 1996; Wood and McDermott, 2001; Wood *et al.*, 2002; Jeffries and Reed, 2000; Kadefors, 2004, 2005; Lui and Ngo, 2004; Wong and Cheung, 2004, 2005; McDermott *et al.*, 2005; Wong *et al.*, 2005; Cheung, 2007; Eriksson and Laan, 2007; Wong *et al.*, 2008; Lau and Rowlinson, 2005, 2009; Pinto *et al.*, 2009; Maurer, 2010; and Eriksson and Kadefors, 2012). However, intra-firm trust is represented rather rarely in the construction management literature. One such example is provided by Wong and Skitmore (2000). This also holds for interpersonal trust, where Emmitt and Gorse (2003) and Lau and Rowlinson (2009) offer rare examples in the literature. According to Emmitt and Gorse (2003:53), interpersonal trust, communication and commitment are vital components in building a responsive and collaborative culture in construction.

Partnerships and alliances typically involve long-term relationships between firms, and trust reduces agency costs involved. However, this literature review demonstrates that there has been relatively little research dedicated to the study of intra-firm and interpersonal trust in construction. As Williams (2001:377) argues, interpersonal trust is an important social resource that can facilitate cooperation and enable coordinated social interaction. Importantly, trust is often initiated by managers, who engage in trustworthy behaviour pre-emptively in order to enhance the performance of their subordinates (Whitener *et al.*, 1998:523). This is where the principal-agent theory framework is likely to be of greatest value to future research in construction. As this framework aptly shows, it will performe be interdisciplinary.

DIMENSIONS OF TRUST: A FRAMEWORK FOR RESEARCH

As has been argued above, the principal-agent theory provides a useful framework for the interplay of economics, sociology, and psychology in the research of the relationships between the project owner, contractor, and their respective project managers. This is shown in Figure 2, which offers a useful remapping of the relationships shown in Figure 1 so as to accommodate the three sets of relationships between project parties.

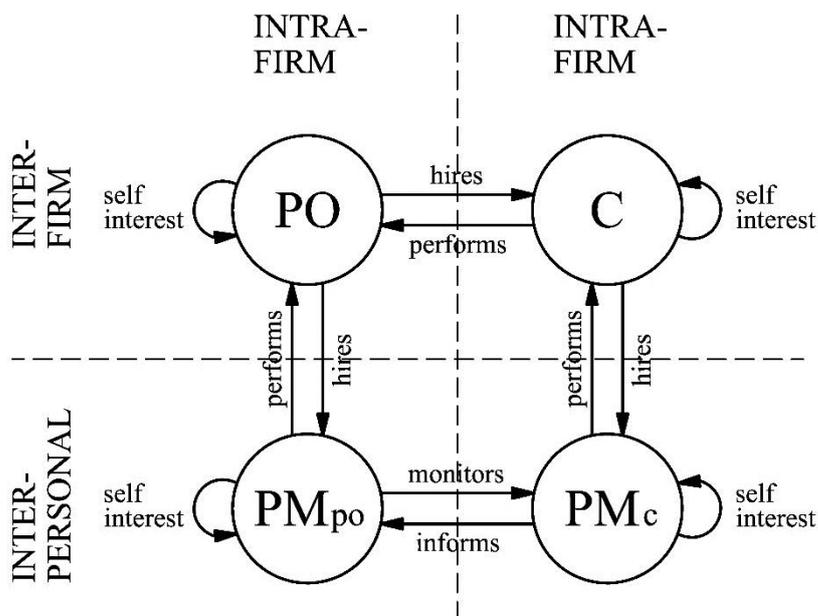


Figure 2: Remapping of the principal-agent theory framework for construction projects showing key relationships between project parties (PO: Project owner, C: Contractor, PM_{po}: Project owner's project manager, PM_c: Contractor's project manager)

In typical construction projects, the inter-firm relationship applies to the project owner and contractor; the intra-firm relationship pertains to both project owner and contractor and their project managers; and the interpersonal relationship applies to the two project managers. Communication risk differs widely across these relationships. Although this would be an oversimplification, it could be said that inter-firm relationships are studied mainly by economics, intra-firm relationships by sociology, and interpersonal relationships by psychology. Still, all three social sciences have a good deal to offer to the study of all three types of relationship in the context of trust between project parties.

It is interesting to consider briefly the dynamics of relationships depicted in Figure 2. What follows is meant only as an illustration rather than an exhaustive depiction of all

possible changes in these relationships. Before a project is initiated, the relationships are of the intra-firm variety. When it is initiated, the relationships are first of the inter-firm kind, and then they turn interpersonal. The process moves backward when the project comes to an end. That is, interpersonal relationships return to inter-firm relationships at project completion. Looking a bit more closely into project dynamics, the process starts with the project owner. The project owner's project manager is selected next. With the help of the project manager, the project owner then selects the contractor. This accomplished, the contractor's project manager is then selected by the contractor, and then the two project managers establish their relationship. Once again, the process moves in reverse at the end of a project. Concerning the construction phase, the relationships between project parties are first of intra-firm kind, then they turn to inter-firm variety, and ultimately they become interpersonal. Communication risks involved follow the same dynamics, and the time dimension of trust can be appreciated in the context of changes in relationships outlined here. Each type of trust can increase, decrease, or vary in more complex ways from the initiation to completion of a construction project. This brief illustration shows that the principal-agent theory framework is useful for bringing together different types of trust involved in construction projects, as well as their changes over time.

Most important, the principal-agent theory framework provides a useful understanding of how all these relationships are intertwined in construction projects. As Figure 2 shows, the relationships between the parties to a construction project can be studied by researchers from all three social sciences at once, thus providing a better understanding of their interplay. This is of special interest in the field of management, which perforce integrates a number of social sciences, including economics, sociology, and psychology. At present, researchers in all three social sciences are well acquainted with the principal-agent theory framework. As Eisenhardt (1989:72) argues, this framework provides a *"unique, realistic, and empirically testable perspective"* on problems of cooperative effort, but excessive reliance on economics with its restrictive assumptions is not warranted in empirical research. This is where interdisciplinary research with broader assumptions is required.

CONCLUSIONS

As has been shown in the literature review above, much of the research in trust in the construction management field is concerned with inter-firm relationships typical of partnerships and alliances. By and large, intra-firm and interpersonal trust are neglected in the literature. Research in trust concerning the relationship between all parties in construction projects needs to develop in three different but inter-related directions outlined by the principal-agent theory framework. These directions, as well as dimensions of trust, depend on the type of relationship between project parties involved. Trust involved in inter-firm relationships falls mainly into the domain of economics, but both sociology and psychology can contribute to the study; trust involved in intra-firm relationships relies chiefly on sociology, but economics and psychology are also relevant to its study; and trust involved in interpersonal relationships falls mainly in the domain of psychology, but both sociology and economics can contribute to the study, as well.

This framework provides a firm theoretical foundation for further interdisciplinary research in inter-firm, intra-firm, and interpersonal trust in construction projects. Grounded in empirical research that has evolved in four stages, which was briefly presented in a separate section above, this is the main contribution of this paper. The

principal-agent theory framework assures that researchers from different social sciences can cooperate on the basis of a common understanding of the same theoretical foundations. The interaction between the three dimensions of trust can be better understood by interdisciplinary research using the shared theoretical framework.

Therefore, the study of trust concerning the relationship between parties in construction projects requires an interdisciplinary effort in which all the disciplines involved - namely, economics, sociology, and psychology - stand to gain from a deeper appreciation of each other's means and ends. This is best appreciated in the research in trust coming from the field of management, which integrates the three disciplines so as to help improve the management practice in many areas of application. It is to be hoped that the framework presented in this paper will foster closer collaboration between social scientists, and that it will thus be of value in research project governance in this promising field.

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SOCIAL NETWORK ANALYSIS ON THE INTER-ORGANIZATIONAL INTERACTIONS IN GREEN BUILDING PROJECTS

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Green building projects are collaboration intensive in nature, and construction of a green building involves execution of complex tasks that are different from those in conventional construction projects. Therefore, collaboration among stakeholders is critical to the success of a green building project. This paper aims to study the inter-organizational interactions among key project stakeholders in green building projects and to investigate the relationship between the interactions and the project performance. To achieve these aims, social network analysis techniques were used to analyse the organizational relationships in green building projects. Considering the nature of green building projects, network measurements were classified into four different aspects – (1) Design, (2) Sustainability, (3) Construction, and (4) Finance. Social network analysis metrics like density, centrality and degree were defined and used respectively to measure the organizational relationships, key players, and powerful and influential players in each network. The developed social network model was applied to a case study green building project in Hong Kong and the outcome is presented in this paper. First hand data concerning communication frequency and information exchanges were collected from key project participants involved in the green building project through interviews and questionnaire. The results show that over-involvement of the client due to the lack of trust in the design team and the strained relationship between the client and the project manager affected the overall project performance. Key players and potential bottlenecks in organizational relationships for each aspect in this green building project are discussed and suggestions for improving project performance were provided.

Keywords: green building, high-performance teams, organizational relationships, project communications, social network analysis.

INTRODUCTION

The number of green buildings has continuously increased in recent years and successful delivery of green building projects requires innovation and strength in the collaborative teams. In contrast to traditional construction projects, green building projects requires a better communication, trust and information exchange among their participants. Multi-disciplinary involvement of project participants causes differentiation in project roles and leads to adversarial relationships between the participants (Chan 2003). In addition, coordination between the project participants was found to be a critical factor in determining green building project success (Li 2011). However, the fragmented nature of the construction industry hinders the inter-

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organizational interactions in green building construction projects and causes more risks in project communications and information exchange. Increased performance in inter-organizational relationships will be beneficial to the industry and help delivering successful green building projects.

BACKGROUND

The multi-disciplinary nature and complexity of green building projects often cause conflicts among stakeholders, project delays and cost overruns. Despite these challenges, the demand for green buildings in the built environment has increased and has become popular among a diverse set of stakeholders. Mollaoglu-Korkmaz *et al.* (2011) stated that a higher level of integration in the project teams affects the project outcome. Valentin and Abraham (2010) concluded that the impacts of stakeholders and organizations in a construction project are crucial to ensure project success. Network based evaluations were used to identify and enhance organizational relationships and project performance (Mandell and Keast 2008, Keung and Shen 2012). These studies have identified the outcomes and importance of inter-organizational interactions towards the success of building projects.

Social network analysis (SNA) has been an instrumental tool for studying the interactions of groups since its early introduction (Moreno 1960). Wasserman and Faust (1994) defined a social network as a social structure made up of actors represented as nodes that are connected by one or more specific type of relation represented as ties, such as friendship, firm alliance, or international trade. A tie can be divided into two types: non-directional and directional (Wasserman and Faust 1994). SNA has been successfully applied to investigate various relationships among individuals and organizations, and knowledge diffusion in multiple domains, including construction. For example, Pryke (2004) proposed a SNA approach that enabled identification and classification of the ways in which construction procurement and methods were evolving in response to demands for reform within the construction industry. Chinowsky *et al.* (2010) proposed an approach to measure the organizational and task performance in a project network for improving project effectiveness.

Previous studies have not studied the collaboration of green building project team relationships, and the impact of different roles in a project. This study aims to fill this gap by considering different aspects of a green building project and studying their respective project team relationships and dynamics. Special role players like the green building consultant, commissioning agent, etc., were included and their functions in different aspects were studied. The design, sustainability, construction and finance aspects were considered and the organizational relationships in those aspects were analysed individually to identify a relationship with project team performance. SNA techniques can visualize and quantify inter-organizational relationships, and therefore can provide useful insights on project participants and their team relationships. A methodology framework was developed for measuring the team performance and applied to a case study in Hong Kong. The methodology framework and the case study will be discussed in the following sections.

METHODOLOGY FRAMEWORK

A high-performing construction team should have strong trust, collaboration and free flow of information exchange between their participants. The inter-organizational interaction social network model that we developed for green building projects is

illustrated in Figure 1. In the model, individual project participants are treated as nodes and their relationships are measured based on the trust bestowed upon each other, the importance of their relationship, communication frequency, and information exchange between the participants for all the four different aspects. Importance refers to the amount of trust, communication and information exchange required between the participants. The relationships between the nodes are directional and marked with arrows. This representation of the project participants as nodes and their interactions as ties form a network of inter-organizational relationships. The inter-organizational social network is then analysed using three network analysis metrics, which are (1) density, (2) degree and (3) centrality.

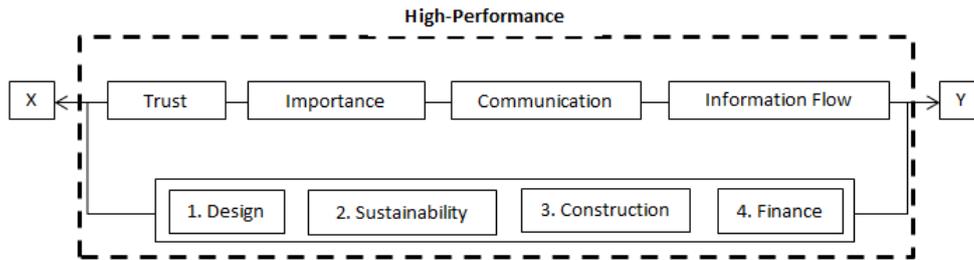


Figure 1: The Social Network Model Developed for Green Building Projects in this Study

Density

Density is the ratio of the number of edges in the network over the total number of possible edges between all node pairs. It is a common approach to measure how well connected the network is. The equation for density is given as

$$Density = \frac{L}{n * \frac{n - 1}{2}} \quad (1)$$

where L = number of existing lines and n = number of existing nodes. The value of density falls between 0 and 1, with 0 being a poorly connected network and 1 being a well-connected network. The implication of the density measure may vary depending on the project and network characteristics. Density can be a very useful measure in comparing different network configurations within a single project.

Degree

Degree is defined as the number of nodes connected to one particular node. In directed graphs, degree can be classified into in-degree and out-degree. In-degree represents the number of incoming ties to a given node, whereas out-degree represents the number of outgoing ties from a given node. A node with a high in-degree in a construction information exchange network indicates power, whereas a node with a high out-degree indicates influence within a network.

Centrality

Centrality is an indicator that describes the prominence and power of a node in the network depending on its relationships with the other nodes. This measure will identify the key players in a network and the relationships with other project participants. The equation for centrality is given below,

$$C_a = \sum_{b=1}^n \frac{Z_{ab} + Z_{ba}}{\sum_{a=1}^n \sum_{b=1}^n Z_{ab}} \quad (2)$$

Where, Z_{ab} is the number of degrees that node “a” receives from node “b” and n represents the number of existing nodes.

The nature of construction and management of a green building project is different from a traditional construction project. Starting from the project team selection, material selection and building practices, the differences range over to extensive documentation and obtaining environmental certification. Green building projects have specialist role players in their project team and executing green building project activities are complex. A green building project will require more collaboration than a traditional construction project, which is of the same type and size. Therefore, we divided a green building project into the following four different aspects:

1. Design focusing ONLY on the structural, mechanical, architectural and other specialized design aspects,
2. Sustainability issues run through the design and construction stages of the project. This aspect focuses on issues like managing pollution, C&D waste, innovative techniques to reduce energy and water use, preparation and submission of green building certification, etc. This aspect will also help identify the different roles played by organizations for improving sustainability. ,
3. Construction focusing ONLY on the construction process, progress, safety and resource management, and
4. Finance focusing ONLY on the project budget and construction cost control.

The scope of these aspects is strictly limited to the definitions to avoid duplication. The chosen social network analysis metrics are applied to all these four aspects individually to measure the network performance of the project team.

CASE STUDY – RESULTS AND DISCUSSION

A green building project in Hong Kong is presented in this paper for illustration and validation of the proposed methodology framework. The case study is a public commercial office building delivered through the traditional project procurement method, with a total gross area of around 100,000 square meters. The project was awarded a Provisional BEAM Plus Platinum certification, which is the highest achievable grade in the Hong Kong BEAM Plus environmental assessment system.

Assumptions

Before conducting the analysis, the following assumptions were made in respect to the nature of the project.

1. In this project, the client appointed the project manager in coordinating the design and construction activities and therefore the project manager is expected to play a major role in project team communication.
2. Since this project was conducted using the traditional procurement method, the architect and the contractor having their own design and construction team.

Therefore, it is expected of them to lead their team communication in the design and construction aspects respectively.

3. This project will be collaboration intensive in nature since it is a green building project.

Data Collection

The project team consists of 21 organizations. Collecting individual responses from every project participant is practically impossible. Since this study is focusing on analysing the inter-organizational relationships, one person from every organization was selected for interview. The selected participants were chosen after thorough background study and preliminary discussions with the project team executives. . . The selected members were the key representatives of the organization and they were directly involved in all the inter-organizational communications. The selected project members were interviewed face-to-face and both qualitative and quantitative data were collected through a research questionnaire. Collected quantitative data included trust, importance of relationship, communication frequency and information exchanges. A Likert scale measurement of 1 to 5 was used for collecting trust and importance of relationship data with 1 being the lowest and 5 being the highest value. Communication data was measured by the frequency of communication existed per day/week/month and information exchanges were measured by the number of times information was exchanged during communication. Considering the scope of this paper, communication frequency and information exchanges data were used for analysis. Trust and qualitative data were used to support the quantitative analysis and for a better inference of the organizational relationships. Data concerning importance of relationship was not used in this paper.

Inter-Organizational Interactions

The questionnaire responses were extracted and inputted to a SNA software tool, UCINET 6.2. Communication and information exchange networks (for all the four aspects) were plotted using the software. The network diagrams are supported by mathematical analysis and qualitative responses from the project participants for network inferences. Firstly, the overall communication frequency of the project team is illustrated in Figure 2.

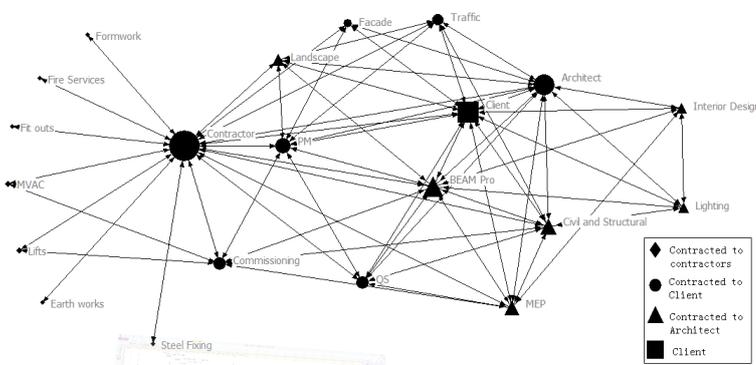


Figure 2: Overall Communication Frequency of the Project Team

This network is comprised of nodes representing the project participants and ties representing the communication between the participants. This study classified the nodes into four different shapes as shown in the figure. The shapes indicate the

contractual relationships between the project participants. This differentiation was used to easily identify communications that occur without any contractual relationships.

The communication graph illustrated in Figure 2 shows a reasonably well-connected network in which most of the project participants know and collaborate with each other to execute project activities. The size of the nodes indicates the frequency of communication of a particular node with other nodes. A larger node size represents a higher communication frequency, and vice-versa. In this network, the project manager was assumed to take a central role, coordinating work with the architect and the contractor, and reporting to the client. However, due to the inefficiency of the project manager in the later stages of the project, the contractor took an active role in project communications with the client, executing complex design activities successfully by effective communication.

Information exchanges help participants share key project knowledge with one another for successful project completion. The information exchanges network will illustrate the exchanges of project information to and from the project participants and identifies important participants during key decision making. All the four networks will be illustrated and explained in the following sections.

Design

The design network shows the information exchanges associated with the structural, architectural, mechanical, landscape and other design aspects of the project. The diagram represents a high level of connectivity and interdependency among the design team. The size of the node indicates the amount of information received by that particular node. Since the project is delivered through the traditional procurement, the architect was expected to play a key role in this network but due to the client's lack of trust in the design team, the client was majorly involved and the architect was a close second. The contractor was also included in key design decisions to effectively carry out the tasks to his sub-contractors. Nodes without any ties are called outliers and they are not part of the network despite being the part of the project team. In the design network, the Commissioning team was not included in the major design decision making issues.

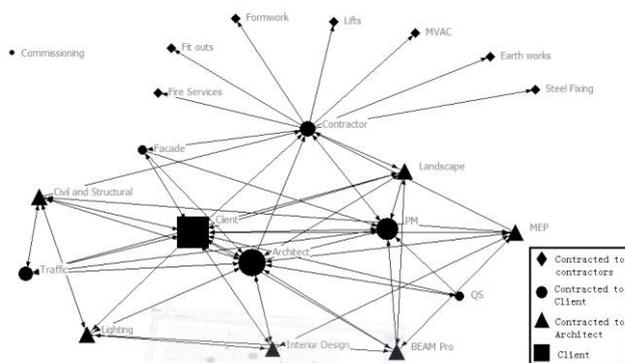


Figure 3: Information Exchanges for the Design Aspect

Sustainability

Sustainability issues were given prime importance subject to the nature of the project. This aspect focuses only on issues related to green building practices, technologies, documentation and certification. Few design related sustainability issues were

considered in the design aspect rather here, to avoid information overlap. A strong collaboration among the project team is necessary to achieve a higher level of sustainability. The case study project achieved the Platinum certification - the highest achievable level in the BEAM Plus assessment system. The client appointed a green building consultant and both were actively involved with the design team to carry out issues related to sustainability. The involvement of the contractor was also a reason for executing all the sustainable design successfully and achieving a higher grade. The over involvement of client once again indicates the lack of trust in the design team. This network also has a few outliers in Traffic, Steel fixing, Earthworks and Formwork sub-contractors.

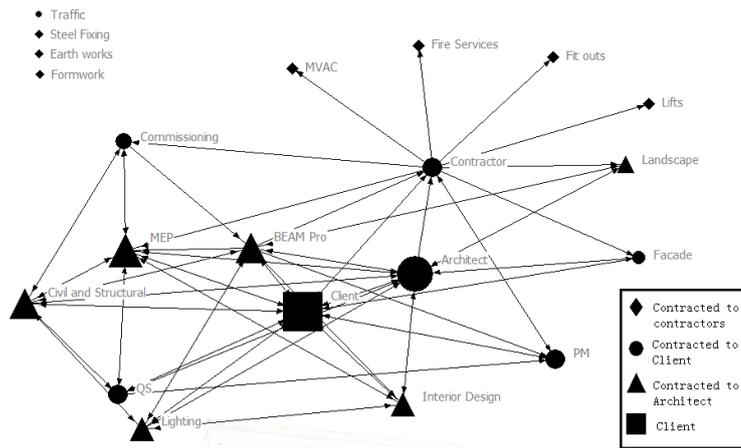


Figure 4: Information Exchanges for the Sustainability Aspect

Construction

The construction network was dominated by the contractor who took a central position. From the qualitative responses of the client, it was learnt that the project manager was expected to involve heavily in this network but due to the project manager’s inefficiency in the later stages of the project, the client had to take a more active role in this aspect. This led to the strained relationship between the client and the project manager and caused considerable time delay and cost overrun. This network does not have outliers with all the project participants involved in some sorts of information exchanges.

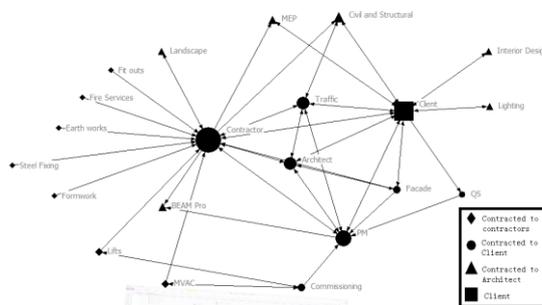


Figure 5: Information Exchanges for the Construction Aspect

Finance

The finance network represents the cost and budget issues of the project. The finance network appears to have multiple subgroups – a primary group under the client and

two secondary groups under the architect and the contractor. The interactions can be related to the contractual agreements of the project team tying the major actors to their pool of associates. There are no isolates in the group and all the nodes maintained an appropriate level of communication.

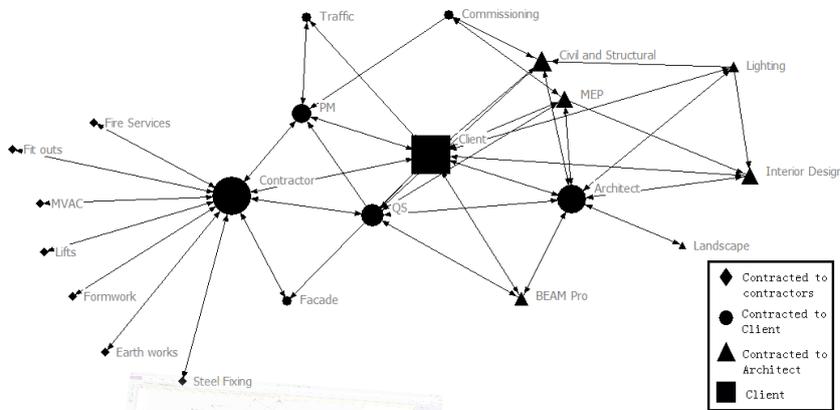


Figure 6: Information Exchanges for the Finance Aspect

Results of the SNA Metrics

The graphs in the previous sections helped us understand the project team dynamics in each of the four aspects. This section will present the mathematical results and discuss the findings of the study. Firstly, Table 1 shows the densities of the four different networks.

Table 1. Density of the Information Exchanges Network

Network Type	Density
Design	0.19
Sustainability	0.18
Construction	0.10
Finance	0.17

In absolute terms, the density of each network is low. The reason for a low density network is because of the contractual arrangements among project participants and the traditional procurement delivery method. In this project, the design and construction team are led by two separate entities and their contractual relationships does not oblige for collaboration.

The centrality metric gives the prominence and actively involved nodes in a given network. Table 2 represents the major role players in each of the four analysed network. The centrality measure considers the amount of collaboration of a particular participant with the entire project team. The contractor played a key role in the design, sustainability and construction networks due to his involvement with both the design and the sub-contractor teams. The client had an in-house QS team and kept close control over the financial issues with the architect and contractor. The results shows that the project delivery norms were not followed properly and it had a direct effect in the team project interactions.

The in-degree and out-degree metrics indicate the powerful and influential actors in a network, respectively. Table 3 illustrates the most powerful and influential node in each network. Due to the lack of trust in its design team, the client was coordinating

with every one of its design team members and played a major role in transferring information. This caused a major imbalance in executing project activities. Too much involvement of the client affected the performance of many project participants. The green building consultant, BEAM Pro worked closely with the client and the design team to achieve a higher certification level. The client's strained relationship with the project manager is the reason for the involvement of the client in the construction issues. The client and the contractor had to play an active role in coordinating construction and financial aspects of the project in the later stages.

Table 2. Top Centrality Measurements of Information Exchanges Network

Network Type	1 st	2 nd	3rd	4 th	5th
Design	Contractor	Architect	Client	Project Manager	BEAM Pro
Sustainability	Contractor	BEAM Pro	Client	Architect	MEP
Construction	Contractor	Client	Project Manager	Architect	QS
Finance	Client	Contractor	Architect	QS	Project Manager

Table 3. Highest In-degree and Out-degree of Information Exchanges Network

Network Type	In-degree	Out-degree
Design	Client	Client
Sustainability	Client	BEAM Pro
Construction	Client	Contractor
Finance	Client and Contractor	Client and Contractor

Discussions

Qualitative data from the project participants were collected to compare the results with actual project performance. The relationship between the project manager and the client strained over the course of the project and it affected the original team dynamics. The client took control over project coordination and many project participants felt that too much involvement of the client hindered participant's work tasks and brought down productivity. Lack of trust on the design team was also a reason for excess client involvement. Ambitious targets were set by the design team initially and there was a scope creep in the later stages of the project. Lack of efficient coordination and supervision caused accidents on site. These factors created adversarial effects on the overall project performance. The project was delayed and exceeded the initial planned budget. Thus it has been found that adverse project relationships between key project participants have a negative effect on key project metrics like cost and schedule. Trust between project participants and collaboration was found to be vital in effective management of green building projects.

CONCLUSIONS AND FUTURE WORK

With the growing trend of green buildings, this study proposed an innovative method to study and analyse green building project interactions. The proposed model will be an effective tool in analysing project team interactions and will help identify potential bottlenecks in project relationships and dynamics. The communication and information exchanges of different aspects of a case study project were discussed and the mathematical results were compared with the qualitative responses. The project team's communication and interaction dynamics deviated from its adopted delivery method and it resulted in a negative effect in project performance. Trust between project participants and collaboration was found to be a vital factor in creating high performance teams. Forming project team with prior work relations and adopting collaborative procurement methods are potential alternatives to enhance project performance. This paper identified potential bottleneck in project relationships in a case study project and provided insights for creating better teams. Future work will include additional case study projects with different project types and procurement strategies to understand their relationship between project team interaction and project performance for deeper analysis.

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GETTING TO THE HEART OF COMMUNITY ACTION AGAINST CONSTRUCTION PROJECTS

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Construction projects have a potentially large economic, social, ecological and cultural impact on the communities in which they take place. As these communities become increasingly empowered, educated, connected and organised, there is increasing evidence that they are able and willing to mobilise action when they become concerned about the impact of construction projects on their lives. From a construction project management perspective, there has been virtually no research into the structure of these groups and how best to interact with them for mutually beneficial outcomes. Using a thematic story telling approach which draws on ethnographic method and social contagion theories, an in-depth analysis of community action against a construction project is presented. It is concluded that these groups are largely anarchic but are held together and sustained by a core group of activists which are often invisible to outsiders. This raises numerous challenges for project managers in addressing community concerns and in mitigating potential cost and time escalations associated with such action.

Keywords: community, action, protest, project management.

INTRODUCTION

Communities are fluid groups of people, who are united by at least one common characteristic such as geography, shared interests, values, experiences, or traditions (Thompson *et al* 1990). Healthy communities are well organised and to mobilise action in response to external threats to their common interests. As Kasperson *et al* (2001) noted, all development projects have a “*ripple effect*” through their impact on the local, national and international communities in which they are embedded. So from construction project management perspective, ‘community’ refers to the people whose interests can be affected by a project (Moodley 1999). However, as Atkinson and Cope’s (1997) analysis of community activism against urban regeneration projects showed, communities cannot be treated as a single homogeneous, easily identifiable group, so it is clear that the term ‘community’ should be seen as an umbrella term representing a multitude of overlapping, competing and often conflicting interests groups which shift over the life of a project, through planning, design, construction and operation.

Numerous authors have explored the positive and negative affect that construction projects can have on communities (Awakul and Ogunlana 2002, Glass and Simmonds 2007, Murray and Dainty 2009, Spillane *et al* 2013). Close and Loosemore (2013) found project managers are generally ill-equipped to handle community concerns

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about these impacts and that there is a tendency for them to see communities as a liability rather than an asset. They also assume that community concerns have been resolved during the early planning stages of projects and avoid community consultation, seeing it as a time-consuming, stressful and burdensome process. Consequently, all too often, seemingly innocuous community protests escalate into lengthy and acrimonious disputes which cause considerable delays, financial cost and reputational damage to the firms involved and social damage to the communities themselves. Much of this problem is due to a poor understanding within the construction industry of how to manage community action. There is a paucity of research into how communities organise themselves and therefore no insights can be offered into how to best interact with them for mutual benefit. To address this gap in knowledge, the aim of this paper is to investigate the social processes which create and sustain community action against construction projects. In particular it is to focus on the role of core group members in driving and sustaining community action. Such knowledge is essential to inform more effective and evidence-based community consultation practices, enabling projects to progress smoothly in consultation with communities rather than in conflict with them.

THE SOCIAL BASIS OF COMMUNITY PROTEST

Communities engage in collective action or protest to exert influence on decision-makers in business or government (Goodwin and Jasper 2003). Political theories have shown how changes in political climates and social trends influence community willingness to engage with protest over time (Klandersman and Staggenborg 2002). For example, publicised concerns about the health impacts of nuclear energy or wind farms are likely to strengthen the likelihood of protest against these types of projects. More recent work by van Stekelenburg and Klandermans (2010) shows there are many reasons why people might engage in protest ranging from actions directed at improving one's personal conditions (individual action) to actions directed at improving the conditions of one's group (collective action). There are also many types of types of actions that people may take ranging from those that conform to the norms of the existing social system (normative action like petitioning and taking part in a demonstration) to those that violate existing social rules (non-normative action like illegal protests and civil disobedience). According to van Stekelenburg and Klandermans (2010) the emergence of action against a construction project would depend on the presence of shared grievances, shared emotions and a shared identity within a community. According to their theoretical model, grievances would originate from common shared interests and/or principles that are perceived by the community to be threatened by a project. The more people feel that interests of the group and/or principles that the group values are threatened, the angrier they are likely to be and the more probable it is that they will engage in protest and non-normative action to protect their interests and principles and/or to vent their anger. Community action is made even more complex because behaviours and perceptions initiated by one community member can also influence others in the same community. Social contagion theory explains that perceptions of risk (and opportunity) associated with a project can change as they travel through community social networks and that this social contagion effect is likely to be influenced by levels of social cohesion within a community which is in turn influenced by the level of shared understanding of protest issues among community members (Scherer and Choo 2003). Importantly, Monge and Contractor (2003) have shown that some people are more able to promote contagion (by spreading ideas) by virtue of their unique location in a protest network (core group

membership). For example, people in central positions are more likely to be influential in spreading ideas about a project and it is this issue of core group influence that has been relatively neglected in the literature on community action. Monge and Contractor's (2003) research suggests that it is critically important to be able to communicate with this group in being able to address any concerns which might lead to an unnecessary escalation of protest against a construction project.

METHOD

To investigate Monge and Contractor's (2003) theories around the existence and role of core groups in community action, an ethnographic investigation was undertaken into a long-standing protest against a large housing project in Australia. In exposing a number of commonly held myths about single case study research, Flyvbjerg (2006) acknowledges that the approach has often been criticized on the grounds that its findings are not generalizable. However, in response he also argues that since universal truths are problematic in the study of human affairs, context-dependent knowledge gained through case study research is arguably more valuable than the search for predictive causal explanations. Indeed, according to Flyvbjerg (2006), it is important to recognise that it is not always desirable to generalise case studies and that good quality case studies are of enormous value as highly valid narratives in their own right. While the advantage of large samples is breadth, the advantage of a small number of case studies is depth which can be achieved by an in-depth longitudinal immersion in the research setting which can significantly improve the reliability of the findings produced (Berg, 2001). Data was collected during the protest by a range of methods which included protest documentation (such as the protest website, other related protest websites, flyers, internal communications and media reports), semi structured interviews with protest participants, analysis of symbolic protest artefacts such as a community picket and Aboriginal protest camp and participant observation of protest rallies and site picket activities. A total of twenty-four semi-structured interviews were conducted with protest members around patterns of communication and personal stories of protest involvement to identify core group members. Establishing trusting relationships with community members and gaining access to reliable and quality data was an intensive and engaging process which lasted over 2 years. It necessitated complete immersion in the protest, a difficult initiation process and participation in many protests and cultural events. There was no contact with the developer at any point before, during or after the protest since this would have undermined the trust shown by activists in the researcher and compromised the research.

Interview transcripts and documentary data was analysed using text mapping software called Leximancer which produces a concept map of key data themes and their relationships (Leximancer 2005). An example of a concept map is shown in Figure 3.

A concept map shows graphically: the main concepts contained within a transcript or text; how they relate to each other; the relative frequency of each concept; how often concepts co-occur within the text; the centrality of each concept and; the similarity in contexts in which the concept occur – thematic groups. Sociograms depicting the social networks underpinning the protest were also produced using a social network analysis software called UCINET (Katz 2004). They revealed the structure of communications within the protest group over time. A sociogram is illustrated in Figure 2 with nodes identifying individuals involved in a protest and the lines between them indicating the existence of a relationship (communication, friendship, family,

power etc). Finally, narrative analysis incorporating topic-centred storytelling was used to explore the deeper meanings that people attached to the protest and their role within it (Polkinghorne 2007). Narrative analysis of stories about the protest were used to ground the theoretical insights derived from the documentary analysis, ethnographies, concept maps, sociograms and literature.

DISCUSSION OF RESULTS

The research discovered multiple layers of activism within the community (Figure 1).

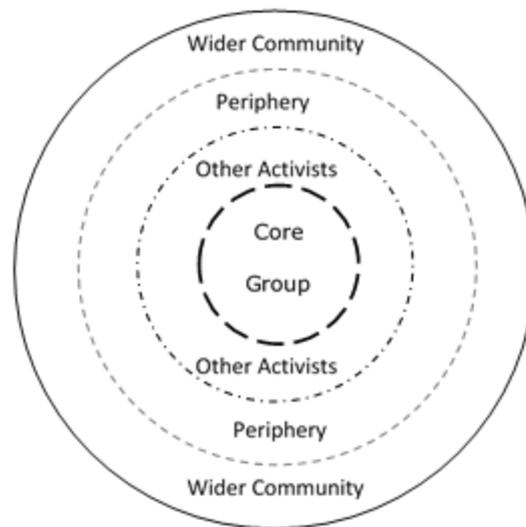


Figure 1: Protest network layers

In Figure 1, the outermost layer was the ‘wider community’ who were casually associated with the protest on an event-specific basis. As one of our interviewees stated:

“... there are a whole lot of people who don’t want to do the picket but they are happy to deliver newsletters or letterboxing... put up posters and things like that...”

The periphery layer depicted activists at the fringe of the protest who maintain an ongoing but limited and inconsistent involvement in protest activities.

“I have always kind of been there, more or less on the periphery and contributed where I could... I kind of devote a bit of time every week to doing my little bit for the picket..”

The next layer represents the activists who get involved on a more consistent basis such as picket duty and attendance at meetings and protest events but typically do not get involved in organisational activities.

“... you know who you can count on, and for instances, some people will help with raffles and some people will help with the barbeque selling food or something like that...”

Finally at the heart of the protest is the core group comprising a small number of respected long-term activists who have played a central role in the protest over time by motivating people, organising events and shaping perceptions and opinions through the provision of information via newsletters, an email network web etc.

“... there is a fairly loose central structure which has representatives from major groups.... I mean you certainly had the movers-and-shakers at the picket too, the picket monsters and that...”

While it was possible to identify a core group which drove the protest, the protest network was described by many activists within as being an informal, amorphous, anarchic and unstructured.

“You have a bunch of volunteers that have no rules or real structure... an individual or group can initiate something... you don't have to be a member to attend, it's very loose, there is no real control over it... that's why this campaign has been very hard to pin down, there is no real cookbook on this one...”

The existence of the core group can be clearly seen in the sociogram of the activist group in Figure 2 (shaded area). The nodes in Figure 2 are interviewees.

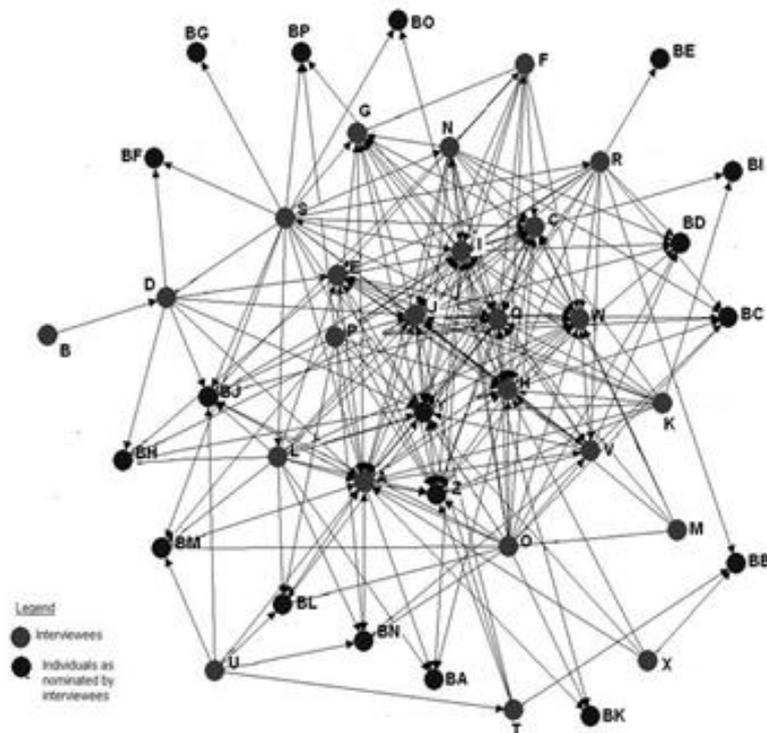


Figure 2: Sociogram of protest network core

The centrality of communications (as indicated by the number of arrows in and out of each node) and a content analysis of the communications with the core group members in Figure 2 showed that the core group played a critical role in facilitating interaction, providing information, mobilising collective action, deciding on strategy and by doing so, shaping opinions, perceptions and in sustaining action over time.

Figure 3 depicts a Leximancer analysis map of important concepts that emerged from the interviews regarding the qualities that core members exhibit which determine their ability to influence opinions, perceptions and sustained action within the movement network.

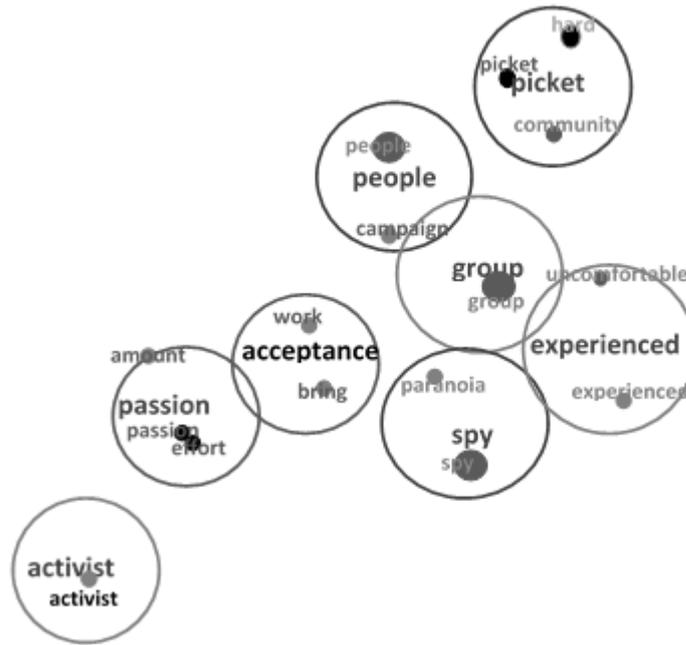


Figure 4: Concepts relating to core group entry

Entry to the exclusive core group membership involved an initiation process where people were tested in terms of their commitment to the cause, their reliability, trustworthiness, fit with existing protest group membership and their ability to contribute:

“... it depends on the newcomer, what ideas and what they can bring to the group, what they produce for the group and what sorts of things will add credibility..”

The core group was the key source of energy for the entire protest movement and exercised its influence on other non-core members in a range of ways including emails, community meetings, media exposure and personal lobbying of other group members to maintain enthusiasm and energy. Of particular interest was the role of the community picket (initiated and maintained by the core group) as a meeting point to sustain protest group identity, cohesion and news of progress. The symbolic and practical importance of physical artefacts such as the picket as a meeting point for the community was even more evident during the later stages of the protest after it had been burnt down by arsonists.

“... it used to be that you would bump into people ... whole lines of communication went down with the picket and the friendships you made were based on your efforts at (the protest) and they didn't really continue after that... ”

CONCLUSION

The aim of this paper was to investigate the role of core group members in sustaining community action against construction projects. An understanding of the role of core groups is missing from both the construction project management and wider community action literature. Through an in-depth single case study of one of Australia's longest standing community protests against a construction project our findings indicate that it is a lack of formal protest group structure, rather than the existence of formal structure that is the most important factor in sustaining community action over time. This finding contradicts Porta and Diani's (1999) research which

suggests that protest movements are more enduring when they are highly structured. The differences in our findings could be explained by the key role of the core group in managing and promoting cohesion among protest members so that this anarchic group functioned effectively. Our results suggest that the core group is the invisible driving force which sustains protests against construction projects. The core group is often hidden from the developer's view but is critical in driving communications, spreading perceptions of risk and building a sense of collective identity and responsibility that motivated on-going participation in protest actions in the highly transitional outer protest layers. The core protest group had the highest barriers to entry, consistency in membership and dedication to the cause of any community layer. Members of this group could be defined by certain common attributes and were largely drawn from trusted activists in the adjacent layer and in response to the need for expertise and resources which were salient to emerging protest issues.

The lessons and implications for managers of construction projects from this research are numerous. First, it is clear that protest groups can develop a life of their own which is beyond the control of project managers and even the protest group members themselves. However, the discovery of different layers of membership and a core group of relatively stable "leaders" means that there is some hope of effective communication if a manager can discover who this central group comprises. The establishment of early contacts with thought-leaders in the community is thus an essential strategy that should be employed by project managers. These early contacts should aim to establish an open and trusting non-legalistic relationship with the protestors since our findings indicate that the more threatened the protest group feels, the more protective and cohesive it will become, and the more difficult it will be to communicate with.

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WORKING TOGETHER IN A KNOT: THE SIMULTANEITY AND PULSATION OF COLLABORATION IN AN EARLY PHASE OF BUILDING DESIGN

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Construction projects are complex, and many open questions arise in the early phases of projects. Turning these questions into realistic requirements is a critical task that demands a good deal of specific information, multiple types of expertise and collaboration between designers. Knotworking is a new way to work as a group for a short period of time to accomplish a critical task in a BIM-based building process. This study focuses on the experimentation with knotworking in an early stage of a building project. A characteristic of knotworking is that continuity is connected to the object of the work at hand, not to the stability of the team. An object of activity is considered as a basic motive and purpose of human activity. The object of the design activity is here a school-community centre in central Finland. According to activity theory, an idea or a concept needs to be experimented with to become a new practice. Over a two-day session, two interdisciplinary teams of participants created alternative design solutions and evaluated them. The teams included an architect, a cost calculator, a structural engineer, a HVAC designer, a coordinator, a visualizer and a developer, and an energy specialist. The data consist of video-recordings and observations of these sessions. During the knotworking session, the participants were able to receive feedback from other design disciplines and stakeholders. Knotworking made the simultaneous exchange of information and sharing of expertise possible. Quick changes between working individually, in pairs, in small groups or in the whole group characterize the pulsating quality of working in a knot. With enabling technology and a new kind of pulsating collaboration, knotworking supports 1) creating concrete design solutions in a short period of time, 2) increasing designers' knowledge of the implications of their decisions on the work of their colleagues and the quality of design, and 3) easing shifts from coordinative talk to collaborative design and back.

Keywords: collaboration, building design, knotworking, pulsation, activity theory.

INTRODUCTION

Construction projects are complex, and the early phases of projects contain many open questions. Turning these questions into realistic requirements is a critical task that calls for a good deal of specific information, multiple types of expertise and close collaboration. Schade and colleagues (2011) describe the early design phase as the point at which decisions with a significant effect on the final costs are made. As a consequence, designers should be more involved in producing different solutions and realistic options for clients to choose among. However, conceptual design is shown as

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a time-consuming process, in which design disciplines carry out their design and analyses separately, and the number of possible iterations is low (Flager and Haymaker 2009, Flager *et al.* 2009, Eastman 2011).

New technologies, such as building information modelling (BIM), BIM platforms, cloud computing and mobile devices, may have the potential to increase collaboration between the different parties of a construction process (Volk *et al.* 2014, Succar 2009, Singh *et al.* 2011). According to Eastman and colleagues (2011), BIM tools enable designers to receive “*almost real-time*” feedback from each other.

However, BIM alone does not improve collaboration across professional communities (Neff *et al.* 2010). Besides new technology, knowledge on information sharing is an important facet of collaboration (Pikas *et al.* 2013). In design meetings, designers try to find or replace missing information by making assumptions, promising to verify information between meetings when this task is easily forgotten, or by searching for the information during the meeting, which takes valuable time and distracts other designers (Koskela *et al.* 2002).

Complex design problems in the building process require designers and specialists to work together to solve specific problems in a temporary team (Dossick and Neff 2011). Kvan (2000) suggests that design collaboration is a more demanding activity than completing a project as a team, as it ‘requires a higher sense of working together’. According to van Gassel (2014), to enhance collaborative actions in design, participants should have the proper tools to explain their thoughts and have ‘a common language’ to understand each other.

Knotworking is a new way of working together as a group to solve critical tasks in a building process (Kerosuo *et al.* 2013). It is a flexible collaboration method for mastering unstable objects and fragmented processes in pursuing intersecting activities. Knotworking is characterized as ‘a pulsating movement of tying, untying and retying together seemingly separate threads of activity’ (Engeström 2008: 194). However, it is not clear what pulsation means in construction processes.

The focus of this study is on the forms of design collaboration in knotworking. How does the collaboration between project participants and design specialists take place during knotworking? Does knotworking enable an effective way of working together in a building project? The case studied here is the design of a school-community centre in an early stage of a building project. Over a two-day session, two interdisciplinary teams of participants created alternative design solutions and evaluated them. The case was part of the development of knotworking that took place in the Built Environment Process Re-engineering (PRE) research programme.² The idea of knotworking was tested in three real building projects in the programme, the first of them being the focus of this study.

Developed in healthcare activities, knotworking has not previously been applied as a collaboration method in construction. We begin our paper with an introduction of the knotworking concept. Then we describe the data and the methods of the study. After that, we present and discuss the results of the analysis, and finally, we conclude the paper with suggestions for further research. The study deepens knowledge on social forms of collaboration early in the design process.

² The PRE programme is part of the Strategic Centre for Science, Technology and Innovation of Built Environment Innovations RYM Oy, <http://www.rym.fi/en/programs/builtenvironmentprocessreengineeringpre/>.

KNOTWORKING IN THE EARLY DESIGN PHASE

Knotworking is a new form of collaborating during critical phases of a building project. It was initiated as a form of organizing and performing work activity in connection to co-configuration models of production, and it represents ‘the emerging interactional core of co-configuration’ (Engeström 2008: 195). Engeström argues that the nature of teams depends on the historical type of production within which they are implemented (p.190). Knotworking resembles teamwork, but knots are less stable than teams. Knots are task-dependent constellations formed on a temporary basis. They are more related to the requirements of the work processes on the level of practices, and the development of knotworking is closely tied to practical experiments and the testing of different project-based tasks.

BIM is considered ‘an emerging technological and procedural shift’ within the construction industry (Succar 2009: 357). BIM enables project partners to be connected more tightly than before through technology, but at the same time they still remain organizationally divided, often lacking timely access to crucial information (Dossick and Neff 2010). The need to develop methods of crossing organizational boundaries and task divisions in a new way is a developmental challenge in BIM-based design contexts. Poor communication, ambiguous requirements and regular misunderstandings often cause delays in the industry (Forbes and Ahmed 2011, Neff *et al.* 2010). The combination of contributors is usually constantly changing during a building project. The coordination of the various contributions and collaboration between participants is based on contractual agreements, rules, the formal division of labour, and routine practices (Hardin 2009, Bishop *et al.* 2009).

New methods organizing project work, for instance, in ‘Big Rooms’, have been developed along with the implementation of BIM to solve the collaboration problems in the construction industry. Knotworking resembles Big Rooms in that designers work side by side in the same place to share information with each other more effectively than if they were working separately in different design offices (Kanzode and Reed 2008). The Big Room is best suited for large projects in which designers are employed in one project full time. Most construction projects are usually smaller in Finland, and designers may work in parallel on several projects in different parts of Finland. Working together in the same premises may then become a challenge that cannot easily be organized.

In this article, we focus especially on the aspects of design actions and interactions in knotworking. Interaction and communication have been the focus of many studies in construction, but what is often missing is their connection to the object of their work activity. Characteristic of knotworking is that the social interaction is connected to the object of work at hand, not to the interaction or communication between designers as such. The object of activity is here understood in its activity-theoretical meaning (Engeström 2008: 88-89) as a purposeful, shared target of the designers’ actions and interactions in the design activity. The object of activity can be understood as material as well as ideal. However, it is not easy for designers to work on a shared object because they often have very different aims and commitments in construction projects (Bishop *et al.* 2009). Learning challenges emerge as participants develop new ways of working and stimulate change both in the participants and their organizations (Fenwick 2007). Organizational learning takes place when participants whose relationships are loose solve complex problems driven by internal motivation (Blackler and McDonald 2000). In this study, the object of the design activity is a

school-community centre in central Finland. The participants solved the learning challenges by developing new tools and social forms of collaboration.

THE DATA AND THE METHODS OF THE STUDY

The data were gathered in the knotworking experiment, which was carried out in the early phase of design. The designers and construction professionals developed the concept of knotworking with the help of the researchers (Kerosuo *et al.* 2013). The participants decided to test knotworking in central Finland, where a city had planned for a school community centre to be built. The knotworking experiment was funded by the PRE research programme. Before engaging in the experiment, the participants met five times in total to plan the experiment. The plan included the list of the participants in the two temporary teams (i.e., knots), the aims of the design work, the initial data, the schedule of the experiment and its working methods, the design and assessment tools, and the collaboration with the client and the end users.

The object of the first team was to create different design alternatives for a new school-community centre on an empty building site (“*Team New*” in the analysis). The second team produced renovation alternatives for an old listed building (named “*Team Renovation*”). Team New included an architect, a cost analyst, a HVAC designer, an energy specialist (who did energy and temperature simulations), a structural designer, a developer, a coordinator (who acted as the leader of the team) and a visualizer (whose task was to create an instrument for comparing the design alternatives of the knot). Team Renovation consisted of two architects, a cost analyst, a HVAC designer, an energy specialist, a structural designer, a coordinator and a visualizer, who also acted as a developer. Both teams had access to the same initial data, the contents of which were the initial options for the models produced by an architect, the client’s requirements and the end users’ wishes for the school-community centre.

The data consist of recordings of the two teams working in two-day knotworking sessions. The knotworking sessions were video-recorded and attended by the researchers. Team New worked 8 hours and 35 minutes and Team Renovation worked 7 hours and 30 minutes during the two-day knotworking session. Five researchers from three different research institutes observed Team New and four researchers observed Team Renovation.

In a first phase of the analysis, the course of the knotworking sessions was strictly classified into collaborative work, individual work and preparation for the presentation of results to the client and the users of the school community centre. In the second phase, every participant’s tasks and actions were listed on an Excel sheet in five-minute time slots with the help of the recordings. A five-minute time slot was chosen for the empirical unit of analysis because it was long enough to contain a meaningful conversation but short enough to identify single events in the knotworking. However, it soon became clear that the strict division between collaborative and individual work gave a very simplified picture of what was taking place during the knotworking sessions. It seemed that the designers were simultaneously engaged in collaborative and individual work as well as in working in pairs and groups.

In the third phase of the analysis, the forms of the participants’ collaboration during the knotworking session were identified. The form of collaboration was marked for each participant in each five-minute time slot. The forms of collaboration were

individual working, working in pairs, working in a group (here defined as a group of 3–7 persons, more than a pair, less than a whole team), and the whole team working together. In addition to these, the group ‘other’ was added to include work that was not related to the design tasks at hand. The participants’ absences from the session, for instance, going to the toilet, were also included in this group.

THE FORMS OF COLLABORATION

Figure 1 below shows the distribution of the individual work and the different forms of collaboration in both teams. The shares are percentages of the total working hours of the two-day knotworking session. Most of the time both teams worked in groups (36% for Team New and 41% for Team Renovation). Typically, the groups dealt with one topic 5–15 minutes at a time. It was also typical that the participants in a group might change during a conversation. The second largest form of collaboration was individual working, which might include asking short questions or providing answers to the others, although the participant’s main focus was on his or her own work. Team New spent about 16% of their time working both in pairs and as a whole team. Team Renovation spent the least time working in pairs. During the pair working, two members of the team worked on the same topic, side-by-side, commenting on and discussing each other’s work. When working as a whole team, everyone listened and followed the presentation on the screen unless they were not actively participating in the discussion. In addition to these collaboration forms, the class ‘other’ describes absences and work that was not included in the knotworking.

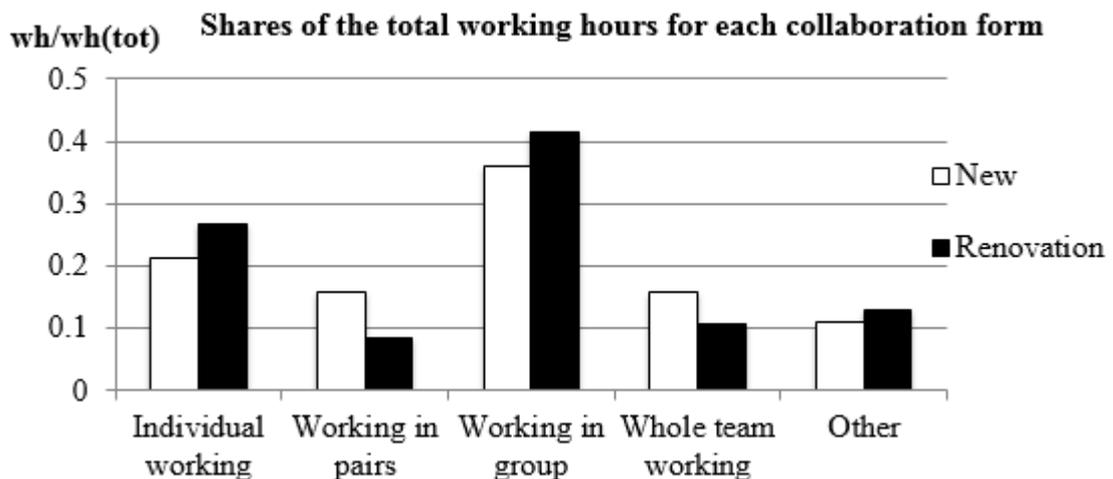


Figure 3 Shares of the total working hours for the individual work and each collaboration form.

Figure 2 shows the distribution of the individual work and the different collaboration forms for each member in both teams. The distributions between the two teams have similarities and differences. In Team New, the cost analyst and the architect did the most of the individual work. In Team Renovation, the energy specialist and the cost analyst worked by themselves the most. In Team New, the energy specialist worked the most in a pair and with the HVAC designer the most. In Team Renovation, the architects worked as a pair the most.

In both teams, the coordinator and the visualizer actively worked in groups. In Team New, the structural designer also spent much time working in groups, as well as the second architect in Team Renovation. In the next section, we present examples of how the forms of collaboration shifted between topics and tasks.

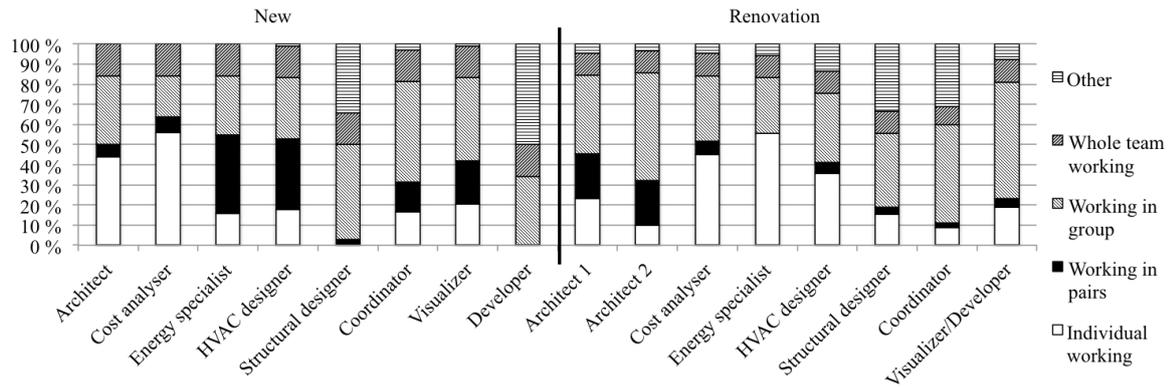


Figure 4 Individual work and the collaboration forms of each participant in the knots.

EXAMPLES OF SIMULTANEITY AND PULSATION IN THE DESIGN COLLABORATION

In this section, we present examples of the diverse forms of working and collaboration that occurred during the knotworking sessions. How did working together proceed during the knotworking? Our aim is to illustrate the specific features of simultaneity and pulsation in knotworking. Two of the examples focus on the most discussed topics in each team: an overheating issue discussed by Team New and the old building and its limits discussed by Team Renovation. The third example focuses on Team New trying to improve the methods and tools of their work in the knot. The tables (1, 2 and 3) show the collaboration forms that occurred during the handling of each topic.

Table 2 Variation of the forms of collaboration during the handling of the overheating issue, Team New. (I) for individual working, (Pa) for pair working, (Gr) for group working, (Wh) whole team working, (O) other.

Time	Arch.	Cost a.	Energy	HVAC	Coord.	Vis.	Struct.	Dev.
4:20:00	I	I	Pa1	Pa1	Pa2	Pa2	O	O
↓	I	I	Gr	Gr	Gr	Gr	Gr	O
↓	I	I	Gr	Gr	I	I	O	O
↓	Gr	Gr	Gr	Gr	Pa2	Pa2	Gr	Gr
↓	Gr	I	Gr	Gr	Gr	Gr	Gr	Gr
↓	Wh	Wh	Wh	Wh	Wh	Wh	Wh	Wh
↓	Gr	I	Gr	Gr	Gr	Gr	Gr	Gr
↓	Gr	I	Gr	Gr	I	I	Gr	Gr
5:30:00	Wh	Wh	Wh	Wh	Wh	Wh	Wh	Wh

The biggest issue for Team New was the overheating problem in a few rooms of the building (see Table 1). The problem became urgent when the HVAC designer and the energy specialist calculated the periods of the facility use. It turned out that the temperature in some rooms was estimated too high. They asked the cost analyst to calculate the costs of a larger AC device. The HVAC designer asked the architect whether they had solved similar problems in previous cases. Meanwhile, the coordinator and the visualizer simultaneously listened to the conversation and worked on another task. The architect showed his modelled plan, and the group speculated whether switching the spaces to another cardinal point would solve the problem. The

coordinator pointed out that most of the temperature load came from the estimated number of children in the rooms. The estimation was considered unrealistically high, because due to the school holidays, most of the children would not be in the facility. At this point, the cost analyst had finished his calculations for the new AC device. The team decided that it was up to the client to adjust to the lower temperature requirements during the summer season or to order a larger and more expensive air conditioner.

The placement of new spaces in the old building was a big issue for Team Renovation (Table 2). The discussion on this topic started when the structural designer commented on the insulating wall to the cost analyst and the researchers. The architects, the HVAC designer and the energy specialist discussed the architects' first design option and its plant room, while the structural designer made some calculations about the insulation. The coordinator came back to the premises after speaking with one of the villagers. He shared some additional information about the old building with the others. The structural designer shared his calculations concerning insulation thickness in the walls. The architect made a quick sketch placing all the spaces inside the old building, and the group discussed whether they should continue exploring that option, even if it did not fulfil all the requirements. They decided to give it a try; it would be an interesting and a different solution.

Table 3 Variation of the forms of collaboration during the discussion about the old building and its limits, Team Renovation. (I) for individual working, (Pa) for pair working, (Gr) for group working, (Wh) whole team working, (O) other.

Time	Arch.	Arch. 2	Cost a.	Energy	HVAC	Coord.	Vis.	Struct.
1:35:00	Pa	Pa	Gr1	I	I	O	I	Gr1
↓	Gr2	Gr2	I	Gr2	I	O	Gr1	Gr1
↓	Gr2	Gr2	I	Gr2	Gr2	O	Gr2	I
↓	Gr1	Gr1	I	Gr1	I	Gr1	Gr1	Gr1
↓	O	I	Gr1	Gr1	I	Gr1	Gr1	Gr1
↓	Gr1	Gr1	Gr1	I	I	Gr1	Gr1	Gr1
2:05:00	Gr1	Gr1	Gr1	Gr1	I	Gr1	Gr1	Gr1

The third example illustrates Team New's attempt to improve their tools and methods of working (Table 3). Team New tried to improve their working methods by implementing Dropbox and trying to unify their space classifications. The coordinator inquired about the classifications that the cost analyst was using in his software. He said that the classification in use was based on energy analysis software, but the cost analyst could also use area information from the architect as a shortcut in his work. He then stopped the discussion in order to ask the HVAC designer about the number of AC devices. The coordinator wanted to try a unifying space classification and the space types used in a different software program. The HVAC designer explained how they combined the architect's space object information with their own classification and gave an Excel sheet containing this mapping to the coordinator. They decided to install Dropbox software to ease the file exchange in the knot. The coordinator helped the architect, the cost analyst and the structural designer to install Dropbox, and the developer reminded the others about the schedule of the day. The energy specialist and HVAC designer continued discussing the E value, and the coordinator started working on the classifications. Later in the afternoon they returned to the

classification topic. The architect shared what kind of classification his software uses. The group concluded that the software should be developed in such a way that the name, number and type of space could be easily transferred to another software program used by other designers.

Table 4 Variation of the forms of collaboration during the discussion on improving the tools in use, Team New. (I) for individual working, (Pa) for pair working, (Gr) for group working, (Wh) whole team working, (O) other.

Time	Arch.	Cost a.	Energy	HVAC	Coord.	Vis.	Struct.	Dev.
2:00:00	Gr	Gr	Gr	Gr	Gr	Gr	Gr	O
↓	Gr	Pa	I	Pa	Gr	Gr	Gr	O
↓	Gr	Gr	I	Gr	Gr	Gr	Gr	O
↓	I	I	I	Gr	Gr	Gr	O	O
↓	Gr	I	Pa2	Pa2	Gr	Gr	Gr	Gr
2:30:00	Gr	Gr	Pa2	Pa2	Gr	I	Gr	O
↓	Break in topic, other discussion and working. Continuing after 1 hour.							
3:20:00	Gr	Gr	Pa2	Pa2	Gr	Gr	O	Gr
3:30:00	Gr	I	Pa2	Pa2	Gr	Gr	Gr	Gr

DISCUSSION

In this chapter, the nature of simultaneity and pulsation is clarified in knotworking. Throughout almost the whole observation period, the representatives of different design disciplines worked simultaneously on different design problems. As examples 1 and 2 show, the simultaneity of conducting design tasks gave the participants an opportunity to quickly test alternative designs and recognize poor design solutions. Rather than just validating a chosen design alternative (Flager *et al.* 2009), the participants were able to run multiple simulations and exploit the results in improved design solutions. The “almost real-time” feedback suggested by Eastman and colleagues (2011) succeeded during knotworking, as seen in example 1, in which the cost analyst provided calculations in less than hour for the rest of the team to evaluate.

The pulsating nature of knotworking is especially explicated in example 3, where the team is trying to create a new classification system. The classification system remains an object of activity (Engeström 2008: 88-89), but the members of the group vary in their focus by engaging, disengaging and re-engaging themselves in the topic. The core of the discussion pulsed and bounced among the members of the group, depending on which part of the classification system was being studied.

After the knotworking session, the participants felt that working together increased their understanding of the purposes and goals of the other disciplines (cp. Kvan 2000, van Gassel 2014). The team learned about each other’s methods of working and tool use as well as the limitations of their methods and tools.

You knew what another [designer] was doing. You knew what costs were taken into account, why did the HVAC designer choose those devices, why does the architect do that and that. Seldom in a project do you get the possibility to clarify the goals and purposes of others so fast. (The visualizer/developer)

The participants thought that the knotworking could be developed as a method for creating an expanded project design. Normally, creating a project design is an extensive process that happens over a long time span. Exploring multiple design solutions in a short time would also be beneficial for the client.

CONCLUSIONS

The simultaneous and pulsating quality of working in knots benefited the early phase of design in three ways. First, it supported the creation of concrete design solutions in a short period of time. The knotworking enabled the design teams to create concrete design solutions and solve problems in few hours that normally would take days to resolve. The results created in the knots were actual design solutions and documents, making them more productive than a usual design meeting. Working in the same place and exchanging information helped the designers to create better options more productively than designing on their own. Options were easily tested and accepted or rejected as a result of the immediate discussion.

Second, knotworking increased the designers' knowledge of the implications of their decisions on the work of their colleagues and the quality of design. It made other designer's choices visible to others and thus increased a common understanding about the other designer's solutions.

Third, knotworking eased shifts from coordinative talk to collaborative design and back. The design teams worked simultaneously and shifted easily from one form of collaboration to another. During the knotwork session, the teams worked mostly in groups, but were also able to work in pairs and individually. All forms of working served their purpose, from individual or pair work to accomplish specific design tasks to groups or the whole team focusing on more general problem solving and developing their work. The forms of collaboration varied even during the handling of one topic. Moving from one topic to another, as well as between collaboration forms, was fluent. The participants could easily take a break from their own work to take part in an on-going discussion and then continue working on their original task.

Knotworking appears to be an effective way to produce design options for early design phases. To implement knotworking in other design phases requires further research and development. The object of activity must be defined and developed together with the participants in each knot.

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ROLE CONFLICT IN PROJECT TEAM DYNAMICS

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Project team dynamics may be affected by mismatches between formal and informal sources of expectations. Conflicting or unclear expectations have not yet been studied closely in construction projects. Using role theory, the effect of such phenomena on project team dynamics was studied in construction projects. Most research into role theory relies on survey data; however, this study takes a qualitative approach. For a public project, contracts were studied, project meetings were observed, and semi-structured interviews with the major members of the design team were carried out to identify formal and informal sources of role expectations. Analysis focused on the misalignment of these sources. A model was developed to help explain project team dynamics and the interaction of formal and informal sources of role expectations. Findings reveal that underspecified roles and responsibilities within contracts and plans of works effected role interactions and ultimately team dynamics.

Keywords: contracts, informal sources of expectations, role expectations, team dynamics.

INTRODUCTION

Construction projects bring together different specialized organizations and professionals. Hughes (1989) showed that even on relatively small projects, before the construction phase starts, the number of people involved in decisions can reach as many as two hundred. Over the course of the project, these people interact with each other to realize project aims. One of the fundamental elements in every interaction between two individuals is the expectations that one person holds for the other. In construction projects, for any given participant, numerous other participants will have multiple expectations regarding the tasks of that participant. Should there be any misalignment or ambiguity within those expectations, the individual as well as his/her relationship with other participants will be affected. This can cause strain and frustration (Kahn *et al.* 1964; Katz and Kahn 1978) to the extent that the person leaves the team which, in turn, may jeopardize a whole project (Chapman 2002). As Crichton (1966) explained, many of the problems in construction projects arose from human relationships.

Another major concern of this research is the source of participants' expectations. The idea is to explore whether they are rooted in formal mechanisms like contracts, codes and plans of works or informal mechanisms such as interpersonal factors and cultural resources such as stereotypes and traditions in construction projects. There have been several studies in construction management research that take into account different formal and informal aspects of construction projects eg. Gluch (2009), Georg and

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Tryggestad (2009) and Dey *et al.* (2008) just to name a few. However, as Wells (2007) pointed out, more sophisticated analytical tools need to be developed and implemented to examine informal aspects. There is a need to view informal as it relates to formal (Chan and Räsänen 2009).

Following this, the aim of this research is to explore situations that are characterized by misaligned or ambiguous expectations among project participants while taking into account their formal and informal sources of the expectations. To address this problem, a model of role process was developed to examine the interaction of formality and informality in the context of role dynamics. The model was used to study three construction projects. This paper illustrates the research with data from one of the projects which was to build a new energy centre and an underground district heating mains system for a public sector client.

LITERATURE REVIEW

The problem of formal and informal sources of expectations and their effect on role dynamics builds on two literatures or topics: roles in construction projects, and informal aspects. As for the former, there are several studies on the matter of roles and “*who does what*”. This literature either concentrates on one specific role (Anstruther 1997, Khosrowshahi 1988) or provides a generic description of roles and responsibilities in construction projects (Murdoch and Hughes 2008, Ndekugri and Rycroft 2000). In contrast, Hughes and Murdoch (2001) focused on how roles specified in different plans of work relate to each other. In their study, the authors compared the formal descriptions of roles and responsibilities in nine familiar patterns of plans of work or procedural documents such as Joint Contracts Tribunal (JCT), British Standards, and Royal Institute of British Architects (RIBA) plans of work. They also examined the terms used to describe responsibilities in those documents. Their research highlighted mismatches in the definitions of roles and responsibilities in different sources, but the effects of such mismatches on the individual and the team dynamics were not addressed.

There is relatively little research on informal elements in the context of roles. A key exception is a study by Gluch (2009) examining both formal and informal aspects in the construction sector. She studied the role and identity of environmental professionals and the way they are formed informally at the workplace. Gluch’s findings show that the authority of environmental professionals is not enough to enact their role fully. To overcome their problems they adopted a formal role in line with their job description and an informal role which was more suitable for that special project. The need to conform to the formal and informal expectations separately and in different ways puts extra pressure and stress on environmental professionals. Other studies looking at construction roles include Kagan *et al.*’s work (1986) work on the role of the design engineer and Georg and Tryggestad’s (2009) examination of the role of project manager, but they all focused on a single role.

Other authors have begun to examine informal factors in team dynamics. To capture the interactions between people on a single project, Nicolini (2002) introduced the term “*project chemistry*”. In addition research on organizational culture, occupational stereotyping and role-based image discrepancies suggest informal sources which potentially influence participants’ image and expectations of each other (Ankrah and Langford 2005, Loosemore and Tan 2000, Vough *et al.* 2012). As valuable as these reports are, each focuses on a single informal source of expectations. Little is known about how informal factors come into play together with the formal factors. In this

study, role theory is used to explore situations where misalignment within the expectations of different participants influences the role dynamics.

THEORETICAL FRAMEWORK

The key idea of role theory is that individuals occupy “*social positions*” and holds “*expectation*” for their own behaviour and the behaviour of other individuals (Biddle 1986). In other words, role theory is concerned with how people expect the person enacting a role to behave based on his/her social position.

There are different perspectives in role theory, but the one relevant to the scope of this research is organizational role theory. Organizational role theory considers roles within formal organizations. The social system in this perspective is assumed to be pre-planned, task oriented and hierarchical. In this approach, roles develop initially from a set of task requirements and explain particular forms of behaviour that are associated with a specific position. The relationships among people in an organization are functional relationships and roles are standardized patterns of behaviour that are required of every individual in the context of that relationship (Katz and Kahn 1978). A key concept in this approach is “*role conflict*” which refers to a situation when an individual is subject to opposing norms and expectations from multiple senders. In other words, it characterizes the situation in which one individual faces incompatible expectations from other individuals with whom he or she interacts. Conflict can also be generated between two or more roles held by one person. However, this type of role conflict is not in the scope of this research because it is not a relevant type of role conflict in the study of participants’ interactions.

In the study of role conflict, there are some fundamental concepts which were mostly introduced and discussed by Kahn *et al.* (1964), who first carried out comprehensive research on this matter. Key concepts include: organization, office, focal person, role set, role senders, role expectations and role behaviour. They defined ‘organization’ as an open and dynamic system that delineates a continuing process of input, transformation and output. An ‘office’ is a relational concept which defines one position within the system in terms of its relationship with others and with the whole organization. The person who occupies a particular office is required to deliver a set of activities as potential behaviours. These activities become a part of the ‘role’ that the person needs to perform. The individual who occupies the office and who the researcher is focusing on is called a ‘focal person’. ‘Role set’ is a collection of individuals who are related with a particular office. The members of a person’s role set are called ‘role senders’ (Rommetveit 1955). ‘Role expectations’ are “*prescriptions and proscriptions held by members of a role set*” (Kahn *et al.* 1964 p.14). The contents of these expectations constitute two elements: one is related to the person’s office and the other one is about his/her abilities. In other words, role expectations involve the role set’s preferences regarding a task and personal characteristics or style. ‘Role behaviour’ is the kind of behaviour which is relevant to the system, performed by the focal person as a member of the system, and is not necessarily in line with the expectations of his/her role senders (Katz and Kahn 1978, p.189).

Kahn *et al.*’s (1964) research focused on the impacts of organization on individual. More specifically, they were concerned with the effects of the environment on physical and mental health of individuals, with the driving force of an individual’s well-being and with organizational effectiveness. Within this framework, they studied the “*nature, causes, and the consequences*” of role conflict. A national survey from

725 persons as representatives of the labour force in the USA as well as structured interviews with 53 individuals from six industrial locations were carried out. Based on the national survey, Kahn *et al.* (1964) discovered that almost half of the participants were facing noticeable role conflict and, among these, 15% reported this issue as a serious and frequent problem. Furthermore, 39% of the population in the study reported being bothered by the fact that they have not been able to satisfy conflicting demands of their role senders. Their findings showed that role conflict may have negative emotional experiences on the part of the focal person, including increased tension, high internal conflicts, decreased job satisfaction and reduced confidence in superiors and in the organization as a whole. To cope with these issues, individuals may take different strategies like social and psychological withdrawal.

Building on the research carried out by Kahn *et al.* (1964), some researchers investigated role conflict within organizations. For example, Quinn and Shepard (1974) showed that 31% of employees within an organization experience conflicting demands from other people. Other negative impacts of role conflict included: increased job tension, job dissatisfaction, employee burnout and decreased organizational commitment and performance (Jackson and Schuler 1985; Van Sell 1981; Netemeyer *et al.* 1990). Other authors studied role conflict for managers within the organization. For example, Floyd and Lane (2000) studied top-, middle- and operating- level managers involved in a programme of strategic renewal in organizations. They argued that while it was not apparent which managers were at greatest risk of role conflict, most of them experienced it to some degree. They also argued that role conflict increased the uncertainty and risk of opportunistic behaviour, damaged to the quality of information exchange between managers and hindered the adaptive process. In a more recent study, Tang and Chang (2010) studied the effects of role conflict on employee creativity and concluded that role conflict has a negative effect on creativity.

The above studies show that the effects of role conflict on the focal person are pervasive. This phenomenon and its effects on the individual, the team and the project objectives were not addressed in construction project teams. In this research, the analysis rests on a modified version of role conflict taken from Katz and Kahn (1978).

THE MODEL OF ROLE PROCESS

The aim of this study was to investigate role conflict as a result of mismatches between role expectations communicated to the focal person considering their formal and informal sources. To accommodate these concerns the classic model of role conflict (Kahn *et al.* 1964) was modified (Figure 1). In this new version, four elements - "*formal sources of role expectations*", "*informal sources of role expectations*", "*formal sources of role behaviour*" and "*informal sources of role behaviour*" - were introduced. In construction projects, formal sources of role expectations and role behaviour were considered as contracts, codes and standards, plans of works, fee and budget constraints, time limits, organizational factors, procurement method and government policies. Informal sources include: fears, sensitivities, motives, values, work experience, educational background, stereotypes and interpersonal factors.

The model has been developed to draw attention to the interaction between two or more project participants with their formal and informal sources of role expectations and role behaviours. More specifically, it has been used to establish whether the sources that triggered a role expectation and that informed the focal person's

behaviour response were formal or informal. This analysis provides a basis to examine misalignments in role expectations and thus helping to explain individual's behaviour.

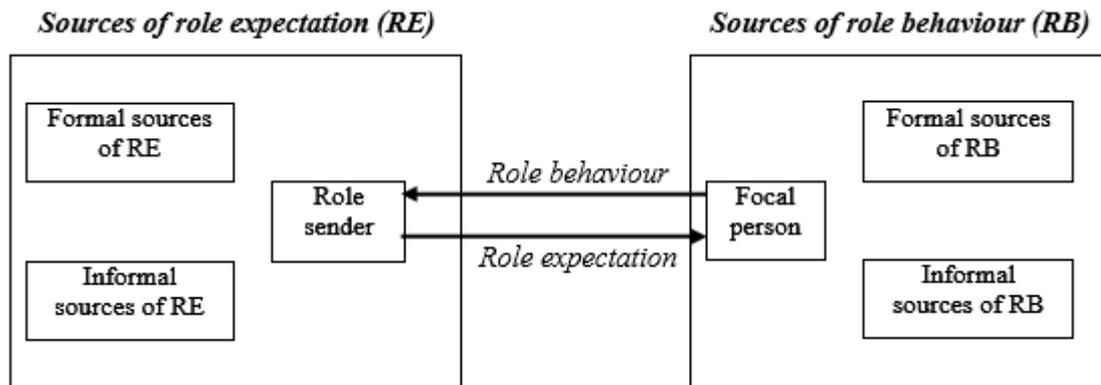


Figure 1: The theoretical model of role interaction considering formal and informal sources of role expectation and role behaviour

RESEARCH METHOD

Most research into role conflict relies on survey data. The current study, however, adopted an interpretivist approach based on qualitative data gathered from three projects in the UK. In these projects, designers' contracts were studied as the most important formal source. In addition, project meetings were observed, and semi-structured interviews with participants at meetings and other members of the project were carried out to investigate the subjective meanings of their actions. The method of selection of the interviewees was informed by the theoretical framework of the research. More specifically, interviewees were considered as the focal person and their major role senders were identified in the course of the interview and, at the same time, they were considered as the role sender of some other participants. The information gathered in the project meetings was used for a further identification of focal persons, their major role senders, participants' relationships and behaviours. It was also used as a subject for a further discussion in the course of the interview.

Before carrying out the interviews, an interview guide was developed. More specifically, a list of questions in three levels was set: the individual, the company and the project level. Interviewees were asked to provide a brief account of their background in terms of educational background, work experience, their position in the firm and in the project. They were then asked to describe the project and more importantly to explain anything that they observed or thought of as particularly different in this project. This question opened up the discussion of problems and challenges in the course of the project. After that, interviewees were asked about their familiarity with the formal documents, especially with their contract/agreement in that project. This particular set of questions was designed to establish their awareness and knowledge of formal sources of role expectations.

For the purposes of this paper, only one of the projects is discussed. This project was still in the design phase and five major consultancies were involved in providing several services, including the project management services, mechanical, electrical and structural services, architectural services, cost services and coordination, design and management services. In total, 13 people from these consultancies and from the client organization were interviewed. Each interview was designed to take about 30 to 45 minutes, but the majority of participants were happy to talk for more than one hour. Interviews were recorded and transcribed verbatim.

Nvivo software was used to organize the information gathered from transcripts, minutes, notes of meetings, and the contracts. Data analysis was carried out using the principles of template analysis. Template analysis is a technique (King 1998; 2012) of thematically analysing qualitative data. It shares principles suggested by Yin (2014) suggests, relying on theoretical positions. Theoretical concepts, like role expectations, role behaviour, and role conflict were taken as the initial coding. Once this was completed, coding was developed further to identify key themes. Data was then re-analysed using the model of role processes.

DATA ANALYSIS

Based on the data analysis three major processes and mechanisms that were involved with situations of role conflict were identified: allocation of responsibilities, the introduction of new technologies and the procurement method of the project. Here one of the cases that illustrated the effects of underspecified responsibilities is presented. The case is the interaction between the project manager and the structural engineer.

Generally in construction projects, designers' agreements, contracts and plans of work specify roles and responsibilities of each party. However, the project manager took the view that there are ambiguities and mismatches within those documents. In his experience, different architects, for example, would interpret RIBA plans of work differently:

“If you went to see six architects and you said, give me your RIBA Stage C deliverables, you'd get six different things.” (Project manager)

The project manager suggested that ambiguities within roles and responsibilities in contracts lead to constant negotiations:

“The awkward part for me is that you sit at a kick-off meeting and the first thing you have to say is: What are you going to deliver? And what people will tell you is: I'm going to deliver a feasibility report or I'm going to deliver a stage c report. Well, what goes in a Stage C report? And then I start: Am I getting 1 to 100s? Am I getting elevations? So from my perspective the no deliverables part can create tension from the outset.” (Project manager)

The project manager further explained that such tension was a result of differences between parties' perceptions about the right level of information for several stages of the project. This led the project manager to play the role of “referee” between different parties. To illustrate this point, he described a difficult moment in a previous project, where roles and responsibilities were not clearly specified. The case involved his interaction with the structural engineer regarding some information that the quantity surveyor required. In that case, the project was in the feasibility phase, and the quantity surveyor needed a piece of information from the structural engineer to calculate the costs. The project manager expected the structural engineer to provide a drawing of the suggested design. What the structural engineer provided, however, was a one-page structural engineering report. It did not clarify which wall would be demolished or where and how big the steels were. Consequently, it did not include enough information for the quantity surveyor to calculate the cost of the project.

The structural engineer believed that producing a proper drawing was not a part of his responsibilities for the feasibility stage. Even though the project manager and the structural engineer were referring to the same document, the structural engineer's agreement with the client, they had different interpretations of the responsibilities of the structural engineer. According to the project manager, the structural engineer

would only provide the required information on the condition that the client was ready to pay more. The client refused to do so and this led to a difficult situation for the project manager.

In this instance, all three parties expected the project manager to solve the problem. The quantity surveyor expected the project manager to deal with the structural engineer and to provide him with the necessary information for the calculation of the cost of the project. The client expected the project manager to obtain the required information without paying extra fees. And the structural engineer, by referring to his contract, refused to produce drawings with sufficient detailed information on them, without extra fees! Yet, the project manager wanted to manage the team harmoniously and to maintain his working relationships. As he explained, if the structural engineer thought that the project manager “*has pinched a grand off him*” in the first two months of a 24-month project, he would lose an interest and stop being responsive. To examine this interaction, the model of role process will be used.

THE MODEL OF ROLE PROCESS BETWEEN THE STRUCTURAL ENGINEER AND THE PROJECT MANAGER

The structural engineer’s role expectation from the project manager was to convince the client to pay an extra fee for the structural engineering drawing. The formal source for this role expectation was his contract with the client; he believed that his contract did not include such a service for that stage of the project. At the same time, the project manager faced two other role expectations. QS’s role expectation from him was to provide that information, and client’s role expectation was to solve the issue without paying extra fees. For his role behaviour, the project manager could not refer to the structural engineering’s contract as a formal source of role expectation due to the ambiguities in it. His informal source was his willingness to manage the team harmony and to keep the good relationship with the structural engineer. Clearly, he was in a situation of role conflict. He explained:

“It’s very difficult to play the strong hand all the time ... because you know that’s going to come back and bite you at some point in the next two years. If you’re too strong, all you end up doing is breaking all those relationships and at some point everyone will go back to the contract. And if you’re too soft everything is always a compromise.” (Project manager)

For the project to go ahead, the project manager put the quantity surveyor’s role expectation ahead of his relationship with the structural engineer. As the project manager expressed it, he had to “*leverage his relationship*” with the structural engineer. He went back to the structural engineer and asked for a hand sketch demonstrating which walls would be demolished, where the steels would be, if an H or a W would be used, and the like. After some role negotiations, the structural engineer then scanned and sent the project manager “*literally red pen over an existing drawing*”. In this instance, ambiguous roles and responsibilities within the designer’s agreement were a source of role conflict for the project manager and forced him into constant role negotiations with other team members. This dynamic is illustrated in Figure .

According to the project manager, this type of problem was quite common in construction projects. To deal with this type of issue the company had developed a document to specify all the “*duties and deliverables*” at each stage of the work for different roles. Should the client add this document to the consultancies’ agreement, participants would become aware of the detailed services they are expected to provide.

This was the case in the project in this research. In other words, the client of the project agreed to add this document to the designers' contracts. While the designers had the right to agree, disagree or negotiate for the services, the existence of such a document helped to clarify any conflicting or ambiguous issues at the very beginning. Ultimately, every party was clear about what they need to deliver, and they accordingly considered (included or excluded) those services in their fee proposals. In the project manager's experience, this decreased the potential situations of role conflict for different parties, and helped the client to maintain better control over the budget of the project.

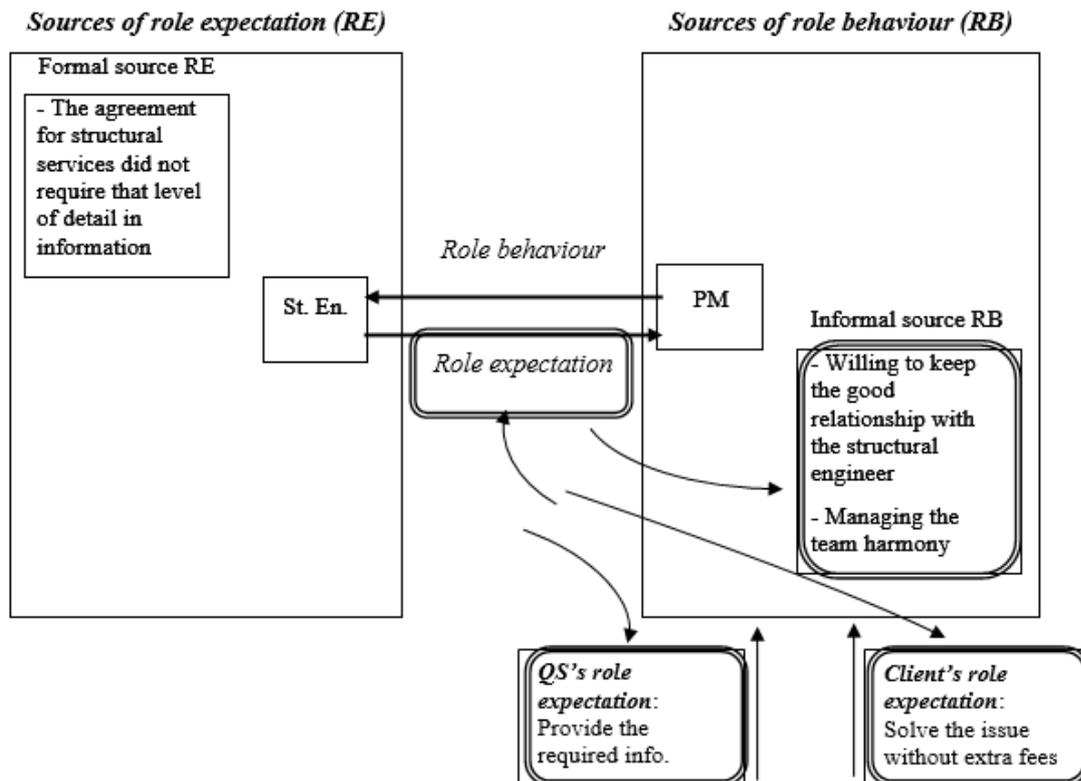


Figure 2: The model of role interaction between the structural engineer (St. En.) and the project manager (PM)

DISCUSSION AND CONCLUSIONS

Drawing on organizational role theory, the research presented here makes two major contributions both to the construction management literature and the literature on role theory. The analysis illustrated a successful implementation of the model of role process to identify the situations characterized by role conflict and to figure out whether they originate from formal or informal sources. This research revealed that formal documents like project contracts and plans of work are involved with ambiguities and lead to conflicting interpretations. This proved to influence the individual and the team. Although the existence of mismatches between and within some contracts and plans of work were identified by Hughes and Murdoch (2001), the effects of such mismatches have rarely been addressed in construction management literature. The analysis showed how the ambiguity within the structural engineer's contract affected participants' relationships. Moreover, a comprehensive document with detailed information regarding duties and deliverables of different project participants proved to be an extremely helpful tool in those interactions. Although the aim of this research is not to promote a greater formalization, a more accurate

allocation of responsibilities can contribute to a better relationship between participants.

As for the theoretical contribution of this research, it is to note that the focus of the proponents of organizational role theory (Kahn *et al.* 1964; Gross *et al.* 1958; Katz and Kahn 1978) was more on the individual and the psychology side of the focal person. The aim of this research, however, was to analyse role interactions between two professionals and, ultimately, its effects on the team level. Moreover, it incorporated the sources of participant's expectations and behaviour and considered the nature of those sources to explore if they root in formal or informal processes and mechanisms.

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MOVING BEYOND PROJECT COMPLEXITY: EXPLORING EMPIRICAL DIMENSIONS OF COMPLEXITY IN THE CONSTRUCTION INDUSTRY

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Complexity is not an under-researched concept within the construction industry. However, because of the nature and characteristics of this concept, most of the works have traditionally tended to approach it in a reductionist manner, concentrating on project complexity above all others. Therefore a more comprehensive understanding aimed at being able to make more informed decisions correspondent to the specification of new construction in the age of digital tectonics should be developed. As there is an undeniable need for new vantage points, the data should come directly from the immediate context in which complexity is to be scrutinised. A deductive approach based on in-depth study of live cases is deemed appropriate for this purpose. With reference to our previous theoretical framework, this paper deepens the quest for a more intelligent decision process by investigating construction case studies. This review of cases will be carried out using our alternative way of reading complexity which is nurtured by its meaning in many other disciplines, encompassing all aspects of complexity in a more holistic manner. The findings of the study are to be further developed through additional research in order to substantially contribute to a more up-to-date, fit-for-purpose decision framework to effectively manage complexity comprehensively where and when required in the construction industry.

Keywords: complexity, case study, systems, complexity science.

INTRODUCTION

The building sector has traditionally been taken for granted by those who are involved in it, ranging from professionals to users and from academics to practitioners. This is because they all have been used to having a selective and fragmental interpretation of it. Despite this very tradition, the building sector is by nature tremendously and arguably contradictory and complicated. The complexity and contradiction are mainly rooted in the differences inherited in the construction processes and their cross-sectional relation. By tradition the processes, as the container, are linear whereas the relations between those processes, as the contained, are usually non-linear. The Chartered Institute of Building (CIOB) (2007&2013) found that complex projects are highly likely to run over time using traditional management techniques and that a new way of thinking is required. This paper aims to highlight the importance of considering all aspects of complexity in the Architecture, Engineering and Construction (AEC) industry, and not focusing purely on those aspects that we are familiar with. The paper uses case studies of 'complex projects' to demonstrate the

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varying scope of complexity that is experienced in the industry to identify the need for a rereading of the concept of complexity in the AEC industry.

COMPLEXITY

Adhering to a neutral standpoint with an exploratory nature in our enquiry, in a previous paper we investigated different types of complexity and classified them as: Behavioural; Organisational; Project; Systematic; Social; Organic; Data; and Technological (Wood *et al.* 2013). Deuchars (2010) believes that the social sciences, in comparison [with pure sciences i.e. physics, biology and mathematics] have been relatively less successful in their attempts to understand complex social systems. Therefore it would seem amiss to artificially separate physical systems from social ones. However, it is essential to remember that more often than not it is very difficult if not impossible at all to: study complexity merely and exclusively in one discipline and; ignore how the concept of complexity in one discipline is formed, and/or informed by its meaning in other fields. Complexity refers to the fact that in a system there are more possibilities than can be actualised (Luhmann 1985) and irreducible heterogeneity is tantamount to complexity (Katz 1986). The formal definitions of complexity as Stewart (2001) suggests fits into two main groups: algorithmic complexity, deriving largely from computer mathematics; and organisational complexity, deriving from the new biology and a revived systems theory. As a rather simple algorithmic definition, the complexity of a system is tentatively the quantity of information needed to describe it (Cohen and Stewart 1995). Organisational complexity, by contrast, is more concerned about the behaviour of a system and its analysis (Nicolis and Prigogine 1989). Or as Coveney and Highfield (1995) suggest within science... complexity is the study of the behaviour of macroscopic collections of basic but interacting units that are endowed with the potential to evolve. Some other characterisations within social science disciplines can be of significant help in casting light onto the notion of complexity with specific purposes of the current research, despite Deuchars' (2010) suggestion that social sciences have been less successful in their attempts to understand complex social systems: '...the degree of complexity in organized social systems... is a function of the number of system components..., the relative differentiation or variety of these components..., and the degree of interdependence among these components' (La Porte 1975:6). What can be adopted from this and adapted to the specifics of this research is first of all the elements (referred to as system components), secondly their variation (variety or differentiation) and lastly but equally important, their degree of interdependence.

Theories of Complexity

Theories of complexity stemmed from the attempts by meteorologists, biologists, chemists, physicists and natural scientists to build mathematical models systems in nature (Gleick 1988; Lorenz 1993; Styhre 2002; Burnes 2004). In this process some particularly distinct theories appeared. Some of key theories in this regard are as follows chaos theory, dissipative structures theory and the theory of complex adaptive systems. The main difference between these three mainstreams, according to Stacey (2003), is that chaos and dissipative structures theories seek to construct mathematical models of systems at macro level (that is, whole systems and populations), whilst complex adaptive systems theory attempts to model the same phenomena by using an agent-based approach. Instead of formulating rules for the whole population, it seeks to formulate rules of interaction for the individual entities making up a system or population (Burnes 2004). There are three essential notions which form the core of

complexity theories: the nature of chaos and order, the edge of chaos and order-generating rules.

Chaos and order

Chaos is usually depicted as a complete randomness particularly because of its idiomatic connotation. From a complexity point of view, however, it is another type of order which differs from the classical types of orders with which we are familiar; an orderly disorder which occurs in nature more often than being ignored (Frederick 1998; Arndt and Bigelow 2000; Fitzgerald and Van Eijnatten 2002). Fitzgerald (2000) describes chaos and order as twin characteristics of a dynamic, non-linear (complex) system and then suggests that in chaos a hidden order may be concealed without which disorder looks like total randomness. Stacey (2003) suggests three types of order-disorder: Stable equilibrium, Explosive instability and Bounded instability. Under the first one, the system will ossify and die, under the second one the instability (as a result of disorder) will run out of control and may destroy the system. Only the second one can be deemed as a viable option under which a system can healthily survive.

Edge of chaos

Stacey *et al.* (2002) uses the phrase 'far-from-equilibrium' for this situation, the best description for an ever-evolving condition between the order and disorder is perhaps given by Brown and Eisenhardt (1997) where they assert that complex systems have large numbers of independent yet interacting actors. Rather than ever reaching a stable equilibrium, the most adaptive of these complex systems (e.g., intertidal zones) keep changing continuously by remaining at the poetically termed 'edge of chaos' that exists between order and disorder. By staying in this intermediate zone, these systems never quite settle into a stable equilibrium but never quite fall apart. Rather, these systems, which stay constantly poised between order and disorder, exhibit the most prolific, complex and continuous change.

Order-generating rules

In complex systems, order is arguably generated by an act of simple order-generating rules. The nature and inclusiveness of the orders are crucially important. These rules on one hand limit the chaos to an extent by which the survival of the system could be guaranteed. Yet on the other hand they provide order to an extent that the system can keep on its routine activities and fulfil its ordinary tasks (MacIntosh and MacLean 2001; Stacey *et al.* 2002). In an astonishing variety of contexts, apparently complex structures or behaviours emerge from systems characterised by very simple rules. These systems are said to be self-organised and their properties are said to be emergent. The above account will form one of the basic principles for using apparently easy rules in handling a system of a relatively high complexity. However, it should carefully be noted that simple rules do not necessarily mean simplicity of solution. Proportionate solution to the degree of complexity is key to handle the situation, behaviour, structure or setting successfully at the edge of chaos. The rules are expected to manage the system in a way that not only is a factor or a relation not undermined or privileged under the influence of the others but also to make sure that no unwanted unpredictedness is likely to happen in the whole procedure. The former may happen simply when the rules are too dominating while the lack of an effective and interactive moderator/coordinator entails occurrence of the latter (Piroozfar 2008). Therefore, the concept of order-generating rules explains how complex, nonlinear, self-organizing systems manage to maintain themselves at the edge of chaos even under changing environmental conditions (Burnes 2004).

RESEARCH METHODOLOGY

This research utilises a case study research approach. Case study research is a thorough investigation of a phenomenon in its natural setting, and often makes use of a variety of data sources (Benbasat *et al.* 1987). It can help form the basis of building new theories (Eisenhardt 1989) or refine existing ones (Siggelkow 2007). As a methodology, case study is a popular approach in social sciences but also has a long history in different disciplines (Creswell 2007). Similar to established quality checks in empirical social research, Yin (2003: 34) quotes precedent works including Kidder and Judd (1986:26-29) to suggest four operationalisation of rigor quality indicators for case study research, viz. (1) construct validity, (2) internal validity, (3) external validity, and (4) reliability. Case study research is based on a constructivist paradigm (Stake 1995) hence concepts are assumed to be subjective. As such meanings are informed by researcher's experience, their interactions with historical, societal and cultural norms and settings as well as their community of practice (Creswell 2009). It has always been criticised for lack of generalisability of its knowledge claims. However, it should be noted that the type of generalisation for case studies – what is known as analytic (al) generalisation (Yin 2014) or theoretical generalisation (Sharp 1998) – is fundamentally different from statistical generalisation. Reliance on different sources for data query and multiple data analysis techniques are regarded as the primary strengths of case study research. This increases the validity of findings (Ridenour & Newman, 2008). For these reasons this research will utilise a multiple-case design with multiple-units of analysis approach to enrich and deepen the findings, increase its construct validity, internal validity, external validity and reliability (Beverland and Lindgreen 2010). In order to demonstrate the wide ranging complexity present in the AEC, a number of case studies were chosen based upon the criteria for complex projects as set out by the CIOB (2011) in Table 1. Data was gathered in the form of a desk study to be expanded upon through the use of interviews in the next phase of the research.

COMPLEXITY: AN INDUSTRY FRAME OF REFERENCE

It has been demonstrated that complexity is a wide ranging subject with a number of different connotations; however, the concept of complexity in the AEC industry is fairly narrow in the subject of complexity, concentrating mainly on project complexity, possibly at the disadvantage of the industry. An important point to bear in mind is that talking about systems, the terms “*complex*” and “*complicated*” denote different notions which might easily get mixed up. The difference between “*complicated*” and “*complex*”, as Cilliers suggests, is that in a complicated system, the components can be clearly identified whereas in a complex system, the interaction between the components of the system, and between the system and environment, are so intricate that it is impossible to completely understand the system simply by studying its components. A complex system is not constituted merely by the sum of its components, but also by the intricate relationship between these components (Cilliers 1998). In other words, in a complicated system what counts is just the set of elements whereas in a complex system in addition to that what really dominate the system characteristics are the way in which those elements interact with each other and the way in which the system personifies itself within its context.

Table 5 Simple vs. Complex projects (adapted from CIOB, 2011)

Simple projects comprise those in which construction has all the following characteristics	Complex projects comprise those in which construction has any one or more of the following characteristics
Design work is completed before construction starts; Work comprises a single building (or repetition of identical buildings); Construction is lower than 5-storey height; Without below ground accommodation; Carried out to a single completion date; Without phased possession, or access dates; With services not exceeding single voltage power, telephone, hot and cold water, and heating; With a construction period shorter than nine months; With a single contractor; and With fewer than 10 subcontractors	Design work is to be completed during construction; Work comprises more than one building; Construction is higher than 5-storey height; Contains below ground accommodations; To be completed by multiple key dates and/or sectional completion dates; With multiple possessions, or access dates; With short possessions; Work contains services exceeding single voltage power, telephone, hot and cold water, and heating; Construction work is accompanied by work of civil engineering character; or The construction period is longer than 12 months; Construction to be carried out by multiple contractors; or By more than 20 subcontractors

The Chartered Institute of Building has, following consultations, launched its Complex Projects Contract 2013 (CPC13). The contract is intended for complex projects, in the UK or internationally, which are likely to have one or more of the complex project characteristics, which distinguish it from a simple project as identified in Table 1. It has been suggested that simple projects can be managed intuitively and have a high chance of finishing on time using (CIOB, 2007). However so called complex projects of complex projects are extremely likely to be late when using traditional time management techniques.

These features concur with many of the factors identified by Wood (2010) relating to project complexity. Although it is encouraging to see that the industry is responding to the increasing complexity of modern construction projects, the focus of the industry appears to be on the project complexity aspect, dealing with the practical aspects such as project size and duration. Complexity can arise from systems with just two variables, however, construction is far more complex, instead of dealing with just two variables construction projects have a number of interacting teams where outcomes in the future depend on the number of teams involved, the quality of relationships between interacting teams and their performance variability. In addition there is also unpredictable interface which may arise from numerous external factors which form an additional set of parameters and make construction inherently difficult (Radosavljevic and Bennett, 2012).

CASE STUDIES

It is clear that the traditional view of the construction process as linear is outdated and inappropriate when considering modern projects with research indicating that complex projects cannot simply be organised into separate components to be managed individually, but must be considered as a system as a whole taking into account the interactions and interdependencies both identified and unidentified. The case studies were selected based on their size, time schedule, budget and the common understanding of the level of their complexity. The cases were studied using intensive content analysis of the commonly available data on projects' websites as well as more specific but commonly available data sheets and documents of each project. The following section will provide a general introduction on each case followed by a

critical reflection of them within the theoretical framework of this study. The detailed analysis of case studies will be used for developing a framework for analytical generalisation of findings which will then be used, in the next stage of research, to expand the more in-depth enquiry using discussion through steering/focus groups of industry experts.

Crossrail

Crossrail is Europe's largest infrastructure program with a budget of £14.5 bn. The project consists of 42km of tunnels and seven new stations with construction of the tunnels weaving between existing underground lines, sewers, utility tunnels and foundations at depths of up to 40m below some of the world's most iconic buildings. When complete the project will increase London's transport capacity by 10%. It has multiple, complex construction projects running concurrently across the whole route. At the same time as constructing eight new underground stations, which have been connected to the existing London Underground and rail networks, and four overground spurs, Crossrail must minimise the disruption to the existing transport system and the millions of commuters that use it each day (Crossrail, 2013).

London 2012 Olympic Games

The project consisted of over 70 projects including and encompassed the delivery of a 14 permanent structures such as the main stadium, aquatics centre, velodrome, athlete's village and press centre as well as some largely temporary structures such as the aquatics training centre, basketball arena and water polo venue. In addition 20km of roads, 26 bridges, 13km of tunnels, 80 ha of parkland and new utilities infrastructure were required (Davies & Mackenzie, 2013). The timescale of the project was spaced over 6 years, starting with the handover of the site in 2006 and ending with the build phase and testing of the facilities in the approach to the games with a cost of £6.8 bn. Due to the nature of the project, the organisational structure established to construct the venues and infrastructure was arranged in two interacting level of systems integration to match the complexity of the project, this was structured as the Olympic Delivery Authority (ODA) acting as the public sector client organisation and a temporary joint venture acting as the private sector delivery partner.

REREADING CASE STUDIES WITHIN THE STUDY CONTEXT

The conventional intellect

If considering the more traditional "*project complexity*" aspect of the project such as those characteristics set out in Table 1, it is clear to see that the Crossrail project would be considered as complex, however in order to fully understand the complexity of the project the wider aspects of complexity theories can be considered. When considering the Crossrail project as a system it is evident that there are a large number of actors or components within the project as a whole and as sub components within the various aspects of the project. This leads to a great deal of interdependencies and interactions both between the internal components but in the case of this project also with the external environment which adds another substantial layer of complexity. This situation places the project in a continuously changing state (edge of chaos) and is thus deemed to be complex in nature.

In a similar way to the Crossrail project, the construction of the London 2012 Olympic and Paralympic Games was a major project that encompassed a number of large independent but interacting projects. Again, when considering the Olympics project in terms of the more traditional project complexity route, it demonstrates nearly all of

the characteristics of a complex project as identified by the CIOB (2011 - Table 1). However, when considering the complexity of the project in a wider perspective, as with the Crossrail project, it can be seen that the complex nature is derived from more than just these individual components but from the interdependencies and interactions required within the system, especially considering the organisational structure and environment in which the project was running.

Complexity above and beyond project levels

Both projects are perceived as complex by different accounts. However, the perceived complexity is above and beyond project level. From a systemic point of view, a project i.e. 'system' has interrelations with its subordinates i.e. 'sub-systems', as agents, elements, components, individuals who/which have been working hand-in-hand to make the project happen. At an upper systemic level, each system sits in a context next to other systems collectively ruled or governed by a superordinate namely a 'super-system'. A super-system is formed not only of its components or member constituents at different levels/tiers but also of relationships, flow of knowledge, information and data between agents inside and out, and also authority (in form of leadership, conventions, ethical codes, political power, society forces, lobbying, etc.) and last but not least financial drivers and the cash flow. That is where a systemic view of complexity helps address or prevent many problems which might otherwise be hard to manage hence overlooked.

Every project even at a much lower level than the Crossrail or London 2012 introduces a new order in many respects. Such projects define the ways in which societal, economic, political, technical and environmental constructs are comprehended. They set new orders ranging from individual to community, urban, national or international levels, least by introducing precedents and new conventions. They introduce new trends way beyond their time and geographical contexts. In such situations the existing orders need to be challenged, manipulated, diverted, redirected, and, from time to time, even broken. Once this took place a new order needs to be successfully and effectively formulated, introduced and enforced; what takes account of all previous mechanisms in their new setting yet is also capable of embracing the new relationships between the existing agents and those between the existing and the new ones. There is always a level of intertwined, multi-faceted, multi-disciplinary complexity imposed by such projects when they break the exiting order and once they are about to introduce the new order - regardless of their level of success in introducing and establishing that new order - which is almost unconsciously inevitably unknown. The matter of the fact, however, is that this is an unknown unknown, which suggests that there are some levels of unperceivable uncertainty involved. This brings along the issue of 'chaos and order', one of the commonly shared principles between distinct theoretical accounts of complexity.

Furthermore in such complex projects, driving forces - both physical and non-physical - exist; both internally and externally. A project is up and running while the driving forces behind it are in a relative balance. This is a real-time, dynamic, ever-changing balance with such a fast pace and so vulnerable-to-collapse nature that takes up on the entire working mechanism within the system (i.e. project) from within and in interaction with its external driving forces and pushes it onto a fragile 'edge of chaos'. It is noteworthy, however, mentioning that, chaos is an order in its own, where the rules are changing so fast that the orders cannot be framed in long enough a period of time - a time frame - clinging to which habitual familiarity can introduce a sense of a recognisable pattern; what can be perceived as an 'order'.

To expand on this very fast-paced change in the existing constructs, introduced as a result of such project, any such trivial, minuscule and short-lived chaotic order, no matter how insignificant or instantaneous they are, is bound to be generated by a rule. The source, effectiveness, origins and roots, reasons and causes of such rules and their resultant orders may not be easily subject to observation, investigation or tracking. In fact this might not even be that important altogether. What is more important is to map such rules - and their corresponding orders - within the bigger picture of the entire system and gauge their effects and implications both in terms of their severity, frequency and importance. This way the whole system can be most effectively and dynamically kept on the 'edge of chaos' so that while the existing 'circumscribing' order is being challenged, altered or dismantled altogether, mini trivial orders can successfully maintain the balance between the chaos and order, leading it into and handing it over to a permanent new order - most likely to be a bigger and more comprehensive one with a corresponding level of complexity - to manage the new setting.

CONCLUSIONS

This paper has demonstrated the viewpoint that complexity in the AEC industry is often characterised by aspects more traditionally identified as factors relating to 'project complexity', with aspects such as the physical size (e.g. storey height), project duration, technical difficulty (e.g. below ground accommodation) and number of contractors involved, being used to indicate the complexity of a project, or whether or not the project is 'simple' or 'complex'. Whilst the industry is responding to the increasing complexity of projects with documents such as the CIOB CPC13 looking to address areas such as collaborative working, integration of the team and disputes (Pickvance and Lane, 2013) there is still a long way to go in terms of fully understanding the complexity of the industry and its impact upon projects. It has also demonstrated that complex systems cannot be studied in isolation and therefore there is a need to broaden the understanding of complexity in the AEC industry and to recognise that it is no longer possible to break a project down into individual components which can be managed in isolation. This has been highlighted through the study of projects deemed to be complex by conventional standards and showing how, when considered from a complexity and systems theory standpoint that projects are highly complex due to their ever changing nature on the edge of chaos due to the high level of independent but interrelated components. It is anticipated that further investigation of the cases highlighted here, as well as other cases will significantly contribute to the understanding of complexity and will facilitate a more up-to-date, fit-for-purpose decision framework to effectively manage complexity comprehensively where and when required in the construction industry. On the other hand it is believed that such contribution can help build up a 'theory of complexity' - the first of its kind - in the construction industry using a grounded theory approach. This will be investigated further in next stage of research.

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A DETAILED ANALYSIS OF EXISTING PROJECT SUCCESS FACTORS

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The quest for knowledge about which factors influence project success has long been at the centre of attention of the project management community. This quest has produced an enormous number of success factors claimed to assist project professionals. This study is built on the results of 100² empirical and theoretical papers written on project success factors published since the late 1960s and aims to take them one step farther and establish their implications through categorising and statistically analysing them, in addition to explaining the underlying trends that exist for changes of success factors over time. Papers have been sorted into 4 groups: construction, IT/IS, new product development (NPD) and general. This classification will help this study to answer the following questions: What are the most repeated success factors in each category? What are the relationships between success factors from different types of projects? How has researchers' focus on project success factors changed over time? Through answering these questions, this paper identifies the fundamental differences between types of projects and warns practitioners that missing the most relevant success factors might lead to focusing on misleading areas of projects. It also reveals that general papers, constituting the majority of papers written on success factors, are not impartial and their results are biased in favour of IT/IS and NPD projects (that were identified to have more similar success factors), hence factors obtained from them are less applicable to the construction industry; something that needs to be considered by researchers in the construction management field. Furthermore, this paper highlights the change in researchers' focus on success factors from those related to the project team and management level to higher levels of the organisation and external environment. The main contribution of this paper is to identify the above hidden implications of papers written on project success factors.

Keywords: project success, statistical analysis, success factors.

INTRODUCTION

One can claim that project success is one of the most investigated subjects in the project management field, starting since results of projects were first assessed in the 1960s and continuing until the present day. Despite this, it still remains a controversial issue because of different judgments of project stakeholders on definitions of success. The definition of success is very much dependent on answers to following questions: for whom? using what criteria? and during what time period? (Morris 1983). Most of studies on project success have focused on two major areas: project success criteria and project success factors which cause a project to succeed or fail. The relationship between these two aspects and practitioners' perception of them have been scrutinised in the literature (Ghasabeh and Chabok 2009; Gunathilaka *et al* 2013; Lim and

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² Please contact the author for a full list of 100 papers used to conduct this study.

Mohamed 1999). Baccarini (1999) defines project success criteria to be the measures determining a project's success or failure and project success factors to work as facilitators of achieving success. He later co-authored a paper (Collins and Baccarini 2004) which showed that time, cost and quality (the iron triangle) are still the most cited success criteria by practitioners. Collins and Baccarini (2004), in addition to many more authors (McLeod *et al* 2012; Wit 1988; Bourne 2007; Rahschulte and Milhauser 2010; Woodward 2005; Atkinson 1999; Nelson 2005), have encouraged the project management community to extend their traditional definition of success criteria from the iron triangle to include other factors such as project stakeholders' requirements. As Cooke-Davis (2002) asserts, one method of doing so is to distinguish between the success of the project management process (under the control of the management team, e.g. on time completion) and the project itself (usually outside the control of the management team, e.g. products match users' business values). Jugdev and Muller (2005) accentuate the same point by raising the issue of effectiveness (considering goals and objectives of users' organisations) as well as the efficiency of the project management process in achieving success. As a consequence, there has been a shift in focus from the iron triangle to a wider spectrum of parameters, such as benefits to stakeholders and end users, illustrated by Ika (2009) through a review on papers related to project success.

The same also applies to project success factors, on which this paper is mainly focused. Morris (2013) defines success factors as those that "*need to be managed in order for project management to be successful in performing its delivery function*". Clarke (1999) claims that benefiting from project success factors as means of focus on the main problems can considerably increase the effectiveness of project management. Similar to project success criteria, there is no consensus on project success factors among researchers. An extremely high number of factors have been mentioned in the literature during the past five decades, making it really difficult for practitioners from different industries to consider them in their projects. In order to address this issue, through reviewing and summarising existing knowledge, some researchers published a number of papers that are discussed below.

Belassi and Tukel's (1996) paper was one of the first to review previously produced success factors and categorise them into four groups of project, project manager and team members, organization and external environment in order to create a framework of success factors. Ika (2009) identified a trend for papers written on project success factors showing that for the first two decades (1960s-1970s) most factors were based on anecdotal evidence. This changed during the next two decades (1980s-1990s) when empirical evidence obtained from opinion surveys or case studies was used in creating frameworks of success factors to be deployed by practitioners. The progression continued towards more sophisticated and inclusive frameworks and more specific success factors in the 21st century. Ghasabeh and Chabok (2009) reviewed 57 papers in search for most repeated success criteria and factors regardless of type of industry and concluded that top management support is the most important factor for project success. One recent study was the one by Gunathilaka *et al.* (2013) who extracted the most repeated success factors of construction projects mentioned in previous studies.

Although the outcomes of all of the above research benefit the project management community, there is a lack of comparison of most repeated success factors obtained in various types of projects that sometimes need different project management practices. The only study that does so is the one by Pinto and Covin (1989), although their work is limited to only one set of factors. They compared success factors of two very

different types of projects (R&D and construction) and indicated that whereas they have some similar success factors, some others are completely different. This lack of research contradicts the findings of Dvir *et al.* (1998) and Shenhar *et al.* (2002) who showed a close connection between project success factors and types of project. There is also a lack of research on the possible trends in respect of changes in the identified success factors during the past five decades. This study attempts to bridge the above knowledge gaps.

METHODOLOGY

In order to address the mentioned shortcomings, 100 peer-reviewed papers, published in a variety of journals and conference proceedings, all written about the influential factors affecting project outcome, were selected. Factors cited in these papers stemmed from their authors' personal experience, case studies and opinion surveys. Each paper falls into one of the four categories of: construction projects (21), IT/IS projects (19), new product development (NPD) projects (17) and general (43) (unconcerned with the type of project). As Shenhar and Renier (1996) mention, the best way to categorise projects is to do this in accordance with their technological complexity and scope size. Regarding this, these three types of projects were chosen because of their different levels of technological complexity and uncertainty in general. The type "general" was also taken into account to check whether papers without any orientation towards a specific type of project produce neutral success factors or are biased towards a type of project. After extracting influential factors from chosen papers, they were combined into 35 more generic factors because of the high number and variety of original factors detected. The number of repetitions of each factor was calculated, statistically analysed and used to understand the possible implications with respect to types of projects and changes over time.

ANALYSIS AND DISCUSSION

What are the most repeated success factors in each category?

Tables 1 and 2 show all 35 success factors and their rankings based on number of repetition in each type of project and the total number of repetitions regardless of industry respectively. Note that each of these factors consists of a number of more specific factors originally mentioned in the analysed papers. For example, stakeholder management (SM) encompasses all factors related to the relationship between a project and its stakeholders from their product requirements' management to information needs. As can be noticed, there are some similarities and differences in the order of the more repeated success factors among various types of projects. For instance, while scheduling/planning (S/P) is among the top 5 for all types, procurement management (PRM) and marketing (MAR) are specifically ranked higher for construction and NPD projects respectively. The data summarised in Table 1 stress the significance of selecting the appropriate success factors in accordance with the type of project because of their fundamental differences. They demonstrate that there is no complete list of success factors to be deployed by all projects and the type of project must be taken into account when selecting the areas of focus to achieve success in managing projects.

Table 1: 35 success factors ranked from highest to lowest number of repetitions in each category

No	General	IT/IS		NPD		Construction		
1	Stakeholder Management (SM)	15	SM	16	TM	8	PRM	14
2	Top Management Support (TMS)	14	S/P	12	MAR	7	COM	13
3	Communication (COM)	13	CM	11	O/G	6	SM	13
4	Scheduling/Planning (S/P)	12	TM	11	QM	6	S/P	12
5	Project Manager/Management Role (PM)	12	BV	11	S/P	5	TM	12
6	Leadership (LEA)	12	M&C	9	PR	5	M&C	10
7	Team Members' Characteristics (TM)	11	TMS	9	SM	5	ENV	9
8	Clear Objectives/Goals (O/G)	10	O/G	9	TMS	5	PM	8
9	Change Management (CM)	8	TECH	8	CUL	5	RM	7
10	Risk Management (RM)	8	COM	7	BV	5	TECH	7
11	Monitoring & Control (M&C)	8	RM	6	TECH	4	TEM	7
12	Level of Authority (LoA)	8	PR	5	DEM	4	LEA	6
13	Organisational Culture (CUL)	8	FS	4	PM	3	TMS	6
14	Problem Solving (PS)	7	LEA	4	COM	2	FS	5
15	Project Review (PR)	7	PM	4	FS	1	LoA	5
16	Clear Business Vision (BV)	7	CUL	4	LEA	1	CCH	5
17	Quality Management (QM)	6	QM	4	LoA	1	POL	4
18	Organisational Structure (OS)	6	CONF	3	M&C	1	PS	4
19	Technology (TECH)	5	DEM	3	CM	0	O/G	4
20	Project Specifications (PSP)	5	OS	2	DM	0	PSP	4
21	Configuration Management (CONF)	5	SOF	2	ENV	0	CM	3
22	Project Trade Offs (PTOs)	4	USC	2	POL	0	QM	3
23	Feasibility Study (FS)	4	DM	1	PS	0	PR	2
24	Project Environment (ENV)	4	POL	1	PTOs	0	OS	2
25	Decision Making (DM)	4	PS	1	RM	0	DEM	2
26	Politics (POL)	3	ENV	0	CONF	0	DM	1
27	Development Method (DEM)	3	LoA	0	OS	0	PTOs	1
28	Sponsor (SPO)	1	PTOs	0	PSP	0	BV	1
29	Software Product (SOF)	1	MAR	0	SOF	0	CONF	1
30	Project Baseline (BL)	1	PSP	0	BL	0	MAR	0
31	User Characteristics (USC)	0	BL	0	SPO	0	CUL	0
32	Tendering Method (TEM)	0	SPO	0	PRM	0	SOF	0
33	Procurement Management (PRM)	0	PRM	0	TEM	0	BL	0
34	Marketing (MAR)	0	TEM	0	USC	0	SPO	0
35	Client Characteristics (CCH)	0	CCH	0	CCH	0	USC	0

Table 2: 35 success factors ranked from highest to lowest number of repetitions in all the 100 papers regardless of their categories

No	Total	No	Total	No	Total	No	Total	No	Total					
1	SM	49	8	PM	27	15	QM	19	22	DEM	12	29	DM	6
2	TM	42	9	BV	24	16	CUL	17	23	OS	10	30	PTOs	5
3	S/P	41	10	TECH	24	17	LoA	14	24	PSP	9	31	CCH	5
4	COM	35	11	LEA	23	18	FS	14	25	CONF	9	32	SOF	3
5	TMS	34	12	CM	22	19	PRM	14	26	POL	8	33	USC	2
6	O/G	29	13	RM	21	20	ENV	13	27	TEM	7	34	SPO	1
7	M&C	28	14	PR	19	21	PS	12	28	MAR	7	35	BL	1

What are the relationships between success factors from different types of projects?

A statistical analysis is conducted in order to better elaborate on the relationships between the success factors associated with the different categories under review. The rank correlation test has been chosen to better illustrate the relationships among these 4 groups of data. As explained by Levin (1984), rank correlation is "a measure of the correlation that exists between two sets of ranks" used for non-parametric data. The fact that this method measures the degree of association based on ranks helps this

study to remain unaffected by the different number of papers analysed for each type of projects.

In order to deploy the rank correlation method, each factor was allocated a fractional ranking value for each project type and the rank correlation coefficient (r_s) was calculated for all pairs of project types using the following formula, where $n = 35$:

$$r_s = 1 - \frac{6(\sum d^2)}{n(n^2 - 1)}$$

d= difference between ranks for each pair
n= number of paired observations

The results were checked using the standard error of rank correlation coefficient and conducting an upper-tailed test (Levin 1984: 628-635), as n is higher than 30 and distribution can be assumed to be normal. Assuming the level of significance to be 0.01, an upper limit of 0.4 is achieved. It can be said that there is an association between values of each analysed pair when the obtained rank correlation coefficient is higher than 0.4. This association is higher when the value of rank correlation coefficient is between 0.6 and 1. This analysis helps to determine which two types of projects have more similar or different success factors affecting them. An example of the rank correlation calculations for General and IT/IS projects and the final results for all pairs are depicted in Table 3 and Table 4 respectively.

Table 3: An example of rank correlation calculations for General and IT/IS projects

General	No of Repetitions	Ranking	IT/IS	No of Repetitions	Ranking	d	d ²
BL	1	7	BL	0	5.5	1.5	2.25
BV	7	21	BV	11	32	-11	121
CCH	0	3	CCH	0	5.5	-2.5	6.25
CM	8	25	CM	11	32	-7	49
COM	13	33	COM	7	26	7	49
CONF	5	16	CONF	3	17.5	-1.5	2.25
CUL	8	25	CUL	4	21	4	16
DEM	3	9.5	DEM	3	17.5	-8	64
DM	4	12.5	DM	1	12	0.5	0.25
ENV	4	12.5	ENV	0	5.5	7	49
FS	4	12.5	FS	4	21	-8.5	72.25
LEA	12	31	LEA	4	21	10	100
LoA	8	25	LoA	0	5.5	19.5	380.25
M&C	8	25	M&C	9	29	-4	16
MAR	0	3	MAR	0	5.5	-2.5	6.25
O/G	10	28	O/G	9	29	-1	1
OS	6	18.5	OS	2	15	3.5	12.25
PM	12	31	PM	4	21	10	100
POL	3	9.5	POL	1	12	-2.5	6.25
PR	7	21	PR	5	24	-3	9
PRM	0	3	PRM	0	5.5	-2.5	6.25
PS	7	21	PS	1	12	9	81
PSP	5	16	PSP	0	5.5	10.5	110.25
PTOs	4	12.5	PTOs	0	5.5	7	49
QM	6	18.5	QM	4	21	-2.5	6.25
RM	8	25	RM	6	25	0	0
S/P	12	31	S/P	12	34	-3	9
SM	15	35	SM	16	35	0	0
SOF	1	7	SOF	2	15	-8	64
SPO	1	7	SPO	0	5.5	1.5	2.25
TECH	5	16	TECH	8	27	-11	121
TEM	0	3	TEM	0	5.5	-2.5	6.25
TM	11	29	TM	11	32	-3	9
TMS	14	34	TMS	9	29	5	25
USC	0	3	USC	2	15	-12	144
$\sum d^2$	-	-	-	-	-	-	1695.5

Table 4: Values of rank correlation coefficient for pairs of projects

Pair of projects	Rank Correlation Coefficient (r_s)	Status
General & IT/IS	0.7625	Highly Associated
General & NPD	0.5549	Associated
General & Construction	0.4767	Associated
IT/IS & Construction	0.3582	Not Associated
IT/IS & NPD	0.6382	Highly Associated
Construction & NPD	0.2339	Not Associated

As can be seen in Table 4, although factors in the general papers are associated with those of all other types, the level of this association is considerably higher in the general and IT/IS pairing than in the other two pairings. This means that factors obtained from General papers are significantly more similar to those of IT/IS papers and relatively more similar to NPD papers than construction papers. This questions the impartiality and fairness of papers introducing success factors for all types of projects. Furthermore, the values of the rank correlation coefficient indicate a meaningful difference between factors obtained from construction papers and those from IT/IS and NPD papers while factors associated with these two later categories are highly associated.

These similarities and differences stem from different types of projects (evidence given above) and are consistent with other studies in the literature. As mentioned above, Pinto and Covin (1989) compared construction and R&D projects' success factors and concluded that while there are some common factors, there are also some significant differences. Assuming NPD to be a specific type of R&D project, results of this study confirms this by showing no association between success factors of construction and NPD projects (while not saying that they are completely opposite). Pinto and Covin (1989) also mention some of the differences of R&D and construction projects that can be traced back to the basic difference between them in terms of scope size and uncertainty and complexity of technologies they deploy, as stressed by Shenhar and Renier (1996). This can also explain the similarities between IT/IS and NPD projects and the differences between IT/IS and construction projects because of the higher technological complexity and uncertainty and more limited scope of IT/IS and NPD projects compared to construction ones.

How has researchers' focus on project success factors changed over time?

One last question this study intends to answer is how success factors extracted by researchers have changed over time. This benefits the research community by providing an opportunity to identify any possible existing trends and is analysed by dividing the papers associated with each of the 4 categories into two time zones of the 20th and 21st centuries and comparing the rankings of the top 20 success factors shown in Tables 1 and 2. Rankings have been chosen for comparison in order to avoid the effects of the different number of papers in each time zone. Results in respect of construction papers show an extensive increase in attention to tendering methods (TEM) and top management support (TMS) although change and risk management (CM and RM) attracted less attention in the 21st century (Figure 1). Regarding papers on NPD success factors, monitoring and control (M&C), technology (TECH), level of authority (LoA) and leadership (LEA) factors have all increased while attention to feasibility study (FS) plummeted in 21st century (Figure 2). In contrast to construction papers, RM were considered by more studies on IT/IS projects in 21st century (Figure 3). General studies showed that researchers considered LEA, SM, project

manager/management (PM) and quality management (QM) as success factors more often in 21st century than 20th century; nevertheless, they showed less interest in factors such as project review (PR) and technology (TECH) (Figure 4).

Figure 1: Change of top 20 factors' rankings through time in construction papers

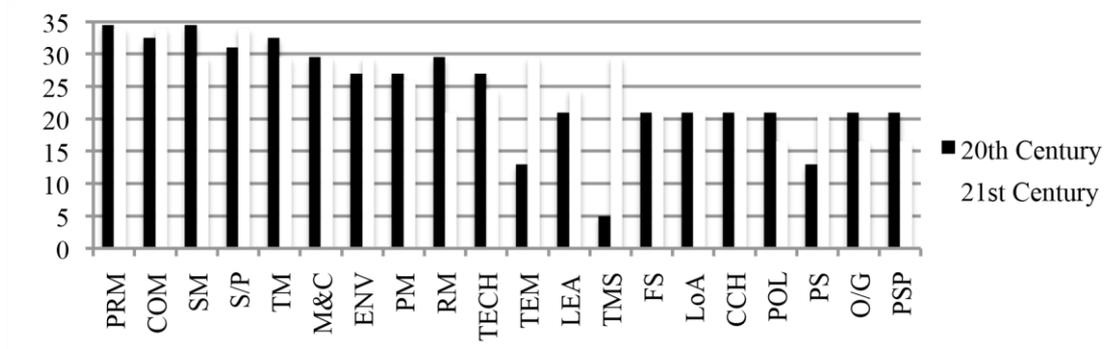


Figure 2: Change of top 20 factors' rankings through time in NPD papers

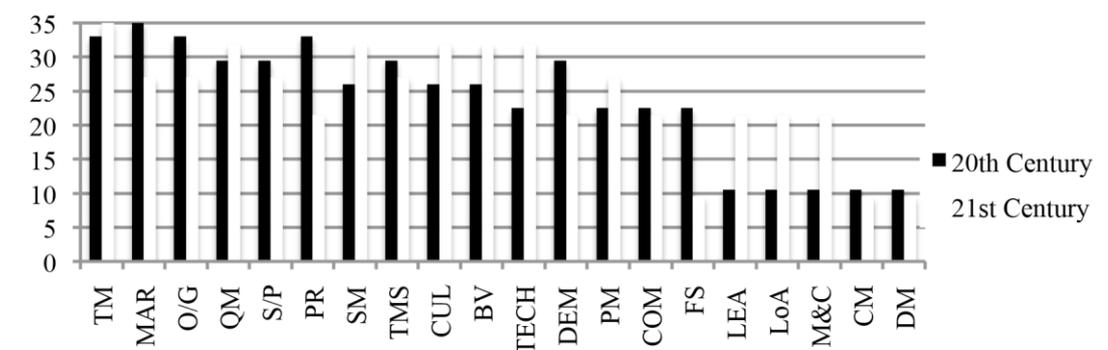


Figure 3: Change of top 20 factors' rankings through time in IT/IS papers

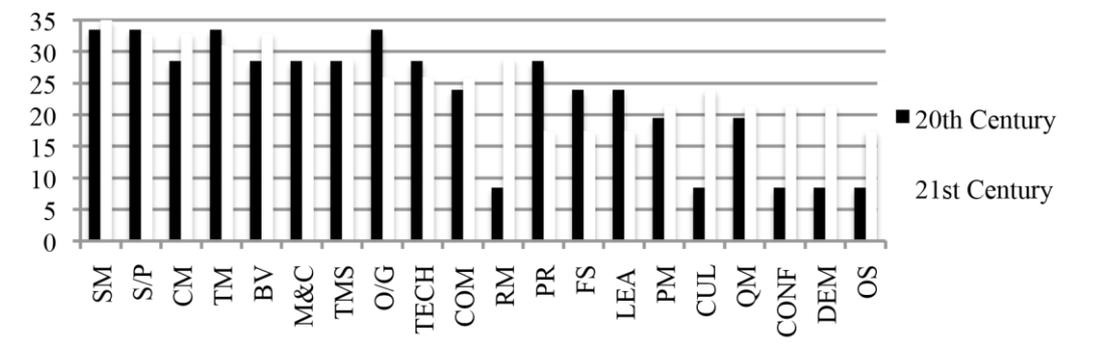
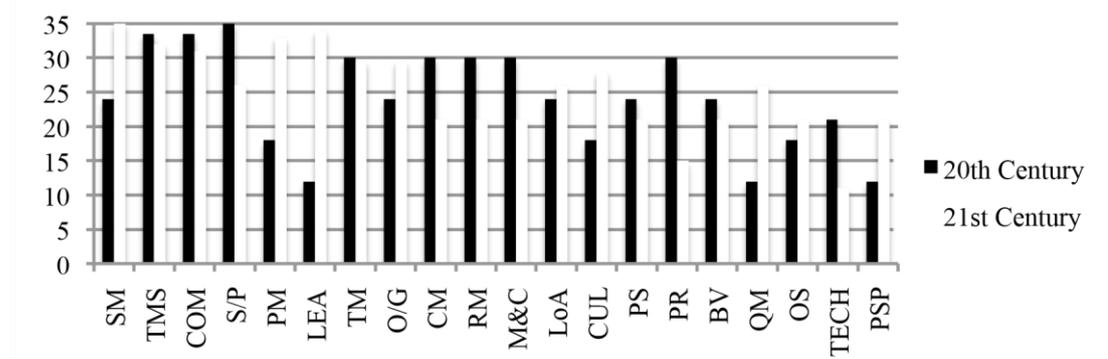


Figure 4: Change of top 20 factors' rankings through time in general papers



In order to have an overall view on the changes of success factors over the past five decades, Figure 5 depicts the information shown in Table 2 for the change of top 20 factors' rankings. In addition, a categorization of top 20 most repeated success factors illustrated in Table 2 was conducted (Table 5) using a framework for the classification of success factors based on level of relevance first introduced by Belassi and Tukel (1996). This will help to provide this study with the groundwork for comparing the level of attention of researchers to each level of relevance in the 20th and 21st centuries.

An implication of this scrutiny of changes of success factors through time is that the focus of researchers has turned from factors related to the project team and management level to factors more relevant to higher levels such as the organisation and external environment. Notice the rise of attention to factors such as organisational culture (CUL), top management support (TMS) and project environment (ENV) compared to the fall of factors such as scheduling and planning (S/P) and change management (CM) in Figure 5.

Figure 5: Change of top 20 factors' rankings through time in all 100 papers

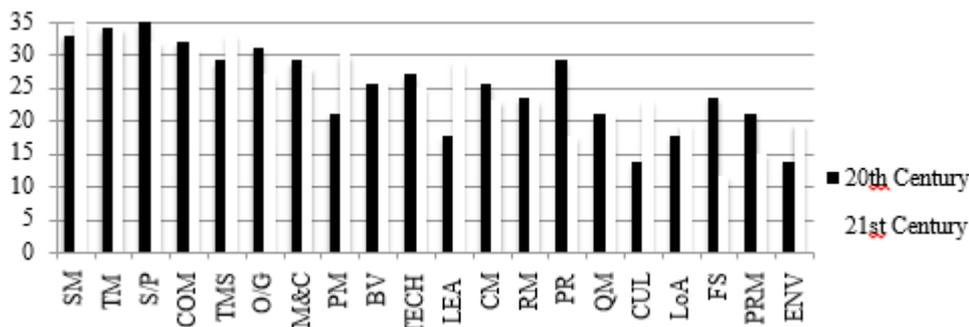


Table 5: Top 20 success factors categorised into levels of relevance as suggested by Belassi and Tukel (1996)

Level of Relevance	Top 20 Most Repeated Success Factors
Project Team	TM, COM, TECH, QM
Project Management	SM, S/P, COM, M&C, PM, LEA, CM, RM, PR, QM, FS, PRM
Organisation	TM, COM, TMS, O/G, M&C, BV, TECH, CM, PR, QM, CUL, LoA, FS, PRM
External	COM, TECH, QM, ENV

SUMMARY AND CONCLUSIONS

After decades of accumulation of project success factors, this study conducted a detailed analysis of them considering their number of repetitions, their relationships with different project types and their changes over time in order to shed light on their probable hidden implications for future research. The findings of this research contribute a number of practical and theoretical values to the existing body of knowledge. Firstly, it demonstrates the importance of selecting appropriate success factors depending on the type of project. This importance stems from differences in scope size and technological uncertainty and complexity of projects and shows that there is no universal list of success factors to be used in all project types. Secondly, It was shown through a rank correlation test that success factors of IT/IS and NPD projects are highly similar; however, they are considerably different from construction projects' success factors. In addition, papers written on success factors unconcerned about the type of projects (named "general" in this study) are not impartial and are

more biased towards factors of IT/IS and NPD projects. This is a warning to researchers in the field of construction management not to consider general papers' success factors as appropriate for construction projects. Thirdly, it was concluded from analysing trends of changes of success factors through time that success factors identified in 21st century are more related to organisation and external environment levels than project and team levels. This change of focus justifies more research on improving organisational and environmental tools and techniques of managing projects because of their higher influence over project success.

One limitation of this study is the high variety of papers used to extract success factors from. They have been written in different contexts and geographical locations that might make findings of this study not applicable to all situations. A similar study, considering papers with the same specifications, can be the subject of a future research.

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SERVITIZATION IN CONSTRUCTION: TOWARDS A FOCUS ON TRANSITIONAL ROUTINES

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Construction firms are increasingly compelled to take into account the through-life performance of the buildings they create. In this article, we examine these trends in relation to the Product-Service literature (commonly referred to as 'servitization') to explore the implications of new business models within the construction industry. It was found that while the range of promising opportunities and problems of greater servitization in the construction industry have been widely explored, there remains a limited understanding of the conditions and consequences of transitional practices involved in greater servitization. Therefore, through the review of the servitization literature, we identify the need to refocus research attention on organizational routines and practices as the unit of analysis to better understand how organisations can make the transition towards more servitized offerings. Rather than taking servitization as the starting point for overhauling existing routines, we argue for the need to study routines as they evolve, to see how a servitization culture is gradually incorporated in everyday management in construction. Thus, the contribution of this article is to propose a shift away from viewing servitization simply as the imposition of a new business model, but rather by mash-ups of existing, complementary and contradictory routines that organisations realise as they make sense of servitization in practice rather than in theory.

Keywords: organisational practices, product-service models, routine, transition.

INTRODUCTION

The "*servitization of business*" (Vandermerve and Rada 1988) refers to the emerging trend in product manufacturers re-positioning their business towards offering supplementary through-life services with their products. These firms are managing to generate lucrative long-term revenues from their combined product-service offering because of their developing capability to address more effectively the needs of their customers. Customer spending patterns indicate that value increasingly lies in the provision of those services that ensure product availability and reliability through the product life-cycle rather than in the manufacture of the initial product. This trend has begun to challenge traditional views within other industries concerning the value of service activities and who should be responsible for the delivery of these service activities. In the context of construction, it is widely accepted that the operational costs of a building far outweighs the initial design and construction costs (see e.g. Ive, 2006). Therefore, with the proliferation of PFI/PPP, especially given demand for infrastructural development, there is growing acknowledgement that servitization

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matters too, where design and construction contractors are increasingly becoming involved in the operations and maintenance of the built assets.

In this article, the wider servitization literature is reviewed to ascertain what the main drivers and challenges are for design and construction contractors looking to play a more prominent role in the operational phases of the project life-cycle. However, the process by which this transition, from product-based operations towards greater service orientation, materialises has tended to be approached from a top-down perspective. Research within the field focuses heavily on the importance of strategic commitment towards greater servitization and how this is subsequently translated into operational reality. Servitization tends to be viewed as a business model used in stimulating organisational change towards greater service-orientation. However, contemporary literature on organisational change takes a more processual view, where transitional routines and practices are emergent rather than engineered. Organisations interact reciprocally between the micro and macro level; this organic evolution involves the ongoing mutual influence between micro-level behaviours and actions, and ever-changing macro-level structures. This evolving, processual approach is, it is argued, vital in understanding what servitization really means in practice. Yet, in treating servitization mainly as a business model that governs organisational routines and practices, just how organisations move towards greater service orientation through transitional routines and practices remains relatively under-explored. Therefore, it is argued in this article that research on servitization in construction should shift away from a strategic, business-model approach, and move towards treating organizational routines, made up of acts of patterning (ostensive) and doing (performative) (see e.g. Pentland and Feldman, 2003) as the unit of analysis to examine how construction organisations can change (and are changing) to become more service-oriented.

THE EMERGING TREND OF “SERVITIZATION”

Traditionally, construction contractors have focused their attention predominantly on the design and construction of tangible goods. Whilst they were normally involved to some extent in services related to the operation and maintenance of buildings, these service obligations were often subsidiary to their design and construction responsibilities. There was a tendency to view these service activities as mundane, reactive and routine; hence, organisations overlooked the potential value they could offer their business (Johnstone *et al.* 2009). Organisations would provide additional services (warranties etc.) free just to secure a product sale or deliver layers of services that did not actually address the customer’s needs (Anderson and Narus, 1995). Changing customer demands are increasingly forcing these organisations to re-evaluate their product-dominant practices. Supplementary service plays a critical role in ensuring products are aligned to the customer’s function, the performance of products and the reliability of products. Increasingly, customers see these aspects as at least as important as the products themselves; spending patterns of customers are moving in this direction (Wise and Baumgartner 1999). These changing mindsets towards product and service are encapsulated convincingly in Vargo and Lusch (2004)’s challenge to academics and practitioners to move towards a service-dominant logic, the premiss of the argument being that suppliers must co-create value through-life with their customers, with Prahalad and Ramansay (2004) asserting that this value co-creation process increasingly lies outside the suppliers’ organisational boundary, lying in the interactions between a network of internal and external actors.

The catalyst for this emerging logic has been a recent trend in product-orientated organisations moving from product delivery towards the provision of integrated combinations of products and services that deliver value-in-use (Baines *et al.* 2007). This process of product manufacturers moving towards holistic service provision was first acknowledged within the academic literature in the work of Vandermerve and Rada (1988) who coined the term “*servitization*”. Emerging trends of servitization have taken on particular importance within the construction industry as the continued proliferation of PFI projects challenges contractors to take a more holistic approach towards the design, construction, commissioning, operations, maintenance and post-occupancy of buildings (Leiringer *et al.* 2010). Success stories of firms moving towards more innovative and collaborative relationships with their clients through “*servitization*” are evident (see e.g. Windahl and Lakemond, 2006, and; Alonso-Rasgado *et al.*, 2006). For instance, within the aerospace sector, engine suppliers such as Rolls-Royce do not just manufacture engines, but also provide through-life maintenance for their engines and lease out the use of their engines through what is known as “*Power by the hour*” (Smith, 2013). Whilst the applicability of cross-industry innovation must be treated with caution (Enkel and Gassmann, 2010), the evolution of the Rolls-Royce TotalCare model, as well as similar innovations from other engine manufacturers within the aerospace sector, call into question whether the M&E supply chain in building construction can play a more effective role in the operation and maintenance of building systems.

“SERVITIZATION WITHIN CONSTRUCTION”

Brady *et al.* (2005) introduced the idea of servitizing within the construction and infrastructure sector, as they observed increasing provision of “*integrated solutions*” which combine products and services to address a customer’s unique requirements over the life-cycle of the project. Case study research within the evolving “*integrated solutions*” literature focuses predominantly on the provision of PPP/PFI projects (Roerich and Caldwell, 2012, Johnstone *et al.*, 2009, and; Storbacka, 2011). Arguably, the process of servitizing and bundling products and services into one unique solution resonates quite clearly with the PPP/PFI framework where the emphasis is not only placed upon the delivery of the built assets but also the servicing of these assets over a 20-25 year period. The underwhelming performances of early PFI projects have been widely documented (see Akintoye *et al.*, 2003). Consequently, there have been reforms in the way PFI projects are commissioned in the construction industry, as seen in the development of the PF2 framework. Therefore, the challenge for construction contractors to adapt to the government's adoption of a more servitized framework for project delivery continues to be a key debate. In this section, the drivers and challenges of adopting a more service-oriented approach in construction are reviewed. It is noted, in this review, that there are two main camps in the literature on servitization; on the one hand, scholars have been seduced by the promises of added value in adopting more service-oriented offerings, whilst others have questioned the realities of the espoused values of the servitization business model on the other. Through this review, it is argued that what remains relatively under-explored are the transitional routines and practices that organisations go through in ongoing change as they make sense of what servitization means.

The drivers

Anonocopolou and Konstantinou (2008) reflect on the fact that servitized business models are increasingly being viewed as “*panacea*” business operations. The

academic coverage of servitization is typically optimistic and reflects an emerging mindset that the logic of the argument for firms to servitize is becoming more convincing. Cohen *et al.* (2006) offers one of the more emphatic calls for firms to servitize, proclaiming that “*This is the golden age of services, and to survive and prosper we’re told every company must transform itself into a service business*” (p. 129). Other authors adopt a more pragmatic approach; whilst they remain upbeat about the service opportunities available to product manufacturers, they insist that these organisations must position themselves carefully in their after-sales service markets by ensuring they select the right service strategies (Auguste *et al.* 2007). Research identifies (e.g. Baines *et al.*, 2011, and; Ulaga and Reinartz, 2011) this specifically as product-centric servitization where the supplementary services provided reflect the unique advantages product manufacturers possess with regard to competing in the aftermarket.

Smith (2013) utilises the successful servitization strategies of an engine supplier in the aerospace markets to highlight the role played by advances in digitization, product reliability, monitoring of real-time product system performance and technological intelligence in transforming existing dynamics in the market for maintenance activities. Technological advancements in product design and manufacture implies in some cases that the product supply chain is now better positioned to deliver supplementary maintenance than traditional maintenance and repair organisations. This is an emerging theme within the servitization literature and that is how the boundaries between product and service (Johnstone *et al.* 2009), as well as production and consumption (Mont 2000) are becoming increasingly blurred; the roles and responsibilities of organisations at these boundaries are changing, creating opportunities for organisations to radically transform their businesses. This is evident within industries that utilise compressed air for their production processes (Radgen 2014). The capacity to deliver operational savings in the delivery of compressed air increasingly lies with the manufacturers of air compressors. Particularly, within Germany this has led to changes in business models towards delivering units of compressed air rather than traditional business models geared solely towards product sales.

Stagnated product markets, more prolonged countercyclical service revenues (Wise and Baumgartner 1999), better connected, informed, empowered and active customers (Prahalad and Ramasmanay 2004), higher potential profit margins in after-sale service activities (Cohen *et al.* 2006) and the tendency for service capabilities to be less imitable for competitors (Mathieu 2001) are all well-documented drivers for product-based organisations moving towards more servitized modes of operating. The “*Product-Service Systems*” literature, a strand of literature that emanated from Scandinavia (Goedkoop *et al.*, 1999, and; Mont, 2000), features a similar concept to servitization but focuses more specifically on the environmental benefits of combining the delivery of products and services. This theme takes on particular importance within the construction industry because of the stringent focus on the energy performance of buildings, especially in PFI projects where the responsibility for this performance increasingly lies with the contractor. Servitization provides the opportunity for suppliers to drive end-user behaviour towards more sustainable patterns of consumption (Tukker and Tischner 2006). This notion builds upon the fundamental assumption that the long-term relationships engineered through servitization encourage suppliers and their clients to work in a more collaborative manner. One useful illustration of this is the energy performance contracts provided

by companies such as Honeywell. They no longer just provide more efficient conversion equipment within buildings but also utilise building automation and control solutions to change customer's energy consumption behaviour.

The challenges

A series of quantitative studies (see e.g. Neely, 2008, and; Lay *et al.* 2010) investigating the performance of firms that were servitizing provide a sobering effect on the "hype" surrounding the process of servitization. The studies, albeit over a restricted sample, indicated that a significant number of servitizing firms were struggling to reap the financial rewards advertised by previous authors. This correlates with a discernible change in the recent tone of the servitization literature which tends to focus more heavily on the challenges associated with making the transition towards more servitized solutions. This aspect of the literature has particular relevance to the problems encountered under the PFI framework.

There are significant contractual challenges associated with driving through the concept, put forward by a service-dominant logic (Vargo and Lusch, 2008), of value-in-use so that customer usage (Ng *et al.*, 2009), product performance, product availability and reliability all fall within the provider's responsibilities. This contractual arrangement is commonly referred to as performance-based-contracting and Caldwell and Settle (2011) utilise evidence from the defence sector to identify the need for pain-sharing and gain-sharing mechanisms to be built into these contracts so as to incentivise end- users and product-service providers to work collaboratively. This often necessitates a shift towards value-based pricing models rather than utilising traditional fixed and cost-plus pricing models (Bonnemerier *et al.* 2010). Whilst on the surface the PFI framework and the unitary charge paid from the government client to the SPV would seem to illustrate such an approach, it is apparent that within the interface agreement lie traditional agreements (Gruneberg and Hughes, 2011) for the separate stages of the project life-cycle which run counter to a servitized approach to asset delivery. The extent to which increased innovation in building energy performance regulatory structures will trigger servitized behaviour from construction contractors will be dependent on the attractiveness of the agreed payment mechanisms. Without construction contractors having total control of energy supply and use, finding a measurable output from which contractor performance can be accurately judged remains a key challenge.

Guo and Ng (2011) identify the limitations of contractual arrangements without the adequate support of relational governance. This can be seen within the wider challenge of trying to embed a service-orientated culture within traditionally product-based organisations (Olivia and Kallenborg, 2003). Martinez *et al.* (2010) discusses the pivotal role played by an "*internal alignment of performance metrics*" in attaining this cultural shift in mind-set towards product-service delivery.

Another challenge was touched upon earlier and that includes building new system integrative capabilities (Brady *et al.* 2005) that allow product-service providers to differentiate their service activities as opposed to those delivered by existing service providers. Ulaga and Reinartz (2011) interviewed 44 equipment manufacturers and from these discussions they identified what they believe these key capabilities are: service-related data processing and interpretation, execution risk assessment and mitigation, design-service capability, hybrid-offering deployment capability and hybrid-offering sales capability. Finally, building upon those system integrative capabilities there are challenges associated with aligning the product supply chain

towards the demands of the customer (Christopher and Ryals, 2014). Identifying critical components of the supply chain where additional incentives should be offered to suppliers (Hughes *et al.* 2007), as well as ensuring that knowledge is transferred effectively across the fragmented external supply chain, remain as key challenges in relation to stymying the adoption of servitisation in construction. Within the construction industry, the maturing BIM capabilities of contractors and the introduction of COBie offer opportunities for providers of PFI projects to address the latter issue more effectively.

The missing link: the transitions

The fundamental assumption of the literature is that the existing management practices are rational (Antonocopoulou and Konstaninou, 2008) and therefore, organisations can overcome specific challenges (such as developing new service capabilities, supply chain integration, introducing a service culture, collaborating more effectively with the client and exploiting new technological innovations) and move to product-service delivery. Failure of traditionally product-orientated firms to move to this new and superior business model is attributed to an irrational tendency for firms to focus on the risks associated with changing their current product-dominant practices. The problem here is that the literature often adopts a traditional perspective of organisational change that views the transition as a series of predictable and rational steps that are systematically carried out (Graetz and Smith, 2010), assuming that they can move from one pre-planned state to another (Bamford and Forrester, 2003). However, more contemporary research into organisational change has viewed organisational change as an emergent process (Bamford and Forrester, 2003) where change is viewed as a continuous open-ended process where practices are continuously adapting to changing conditions. Observing servitization as an emergent process where existing routines continuously interact differently under changing conditions, rather than the process of overhauling existing routines (Vargo and Lusch, 2004) provides a more informed interpretation of how a service culture is gradually embedded into traditionally product-orientated organisations.

FRESH PERSPECTIVES ON SERVITIZATION: TOWARDS THE STUDY OF TRANSITIONAL ORGANISATIONAL ROUTINES AS A UNIT OF ANALYSIS

By viewing the servitization transition through a processual lens (see e.g. Nayak, 2008) where organisational change is emergent rather than engineered, we can utilise organisational routines as a unit of analysis (Pentland and Feldman, 2005) to investigate how organisations adapt to more servitized modes of operating. Organisational routines are increasingly seen as generative, dynamic systems that are characterized by "*multiple actors and interdependent actions*" (Pentland and Feldman, 2005). By unpacking these routines and exploring their internal structure there is the opportunity to identify how separate parts of routines emerge alone and also interact with other parts of the routine (Feldman and Pentland, 2003). These parts have been labelled as ostensive (acts of patterning) and performative (acts of doing), and are recursively interdependent.

By adopting the lens of organisational routines, and by interrogating the recursive interrelationships between the ostensive and performative parts of routines as organisations go through on-going change towards more service-orientation, we would be in a better position to understand just how servitization is not only aspirational, but that the strategic intent can translate to operational reality.

Furthermore, by opening up the study of organisational routines as the unit of analysis, one can ground the study of servitization in the realities of practices by social actors, both within and across organisations. Feldman and Pentland (2003) suggested that the exploration of the contested nature of organisational routines opens up the possibility to understand organisational change. Organisational change literature separates the two types of change organisations can experience. First-order change (Watzlawick, 1974) refers to the times of organisational equilibrium where change is slow, steady, continuous and incremental, whereas second-order change relates to periods of disequilibrium where change can be transformative, radical and divergent. Feldman and Pentland (2003) indicate that analysis of organisational routines can prove increasingly useful to study the latter whilst case study research (Caldwell *et al.* 2011) identifies the shift towards more servitized operations on PFI projects tends to be more closely related to second-order change on a macro-level. Storbacka *et al.* (2012) assessed the fact that the value co-creation process that underpins the servitization concept is increasingly located within routines that are enacted at organisational boundaries between different actors. Understanding routines as truces (Nelson and Winter, 1982), where inter-organisational conflicts are acted out and resolved, will allow us to explore how value is co-created when roles and responsibilities for the design, construction, commissioning and operation of buildings become more blurred under more servitized contractual frameworks as in PFI projects. The political conditions at play within the complex network of actors stand to jeopardise the delivery of assets on PFI projects; by appreciating organisational routines as a lens for understanding this conflict, there can be a greater understanding of the interests and expectations of different stakeholders (Antonocopoulou and Konstantinou, 2008).

The "*integrated solutions*" literature focuses heavily on the role played by strategic management in integrating a servitized approach at an operational level. Case studies focusing on the successful delivery of integrated solutions certainly emphasise the importance of commitment towards servitization at a strategic level (Windahl and Lakemond, 2006). There remains little research though into the process of translating strategic intent into operational reality. Organisational change literature explores in depth the problems associated with receptivity towards change from the overall workforce (Antonocopoulou and Konstantinou, 2008). However, in this paper, we argue that the servitization literature focuses too heavily on the transition towards servitization as a top-down process. We draw upon findings within the organisational change literature that argue second-order organisational change at the macro-level can be the consequence of first-order organisational change at the micro-level (Anderson, 1999). In turn the macro-structure of this complex eco-system of interacting actors then influences individuals, "*and the evolutionary process moves constantly between micro behaviours and emergent structures, each influencing and recreating each other*" (Mitleton-Kelly, 2003). Combining bottom-up and top-down perspectives of organisational change illustrates the role played by the changing organisational routines at an operational level in shaping the sort of radical change incurred by servitization at the mezo-level and macro-level. Therefore, this paper proposes we use organisational routines as the lens for observing how these incremental changes at a micro-economic level manifest themselves in the mash-ups of existing complementary and contradictory routines (Feldman and Pentland 2003).

CONCLUSIONS

The paper has utilised the servitization literature to comprehensively assess the challenges and drivers for design and construction contractors who are seeking to play a more prominent role in the operation and maintenance of buildings. This becomes increasingly important in the context of PFI projects where contractors are increasingly being encouraged to take a more holistic approach to asset delivery and maintenance. However, whilst useful in demonstrating general trends and the context of servitization, it fails to illustrate how transitions towards servitized modes of operating materialise. This paper highlights the need for a better understanding of how the interactions between the micro-level and macro-level stimulate organisational change in the context of emergent servitized behaviour. It proposes that organizational routines at the interface of design, construction and maintenance must be examined to establish how these affect the process of wider transition towards servitization.

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ALTERNATIVE PROJECT DELIVERY SYSTEMS FOR TRANSPORT INFRASTRUCTURE IN GERMANY

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Transport infrastructure projects are important for the development of the economy, industry and mobility. Such projects are long-lasting and have huge budgets. In addition, they are affected by the needs of the public owner, and usually involve many stakeholders. The current project delivery system in Germany is characterised by its traditional nature, in which the processes of design and construction are sequential. The owner contracts separately with the designer and the contractor. This separation hinders the collaboration and communication between the designer and constructor. Furthermore, the traditional procurement method based on the lowest price aligns with diverse challenges which often results in cost or time overruns, as well as in adversarial relationships amongst the involved parties. This fragmented structure of the construction industry is dissatisfying for the project participants. This paper examines the actual situation of project delivery and its shortcomings and it therefore investigates the reasons behind the problems of project delivery such as poor planning, scope changes or inappropriate risk allocation. In the 80s and 90s, the Anglo-American construction industry suffered from similar problems. This situation has been analysed by many reports, where suggestions for changes were made and solutions to overcome the adversarial situation of the industry were offered. Consequently, new delivery systems were developed. This paper provides an overview of the problems and obstacles associated with implementing alternative systems regarding the procurement law of public projects in Germany.

Keywords: alternative delivery systems, procurement law, transport infrastructure.

INTRODUCTION

Transport infrastructure projects are important for the development of the economy and industry. They are also needed to meet the increasing demands of mobility. The location's advantages of Germany as an industrial country at the heart of Europe are hardly conceivable without a modern and efficient infrastructure system. Over their life cycle, transport infrastructure projects are fraught with risks and uncertainties (Spang and Riemann 2011, Naumann 2007). They have immense budgets, often billions of dollars. Furthermore, their impact on the environment is huge. Transport infrastructure projects are long-lasting. It can take decades from inception until realisation. In addition, they are affected by the needs of the public owner, and usually involve many stakeholders (Hertogh *et al.* 2008).

A large number of infrastructure projects are confronted with cost and time overruns. Furthermore, the relationship between the owner and the contractor is often adversarial. This situation is no-longer satisfying for all project participants. This paper examines the current situation of project delivery in Germany, which is

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characterised by its traditional nature. It also describes its shortcomings and potential of improvement. Subsequently, the paper shows an overview about the drivers for change at the international level and highlights some of the alternative project delivery systems in infrastructure projects. Last but not least, the paper discusses barriers associated with implementing alternative systems, regarding the procurement law of public projects in Germany. Finally, conclusions for research are drawn.

AN OVERVIEW OF INFRASTRUCTURE PROJECTS

Transport infrastructure in Germany

There is no unified definition of infrastructure in literature. Infrastructure projects provide “*basic services to industry and households*” (Grimsey and Lewis 2002). Generally, infrastructure projects are divided into “*economic infrastructure*” such as bridges, road, rail, and air transport facilities and “*social infrastructure*” including health and tourism facilities (Ng and Loosemore (2006). The European Commission defines transport infrastructure as “*all routes and fixed installations of the three modes of transport being routes and installations necessary for the circulation and safety of traffic*”.

Germany has one of the largest and most advanced transportation systems in the world, which demonstrates Germany’s position as transportation and communication centre in Europe. Germany’s road network with a length of 651,000km is one of the densest networks worldwide. Besides, the German railway has an extensive network of 41,500km (International Transport Forum 2012).

In Germany, the entire investment for new construction, replacement and maintenance of state-owned railways, highways, waterways, and projects of public transport between 1991 and 2005 amounted to approximately € 165 billion. The plans for the years 2006 to 2010 come to € 11 billion annually (Naumann 2007). For realising infrastructure projects for the period (2012 until 2013, partly 2017) in Germany a new program (Infrastrukturbeschleunigungsprogramm) was introduced in 2012. The projects will receive an additional 1 billion Euros, 600 million for roads and 100 million for rail (International Transport Forum 2012).

Planning, decision-making and financing of infrastructure projects are mainly politicised at national level (Short and Kopp 2005). In Germany, the federal government, the states and the local authorities are responsible for the development, evaluating and financing of infrastructure projects.

Current project delivery system

The current project delivery system in Germany is characterised by its traditional nature, in which the processes of design and construction are sequential. The owner holds separate contracts with the designer and the contractor. Infrastructure projects go through the following phases (figure 1): feasibility, technical design, legal approval, tendering and execution. The owner assigns a designer to do technical design and legal approval for a project (Spang 2011). Hence, participation of many stakeholders and considerations of a large number of regulations, the planning approval procedure of infrastructure projects is sophisticated and enormously time-consuming (Sözüer and Spang 2012). Once the design phase is completed, the owner announces for bidders within an open bidding procedure.

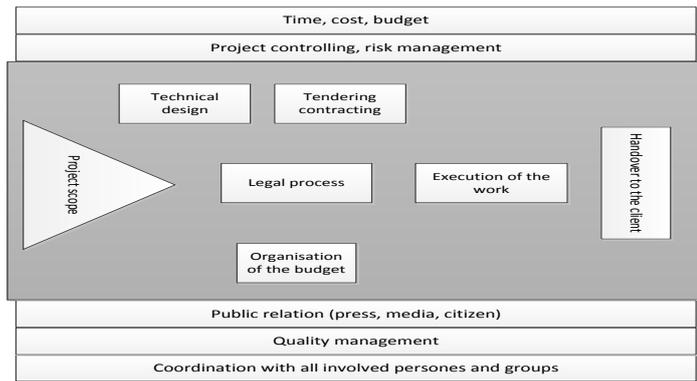


Figure 1: Project tasks in infrastructure projects (Spang 2011)

According to the VOB (German Construction Tendering and Contract Regulations), the standard form for awarding construction public projects in Germany is “*Die Einzelvergabe*”- a single award. In contrast to the general contractor, the project will be divided into work packages and each package will then be awarded separately by the public owner to a single contractor (figure 2). In most cases, the public owner is obligated to select the contractor on the basis of the lowest price. Unit-price contracts have to be used exclusively for public projects. Whereas Lump-sum is only allowed to be used in rare exceptions.

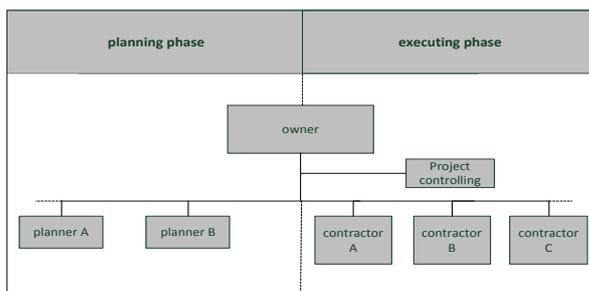


Figure 2: single award (Girmscheid 2006)

Shortcomings of traditional delivery system

Infrastructure projects appear to have common problems worldwide. Generally, they don't have a good reputation because of their cost and time overruns (Hertogh *et al.* 2008). A Study of Flyvbjerg *et al.* (2002) examined construction costs of 258 large transport infrastructure projects worth US\$ 90 billion, which are located in 20 nations. Main conclusions of this study are:

- Cost escalation occurs in almost nine out of 10 projects,
- Rail projects seem to be particularly prone to cost escalation (44,7 %)
- Road projects appear to be less predisposed for cost escalation (20,4 %)

Germany's infrastructure projects are no exception. Several examples for infrastructure projects with cost overruns can be given, e.g. Mega Project City-Tunnel-Leipzig and Underground Station Stuttgart 21. Reasons of project cost overrun include design changes or mistakes, long-lasting delivery phases, inappropriate contractors and cost underestimation. (Gaddis 1994, Flyvbjerg *et al.* 2003, Sözüer and Spang 2012)

Short and Kopp (2005) state that planning methods of transport infrastructure vary from one country to another, but they have one thing in common that transport

planning processes take a long time (up to 20 years). Hertogh *et al.* (2008) noticed that the reasons of delays in infrastructure projects are mostly in the planning and not in the construction phase. On the other hand, delays within the construction phase could be the result of unexpected weather conditions, errors in the plans, change orders, inadequate project preparation and poor coordination.

Because design and construction are separated, the collaboration and communication between the designer and the constructor are limited. A field study at the University of Kassel, concerning the relationship between clients and contractors in the German construction industry, shows that 54% of the participants (clients and contractors) find the current situation as partially cooperative and 39% as barely cooperative. For about 44% of all participants there is no winner from this situation (Spang *et al.* 2009).

In addition, because of the separation between the design and construction phases, the design and build entities follow different financial goals within the same project (Spang 2011). While the owner and his designer desire optimising the project at the lowest cost, the contractor aims to complete the project within time and price and maximizing his profit. This often leads to disputes between them. Public owners have to award their projects upon the current regulation of VOB/A (German Construction Tendering and Contract Regulations-award).

According to the study (Spang *et al.* 2009), 25% of the participants see that the VOB (2002) doesn't promote a "partnership". 42% of the participants agreed with "partially" promoting a partnership (Spang *et al.* 2009).

In the traditional method, the project owner attempts to transfer all possible risks to the contractor. The contractor in turn shifts the risks to the subcontractors. In the end, the risks will be undertaken and managed by the party, who can handle them the least. In the field study of Spang *et al.* (2009), 42% of the participants (owners and contractors) approved that a fair risk allocation is not present, and 36 % of the participants see that a fair risk allocation is only partially existent.

NEED FOR CHANGE

Literature review

As shown above, the current stalemate in Germany often finds its main cause in the traditional method, which signifies the awarding of contracts to the contractor with the lowest price.

On the other side, the advantage of the traditional delivery method is undoubtedly linked to its long tradition and is thus well-established and well-understood by the project participants. The roles, functions and responsibilities of each party are laid down in standards and regulations. The procedures of the traditional method are accepted and common ground for all participants. Another advantage is that the design remains under the owner's control and the design team looks out for the interests of the owner. Because a total price is not agreed in this case, design changes are possible even during the construction phase. Tendering on the basis of low price allows the owner to receive a reasonable cost for the project (Greiner *et al.* 2009).

In order to overcome the fragmented situation in Germany, especially in the public sector projects, rethinking by the project participants and significant changes particularly in the public procurement method are required. While some studies in the private sector have experimented with the implementation and transfer of alternative approaches in order to achieve better project outcomes including reduced disputes as

well as time and cost delays, this is not the case in the public sector. In Germany, comparative scientific studies in the field of transport infrastructure are very few. Calls for change have been raised recently. Doing everything a little better than before is not enough anymore (Spang 2006). Girmscheid (2008) considers that there is an urgent need for a paradigm shift, which requires a rethinking by the project participants. According to Spang (2006), a paradigm shift is necessary to enhance collaboration between owner and contractor.

Potential for improvement

Spang (2006) identifies a number of aspects for improving the delivery of infrastructure projects. These include:

- Improving the cooperation between the owner and the contractor through “*partnering*”-relationships, in order to achieve a win-win situation for all project participants.
- Integration between design and construction phases: An early contractor involvement in the planning stage can optimize the design phase through his know-how.
- Fair risk management between the project participants: The owner and the contractor identify all known and potential risks, and assess and evaluate them. Risks should be allocated to the party which is considered to manage them most effectively with appropriate compensation.
- Clearly defined decision-making procedures: The execution of projects takes place in a dynamic environment, where decisions must be made rapidly and continuously. Delayed decision making increases the potential for conflict between the project participants and jeopardizes the costs and scheduled targets. Therefore, clear decision-making should be created contiguously with clear responsibilities.
- Alternative dispute resolution: As a result of conflicting interests, unfair allocation of risk or non-timely decision-making, conflicts arise between the parties. Conflicts are usually associated with cost and scheduled consequences. Therefore, alternative dispute resolution methods are essential for the construction industry.
- Alternative procurement criteria based on experience and qualifications: The low-bid must be no longer seen as the decisive criterion for the award. Technical and operational expertise and successful experience with similar projects should also play a role in the selection of the proper contractor.

Drivers for change-international review

The Anglo-American construction industry suffered in the 80s and 90s from similar problems as the actual situation in Germany: Increasing complexity of construction projects, a growing number of disputes among contract parties, cost and time overruns. Besides, the traditional method (Design-Bid-Build) could not meet the technical and economic requirements of the accelerated construction (Dorsey (1997), Morton (2002)). Many owners and contractors voiced displeasure with this situation. Therefore, many reports analysed this situation, made suggestions for change and offered solutions to overcome the adversarial situation of the industry, through moving from traditional approaches towards alternative and more innovative ones.

The Latham Report (1994) focuses on the adversarial nature of the construction industry and considers this as a main factor for poor communication. Therefore, the

report emphasises on the importance of team work based on fair and partnering relationships. This leads to the improving of performance as well as to a win-win situation for all participants. Furthermore, the Report makes a large number of important recommendations, such as making a greater use of alternative tendering procurement procedures, dispute resolution and partnering arrangements.

The Egan Report (1998) stated a need for a radical change in the construction industry. It identified five drivers for change to achieve an enhanced performance: “*committed leadership, focus on the customer, integrated processes and teams, a quality driven agenda and commitment to people*”. Furthermore, Egan emphasised on the need for long term relationships and fair risk allocation.

Consequently, alternative approaches have been developed and widely implemented primarily in the private sector. Traditional methods are still mainly used to procure public projects. Alternative approaches, like Design-Build, Construction Management at Risk or Alliance-Model, have been increasingly used in infrastructure projects.

In the UK, Design-Build or one of its variations is the standard practice for road projects. Based on a pre-design, the owner contracts a design-build contractor to realise the project. This way, the owner has a single point responsibility for both, design and construction (Dorsey 1997). The owner can select the contractor based on quality, price or a combination between them. In the course of Design-Build, the contractor and the designer already work collaboratively in the design phase.

In the USA, Design-Build and Construction Management at Risk have been used for the delivery of infrastructure projects especially by road and highway projects.

In Australia, “*Project Alliance –Model*” is used for road projects. In a project alliance, the owner and none-owner participants, like designer, contractor and service provider etc. work together as an integrated team in order to deliver a specific project. They arrange a contractual framework, where their commercial interests are associated with the project results (Ross 2003).

GERMAN PROCUREMENT LAW

The public procurement law in Germany contains rules and regulations that have to be considered by public agencies for the procurement of works, services and goods. The German public procurement law aims mainly to assure an economical use of public funds as well as avoiding corruption. Furthermore, it makes sure that the core principles of public contracting like transparency, competition, the principle of non-discrimination, the principle of equal treatment and the consideration of medium-sized construction companies, are respected in every tender procedure (Heiermann 2013).

The German public procurement law is influenced by European Regulations. According to certain thresholds, the German public procurement differentiates between contracts below and above the thresholds (figure 3).

At national level, VOB/ A (Construction Tendering and Contract Regulations-award) are obligatory for the public authorities. On the contrary to many alternative approaches, procurement and contract agreements according to VOB do not consist, or even promote innovative aspects like incentive payments, alternative dispute resolution, fair and contractually backed-up allocation of risks, using open book principles, continual improvement processes, simultaneous engineering, partner selection upon qualification and early contractor involvement.

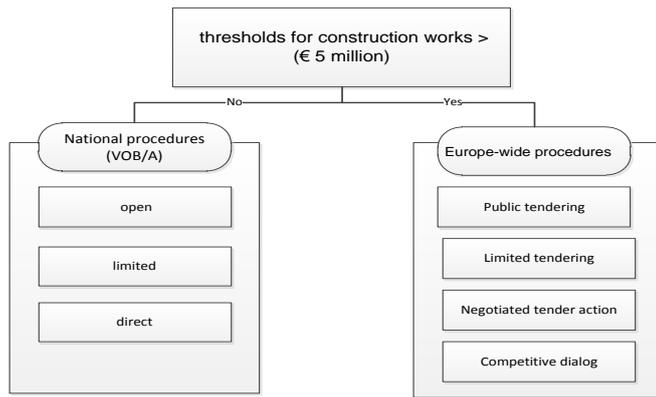


Figure 3: public procurement in Germany (Heiermann 2013)

Furthermore, VOB dedicates dividing the construction work in work packages - “*Fachlose*”, which are to be awarded to separate contractors. The general contractor form is only to be used in exceptions. A Design-Build contractor or a virtual project organisation like an Alliance-Model is absolutely out of question for infrastructure projects. Under the current procurement law, innovative approaches could not be used for transport infrastructure.

CONCLUSION

Considering the previous discussion, it becomes clear that there is a need for change towards using alternative approaches in Germany, which provide a better project delivery. In spite of the advantages and opportunities of alternative project delivery systems, they have not been implemented for infrastructure projects in Germany. Moreover, a systematic analysis has not yet been undertaken concerning such projects. On the other hand, adopting and implementing alternative delivery systems faces a variety of barriers including legal, political, organizational, institutional and cultural issues. In order to surmount the barriers of implementation, researchers should point out the advantages and disadvantages of delivery systems for infrastructure projects. This will enable the public owner to understand these systems as well as their potentials and will provide a comparison with the traditional system. Besides highlighting best practices in this field and understanding the specifics of each approach, choosing the proper approach depends on the project characteristics and framework conditions, as well as on the desired output. A reform in public procurement analogous to international experience is very important. Therefore, the current legal regulations should be modified or new regulations should be issued.

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INCORPORATION OF DIFFERENT AND CHANGING CLIENT INTERESTS IN THE COURSE OF A PROJECT

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There is a widespread assumption that clients' expectations should be accommodated during a building project. However, there may be conflicting expectations within a client organization and these may change over time in the course of a project. Actor-Network Theory (ANT) is used to study the incorporation of client expectations into the on-going development of a building project. To illustrate this, negotiations over a particular decision, namely the location of a building on one university campus was analysed. Negotiations went through a number of stages, involving a master plan architect, members of the public, campus maps and the Vice Chancellor. An ANT analysis helped to trace diverse actors' interests in a series of discussions and how these interests conflict with each other as one option was chosen over another. The analysis revealed new client interests in each negotiation process. Also, the prioritisation of client interests changed over time. The documentation of diverse and dynamic client interests especially contributes to the understanding of how some client interests fail to be incorporated in decision-making processes.

Keywords: actor-network theory, client organization, decision-making process, stakeholders, material objects.

INTRODUCTION

The incorporation of client needs in a construction project has been an important research topic in construction management (CM) literature. Ruddock (2013) raised a difficulty in studying this topic that "*construction clients are multifarious and internally complex*". This paper challenges this difficulty by presuming diverse and dynamic aspects of a client in a project context. A basic assumption of this research is that a construction project is shaped by clients' diverse and changing expectations in the course of a project. The aim of the research is to understand how different and changing client expectations were incorporated during a building project. This paper takes one episode as an example.

LITERATURE REVIEW

The issue of clients' needs has grown in importance in CM literature. The alignment of client needs with contractors' capabilities has often been regarded as a key client strategy (e.g. Chinyio *et al.* 1998). It has come to be recognized that client needs are dynamic and diverse. Thus, some authors have called for broader management methods to manage client needs over time during a project (e.g. Newcombe 2008). Other authors have analysed interactions between a client and a project team as a

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process in which client goals and requirements are incorporated during a project (e.g. Ivory 2004). A few researchers have recently applied actor-network theory (ANT), which provides a useful vehicle to study the incorporation of client expectations and interests across shifting multiple actors' interactions in the course of a project (e.g. Tryggestad *et al.* 2010).

Integration of client needs into contractors' performance

Literature on client strategies in construction projects has often assumed that better client-contractor relationships enhance client satisfaction, based on the assumption that meeting explicit client needs is key to assessing project performance objectives. Briscoe *et al.* (2004) studied client strategies for supply chain integration including the use of communication tools and the selection of procurement route. They identified a specific procurement decision that improved long-term relationships. However, they noted that clients who had clear and explicit needs tended to have more effective long-term relationships. They did not further explore how to clarify client needs.

Some scholars have attempted to align client needs with contractors' performance. More specifically, the selection of contractors' capabilities according to a typology of client needs has been proposed. Chinyio *et al.* (1998) categorized client needs in terms of project performance including safety, quality and time. These values were supposed to guide clients in the selection of appropriate contractors. Similarly, Blismas *et al.* (2004) suggested a typology of clients' multi-project portfolios to investigate the influence of client environment on project delivery. In a typology of clients' portfolios, they suggested that some types of client tended to change their objectives and, thus, called for flexibility during a project. Researchers in this area recognize and identify issues around the diversity and dynamics of client needs in the course of a project. However, they typically do not focus on how to deal with these issues.

Management of dynamic and diverse client needs

A number of authors have looked to process management methods to continuously manage clients' dynamic and diverse goals and needs in the course of a project. In a study of a major redevelopment project, Newcombe (2003) adopted a stakeholder-mapping approach. He analysed the different interests of key project stakeholders, including the general public, the developer and the local authority. Based on his analysis, Newcombe (2003) demonstrated that project managers should pay particular attention to those stakeholders who are likely to enforce their own expectations in an unpredictable manner. The aim of his research was to avoid conflicts and improve project performance, but not to meet dynamic and diverse client needs. In contrast, Green and Simister (1997) used a participative research seminar with the aim of helping a client organization develop shared understandings of a project, especially before the briefing of design specification. They documented the multiplicity of perspectives within the client organization and argued that the social construction of shared understanding among these participants is necessary. Following Green and Simister (1997), we adopt a social constructivist approach to examine the construction of shared meaning among participants who have different perspectives.

Participants' interactions for the incorporation of goals, aims and motives

Connaughton (1993) is one author who has analysed the way a client organization sets different and changing goals or requirements. He analysed pharmaceutical companies' investment decision-making and implementation processes in factory projects. In his analyses of resource allocation and political procedure, he documented the successive

changes in client goals during the projects. Thomson (2011) paid particular attention to emergent client requirements in the course of a project. He analysed information exchange between the client organization and the project team. In his analysis, he observed that multiple requirements arose from different people within the client organization at different times in the course of a project. These two authors investigated the way that a client organization identified different and changing client requirements and goals in a client organization or between a client organization and a project team, in either formal or informal procedure. However, they did not document how participants negotiate with each other to share an understanding of client expectations from different perspectives.

During a construction project, project teams are expected to understand and incorporate dynamic and diverse client needs and goals. However, it has been recognized that a project team has also its own distinct concerns apart from their clients. Ivory (2004) studied client, user and architect's interactions and their implications for design and innovation processes. He documented negotiations over a difference between the architect's strategic motivations beyond the project and client, project-specific goals. He concluded that architects sometimes need to resist clients' conservative views to implement innovation. Ryd (2004) studied the role of design brief documents as carriers of client expectations throughout the brief, design and construction stages in a project. She traced the changing perspectives of a project team on the client's original brief over time, including a project planner and a contractor. She concluded that the briefing document was a decisive interactive element between stakeholders in the course of a project. In this process, the client's needs and requirements were incorporated into the building project through stakeholders' negotiations over a series of produced documents.

Building on Ivory (2004) and Ryd (2004), the assumption of this research is that project participants who have conflicting goals and motivations negotiate with each other to develop a project. The model of this research is that a project develops through a series of negotiations involving a client organization, project team and documents. This general model, in turn, allows for inquiry into how client interests are incorporated in the course of a project. Client interests travel across negotiations between multi-shifting stakeholders and material objects from briefing to design, and to construction delivery process.

Actor-network theory in CM research

During the course of a construction project, changes occur in two key ways. First there are various issues that are subject to negotiations. Second, the people involved in these negotiations are a continuously changing constituency. Recently, in CM research, ANT has been used to study the succession of interactions in a construction project. A particular feature of ANT is that it avoids the dichotomy of identifying internal and external factors of dynamics. Thus, who are the relevant actors and who are not in a particular interaction are not defined *a priori*. Also, ANT does not make *a priori* assumption about actors' properties. For example, material objects are also analysed as participants in interactions. These two points enable researchers to describe associations of multi-shifting stakeholders and material objects by following the passage from one interaction to another.

Harty (2008) used ANT to study the implementation of 3D CAD in a construction project. He observed that circulating objects, such as drawings, travelled within and between networks of actors over time, which gradually incorporated the concerns of

IT support, structural engineers and CAD drafters to develop a layering method. Tryggestad *et al.* (2010) used ANT to study the development of a skyscraper project. They investigated how objects, project stakeholders and the emerging building interacted with each other, which led to the continuous development of project goals and design specifications. They documented a series of interactions where participants' dynamic expectations and ambitions were incorporated into the ongoing development of a project. However, they did not analyse the negotiation processes that led to the project development in detail. Our research builds on Tryggestad *et al.*'s approach that a project develops through a series of interactions between various actors and material objects. In this research, detailed discussions are particularly studied in which actors attempt to incorporate their own goals and motivations into the development of a project. This analysis, is then used, to identify the way that clients' expectations are incorporated in a project.

Theoretical framework

ANT was originally developed as a method to analyse the development of science and technology. The method treats scientific knowledge or technological artefacts as produced through a network of heterogeneous and dynamic actors. (Law 1992).

A building project is particularly analysed as being developed through various actors' attempts to incorporate their interests into a project. Actors, including clients, architects and material objects, come together to develop a project. In this process, actors have their own expectations for the development of a project. Actors attempt to align other actors, as well as material objects, so that all of these elements are committed to envisaged pathways to develop a technological artefact. The characteristics and inter-relationships of these elements are defined in a certain way. This attempt to link together different elements and to define their roles and characters is called problematization (Callon 1986).

Actors' goals, motivations and aims which are defined in the alignment with other actors and material objects are called interests (Callon and Law :1982). Actors put forward their problematizations based on their own interests. In problematizations, actors consider their own interests, relevant actors and the relevant actors' interests. Actors' interests are defined in a way that actors in networks interact with each other to select one option from available options for the development of a project. The success of a problematization depends on an actor's ability to convince the relevant actors and on their reactions to the problematization. As a result of negotiations over problematizations, one option for the development of a project is chosen over another. This, in effect, leads to the incorporation of some interests over others.

These concepts – problematization and interest – are used for the case study analysis. My research model is that various stakeholders and documents discuss with each other with their attempt to align actors, their interests and their preferred option for the location of the building. The success or the failure of these attempts during negotiations is the way some client interests are incorporated into a project whereas others are not.

Based on the assumption of ANT that actors' properties are not defined *a priori*, I only analysed actors' interests during a negotiation at a particular moment of a project. More specifically, client expectations were identified in relation to a decision about a specific issue, to various relevant actors and to material objects around this issue. The limitation of this approach is that the analysis does not emphasize stable goals which

are set by powerful actors. Instead, this approach highlights dynamic client interests which are adapted to a project context in a series of negotiations.

RESEARCH DESIGN

The Marvin building in the Colmer University in South England was studied. This building was designed to house facilities for the School of Film and Drama (SFD). (The names have been anonymized to maintain confidentiality.) As such it required special facilities including a theatre, film and TV production facilities. The feasibility study for the building project took place in 2007 and the construction was completed in 2011. The final project cost was about £11 million.

The research was carried out by the first author of the paper and first-person narrative is used to present her account of the work. Data was collected from retrospective interviews with 13 project participants and from documents produced during the project. The duration of each interview was approximately 90 minutes. The interviewees were from both the client organization (including the representatives of SFD and the Deputy-Vice Chancellor), and the project team (including architects). The interviews started with the participants from the client organization, and proceeded with further relevant participants identified from the interviews. From these, I identified discussions and negotiations that were most remembered as controversial. Also, I used the documents to understand the sequence of events, to supplement the data, and to support my arguments in the analysis. The documents include architectural drawings, proposals, review notes and emails.

ANT was used as analytical method to systematically document the discussions over key issues. For the purposes of this paper, one particular episode has been selected from the case study of the whole project. Research questions for the issue about the location of the Marvin building are:

- What were actors' interests identified in a specific problematization with regards to the location of the building?
- How were actors' interests incorporated during discussions as one option was chosen over another for the location of the building?
- Why were some client interests incorporated while others were not in each negotiation?

ANALYSIS AND FINDINGS

Three key discussions were identified around the decision over the location of the building. First, the Head of Space Management (HoSM) and a master plan architect proposed potential building sites and recommended one of them. Second, members of the public opposed this proposal during the exhibition of a draft campus master plan. Third, the final decision on the location of the building was made by the Board of the Governance (BG), which overruled the Dean of Faculty's opinion.

Discussion 1: Proposal for the location of the building

Colmer University had developed its Estate Strategy (2004-2013) to promote more efficient use of the spaces owned by the University. In the Estate Strategy, several strategic estate objectives were set out. One of them was to establish zones on the University's main campus so that cognate activities would be co-located. A campus master plan was developed to implement the Estate Strategy. At that time, the SFD was located on another campus which was planned to be closed by 2012. A new building for SFD was one of the University projects envisaged for the next five years.

At the feasibility meeting for the new SFD building in July 2007, the location of the building was discussed. The feasibility group members requested the HoSM to appraise options for possible locations. The HoSM considered the East and West of the Purbeck building as most appropriate sites. She raised one of the requirements for this proposal as to be near to the School of Communication. She employed the Estate Strategy to support this proposal, which encouraged academic integration between schools and departments whose academic activities are related to each other. In relation to the options of the sites next to the Purbeck building, she aligned the Purbeck building with the SFD building as well as the University's interest in her problematization. HoSM's problematization identified the University's interest in academic integration between schools and departments.

The HoSM asked a master plan architect to comment on the advantages and disadvantages of the sites at the East and West of the Purbeck building. The master plan architect recommended the East of the Purbeck building in preference to the West. In his report, he pointed out that the West site was highly visible to visitors from outside the campus. This site faced the main entrance of the University. He identified the University stakeholders' interest in accessibility for visitors to the SFD building as the building was supposed to accommodate the public theatre space. However, this site was next to an existing listed building; the architect noted that the proposed building might introduce a visual contention between the two buildings. In relation to the option of the West site, he aligned the entrance, visitors, the existing listed building and the University's interest in the accessibility of the building in his problematization. In contrast, he defined the East of the Purbeck building as the site providing an opportunity to create two separated quadrangles in a central space of the campus. The architect's interest was in using this building to provide a vibrant atmosphere by dividing an open space at the centre of the campus. However, the building on this site would not be visible from outside of the campus. In relation to the East option, the architect aligned the central space, visitors from the outside and his own interest in the improvement of the centre of the campus in his problematization.

In his recommendation at the end of the report, the architect wrote *"[i]ts location will therefore be influenced by whether the University wishes to encourage visitors into the heart of the campus, or whether it would prefer to maintain a degree of separation by locating it at the periphery of the built core."* This quote points to the architect's strategy to convince the University. He stated that the University could change its interest in the accessibility from the outside campus to the interest in drawing visitors into the centre of the campus. In his problematization, he redefined the University's interest so that the East option was chosen while incorporating both the architect's interest in providing vibrant atmosphere at the centre of the campus and the University's redefined interests. As a result, this proposal was agreed by the HoSM and the feasibility group members.

Discussion 2: Public consultation

In parallel with the feasibility study of the SFD building project, the campus master plan consultation team developed a draft master plan in October 2007. This draft master plan was agreed internally by the University senior people. Following this, Colmer University held a public consultation in order to obtain the views of the public, including local residents, University students and staff. The public consultation took the form of a six-week exhibition, in which the members of the public were invited to view the campus master plan. In the exhibition venue, the campus master

plan was presented on 12 presentation boards. The background and purpose of the master plan and the current problems of the campus such as vehicular routes and building condition were demonstrated. At the end of the presentation boards, 13 key themes of the improvement plan were identified and proposed.

The SFD building project was one of these key themes; it was indicated on two campus maps on the presentation boards. In both of the maps, the location of the building was positioned on the East site, which was in the middle of an open central space. The plans for all the future projects were communicated equally without a detailed description of each project. The architects' problematization for this public consultation was that the University was interested in showing the local authority that public views were being taken on board in the development of a campus master plan. The University did not have an interest in taking into account their comments on the detailed plan for each project. Thus, the presentation boards did not communicate the potential function of the SFD building; they did not communicate that the building would accommodate the public theatre space or common teaching space shared by schools and departments. The architects created the presentation boards in the alignment with the University's interest and the local authority in their problematization, thus presented only the location of future projects without the description of each project.

In the exhibition, respondents were given forms asking their attitudes or views on the 13 themes. Among the 13 key themes, two themes were especially related to the location of the SFD building: Theme 4 *“to reinforce the square at the centre of the campus”* and Theme 7 *“to provide a new School of Film and Drama building”*. In the comments collected after the public consultation, the majority of the responses opposed the loss of the green space caused by the erection of the new SFD building. Comments included statements such as *“will have serious negative impacts on our ability to recruit students if green space is removed”*, *“very obtrusive location – cutting in half one of the few well planned open spaces on campus”*, *“should not be built here under any circumstances.”* In sum, the majority of the respondents did not agree with the University's East option. In relation to this option, the public aligned the green space, the SFD building and their interest in maintaining the openness and brightness of the green space in their problematization.

Other collected comments showed the public's agreement on the proposal under certain conditions. There was a suggestion of downsizing the building so that the open space was not shaded by the building too much. Also, a few comments agreed that the location was appropriate if the building was to be shared among schools and departments. They redefined the SFD building as a small building or accommodating shared facilities to align the SFD building with the East option based on their interests. The lack of the information about the building itself may be a part of the reason why the majority of the public paid particular attention to the green space and opposed the East site. This implies that the way the University's interest outside the project attracted the public's particular interest was through the medium of the campus maps. In the architects' problematization, the design of the campus maps was aligned with the University's concern about the local authority's attention to the development of the master plan. In the public's problematization, the public's interest in the openness of the green space was aligned with the option of the East site based on the campus maps, which were created in a way that the University's concern was privileged.

Discussion 3: Final decision of the location of the building

After the public consultation, the architects reconsidered the proposed location of the building. The architects first reconsidered the size of the building based on some comments. They considered that the centre of the campus was still an appropriate location if the building was smaller. In this problematization, they aligned the University's interest in the visitors' easy access to the building with the East site. Also, the architects proposed building on a car park as an alternative site for the smaller building, which was away from the green space but close to Purbeck building. In this problematization, they aligned the public's interest in maintaining the openness of the green space with an option for building on the car park, while moderating their own interest in reinforcing the centre of the campus.

The two potential building sites for the SFD building were considered as options by the Board of Governance (BG). According to the interview, the finance officer stated that it was informally the Vice Chancellor's very strong view that led to the final decision, though it was formally the BG's decision. The finance officer was not personally interested in the location of the building, and said that the majority of the members in the BG were not interested in this issue. The finance officer explained; *"Well, he is the chief executive of the organization..., so not altogether surprisingly people would listen to what he says"* (Interview with the finance officer 2013). This implies that the BG members aligned three aspects in their problematization: the Vice Chancellor's preference, their own interest in following his hierarchically higher position and their absence of interest in the location of the building.

The Deputy Vice Chancellor also stated that the Vice Chancellor made the final decision. He did not know exactly why the Vice Chancellor preferred this location. In fact, he was personally in favour of the centre of the campus due to his interest in the visibility of the building. However, he recognized that this location *"might have proved unpopular with colleagues"* (Interview with Deputy Vice Chancellor 2013). This implies that the Deputy Vice Chancellor moderated his interest in the visibility of the building as he aligned the public's interest in the green space with an option for the building on the car park in his problematization.

At the feasibility meeting in March 2008, the feasibility group heard that the location of this building would be the car park. The final decision on the location was communicated as the united decision of the BG by the Deputy Vice Chancellor, the chairman at the feasibility meeting. In the feasibility meeting, the SFD was not very interested in the location of the building, but understood that this decision was made as the Vice Chancellor wanted to maintain the openness of the green space. The HoSM mentioned that, at the meeting, there was a discussion about the benefit for the University as a whole and said, *"that was a real nervousness about making that central key green space feel more enclosed"* (Interview with HoSM in 2013).

In this feasibility meeting, there was opposition to the option of using the car park by the Dean of the Faculty. She preferred the East site. In relation to this site, she aligned the Purbeck building with the SFD building and identified her interest in maximizing academic integration between the schools in the same Faculty in her problematization. The, the feasibility group members aligned the following aspects in their problematization: the Vice Chancellor's preference for using the car park, the public's interest in the openness of the central space, the Dean's interest in academic integration in relation to the option of the East site. As a result, they chose the car park space as the location of the building instead of the East site. To choose the car park

space instead of the East site as the location of the building, they prioritized the Vice Chancellor's preference and the public's interest over the Dean of the Faculty's interest in academic integration. Interestingly, the University's interest in academic integration was incorporated in the first proposal but not in the final decision. As the alignment of actors, interests and options changed, the prioritization of client interests also changed.

DISCUSSION AND CONCLUSIONS

In a series of discussions over the location of the building, some client interests were incorporated while others were not. This was because client interests were newly identified as new actors, interests and options were introduced in each negotiation and that these diverse interests conflicted with each other to choose one option over another for the location of the building.

In the initial proposal, the architect redefined the University's interest in order to recommend the East site over the West site. As the architect recognized that the University was interested in the accessibility of the building for visitors, the architect redefined that the University was interested in drawing visitors to the centre of the campus so that it was aligned with the option of the East site. As the East site was chosen over the West site, the architect's interest in providing vibrant atmosphere at the centre of the campus and the University's interest in drawing visitors into the centre of the campus were incorporated. However, the University's interest in the building's accessibility for visitors from outside of the campus was not incorporated.

In the public consultation, the campus maps were designed based on the University's interest outside of the project, which, in effect, introduced the public's interest. The architects designed the presentation board in a way that they incorporated the University's interest in convincing the local authority about the democratic process of developing the campus master plan. The presentation based on this interest attracted the members of the public's interest in the openness of the green space as they opposed the East site as the location of the building. The University's interest outside of the location of the building unexpectedly introduced new interests into the discussion as the members of public provided comments based on the campus maps in the exhibition.

In the final decision on the location of the building, the Vice Chancellor's preference communicated by the Deputy Vice Chancellor was prioritized over the Dean's interest. In the feasibility group meeting, the members aligned the Vice Chancellor's preference for using the car park space, the public's interest in the central open space as well as the Dean of Faculty's interest in academic integration in relation to the options of the car park space and the East site. In the end, the car park space was chosen as the building site, and thus, the public's interest in the openness of the central space was incorporated, whereas the Dean's interest in academic integration was not incorporated. Although the University's interest in academic integration was incorporated in the first proposal, the same interest was not incorporated in the final decision. In a series of discussions, the previously incorporated interest was dropped in the alignment with a new actor, a new interest and a new option.

In this research, the diversity and dynamics of client interests have been analysed in a series of negotiations. Changes in the prioritization of client interests were observed as the choice of options was iteratively considered. ANT approach especially helps to understand the process of how some client interests fail to be incorporated by taking into account unexpected actors' influence on decision-making processes. This

research contributes to a nuanced understanding of client decision-making processes in building projects as called for by CIB W-118. It provides deeper insights than the more conventional approach, such as the study of roles and responsibilities or processes and mechanisms. The analysis of particular actors' roles does not capture the way unexpected actors (e.g. campus maps) influence clients' decisions. Also, the adoption of linear management process hardly captures how some client interests eventually fail to be incorporated in a series of discussions.

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INTEGRATING EXTERNAL STAKEHOLDER IDENTIFICATION AND PROJECT INITIATION IN CIVIL ENGINEERING INFRASTRUCTURE PROJECTS

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Current evidence suggests that there is a delay between the start of project initiation and the beginning of external stakeholder identification during the initiation phase of civil engineering infrastructure projects. A major consequence of this delay is limited project success. The aim of the research reported in this paper is, therefore, to explore the timing between project initiation and external stakeholder identification in order to understand its impact upon project success. A desk study involving three railway projects in three European countries was undertaken. It was found that external stakeholders are often asked to support proposals that may constitute opportunities to the project initiator but neither solve the external stakeholders' problems nor meet their expectations. It has also been identified that the time lag between project initiation and external stakeholder identification leads to external stakeholders having limited (if any) input into key aspects of the project defined before they get on the scene. This often results in misalignment of the project purpose and stakeholder expectations, thereby leading to lack of buy-in from external stakeholders which in turn can limit project success. Chances of project success can be improved by minimising the time lag, and the time lag can be minimised by integrating the project initiation and stakeholder identification processes. Such integration (which is the subject of on-going work) will lead to stakeholders agreeing the problem to be addressed by the project, defining options, and assessing the options for a consensus or near-consensus project that can be implemented with minimal disruption and/or challenge - and this will, in turn, boost chances of project success.

Keywords: civil engineering infrastructure, project initiation, project success, stakeholder identification.

INTRODUCTION

Civil engineering infrastructure projects, such as highways, bridges, airports, pipelines and railways, form the backbone of any modern, successful and competitive economy (HM Treasury 2012), improve quality of life and enhance the well-being of a modern society (Ng *et al.* 2012). However, these projects often have a significant impact upon the lifestyle of a community, and their economic, environmental, sociological and political implications could last for varying periods of time (Koehn 1993). Therefore, the number of external stakeholders affected by a typical civil engineering infrastructure project can be large, and consequently present numerous interfaces that

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have to be effectively managed (Chinyio and Akintoye 2008). External stakeholders are those individuals and organisations that have no formal contractual relationship to the project but can have a strong interest in what is going on regarding the project (Cleland and Ireland 2007). According to Bourne and Walker (2005), in order to maximise external stakeholder positive inputs and minimise any potential detrimental impacts, it is vital to successfully identify and effectively collaborate with them to thoroughly understand both their expectations and potential impact upon project success.

The importance of managing external stakeholders to construction project success has been increasingly recognised (Jepsen and Eskerod 2009; Aaltonen *et al.* 2008; Moodley 2008; Young 2006; Fewings 2005; Olander and Landin 2005), and this is particularly the case for civil engineering infrastructure projects. Stakeholder management has been defined as “*the continuing development of relationships with stakeholders for the purpose of achieving a successful project outcome*” (McElroy and Mills 2007: 760). This definition underlines the importance of developing relationships with stakeholders to project success. Moreover, Project Management Institute (PMI) has recently added project stakeholder management as a “*10th Knowledge Area*” due to the importance attached to appropriate engagement of stakeholders in key project decisions and activities (PMI 2013). Therefore, civil engineering infrastructure projects need to adopt an effective external stakeholder management approach to increase chances of project success.

Actually, the discourse on stakeholder management has been evolving since Freeman’s major contribution to the project management literature in 1984 (Littau *et al.* 2010). Since then, a number of stakeholder management approaches have been developed. In this research, eight approaches have been identified (PMI 2013; Luyet *et al.* 2012; BS 6079-1 2010; Yang *et al.* 2009; McElroy and Mills 2007; Preble 2005; Karlsen 2002; Cleland 1986), and it was found that although each approach adopts individual tools, techniques and stakeholder classification criteria to facilitate the execution of the process, all of them are similar in terms of the steps followed. Therefore, a generic stakeholder management approach has been derived from comparing and contrasting the eight approaches to identify which aspects they share and which sequence of steps they agree on. It was found that the eight approaches agree on four generic processes namely identification; analysis; engagement and evaluation.

The research reported in this paper is concerned with the first step (identification) during the initiation phase of civil engineering infrastructure projects. Stakeholder identification is defined as “*the process of identifying all people or organisations impacted by the project, and documenting relevant information regarding their interests, involvement, and impact on project success*” (PMI 2008: 246). It is widely agreed that external stakeholder identification should start at an early stage of the project lifecycle (Moodley 2008; PMI 2008; APM 2006; Young 2006). Moreover, previous studies of public participation in infrastructure projects have also emphasised the necessity to engage the public and external stakeholders at an early stage in the development of infrastructure projects. Ng *et al.* (2012), for instance, proposed a systematic participatory framework for infrastructure construction projects. They built participatory activities, and recommended a number of participatory techniques for each phase of the project lifecycle. However, their framework assumes that the public is involved after concept plans are prepared by the project initiator. Similarly, Li *et al.* (2012) proposed a process flow of public participation for infrastructure construction

projects. The process introduced comprehensive public participation by examining the practices and limitations of China's current EIA-based public participatory process which is undertaken within the context of environmental impact assessment (EIA), as, in China, a participatory mechanism for infrastructure projects exists only as part of the EIA process (ibid). However, the proposed process flow indicates that the project is already initiated when participation takes place.

External stakeholder inputs are ignored until the need for a project is captured and a number of options are identified to propose a preferred solution. There is no evidence for effective external stakeholder involvement in the project initiation process despite agreement on the importance of involving them early. A civil engineering infrastructure project is either derived from opportunity, arising from a perceived need or related to a recognised problem (Corrie 1991). According to APM (2006), this pre-project activity is performed within organisational functions or departments, while the decision to proceed with a project is made by senior management. In the United Kingdom, for example, the developer of any nationally significant infrastructure project is required to extensively consult with the affected external stakeholders of their proposals before submitting an application for development consent (The Planning Inspectorate 2012). However, the consultation does not start until the developer has prepared their proposal and notified the Planning Inspectorate that they intend to submit an application in the future. This suggests that external stakeholders are having limited (if any) input into key aspects of the project before they get on the scene, whereas some evidence (National Audit Office 2011) has recently been presented suggests that successful initiation of a major infrastructure project requires external stakeholder involvement. External stakeholders need to understand what outcomes potential civil engineering infrastructure project is meant to deliver, and participate in articulating its objectives (ibid).

The starting point of the project initiation phase should be the definition of the problem or opportunity the project is meant to address. Infrastructure projects should be aimed at addressing problems - and these problems will be faced by all society including external stakeholders. When the process of defining and agreeing the problem involves external stakeholders, the project that is initiated to address the problem is likely to be supported by external stakeholders. In practice, stakeholder identification and project initiation do not appear to be harmonised - and this tends to limit project success in infrastructure projects. It is the authors' contention that harmonisation of stakeholder identification and project initiation can be addressed by minimising the time lag between the start of the initiation phase and stakeholder identification process. Therefore, the aim of the work reported in this paper was to explore the timing between external stakeholder identification and project initiation processes during the initiation phase of civil engineering infrastructure projects with a view of proposing future work in this important area.

RESEARCH METHODOLOGY

In order to explore the timing between the start of project initiation and the beginning of external stakeholder identification, a desk study was conducted. The desk study involved three railway projects: expansion of the west coast line through the city of Lund, Sweden; Betuweroute rail project, the Netherlands; and High Speed 2 (HS2) Railway, United Kingdom. The focus of the study was on issues relating to project initiation and management of external stakeholders in the three projects. The desk study involved a critical study of journal articles (Olander and Landin 2008; 2005),

government publications (Department for Transport 2012a; 2012b; 2010; Great Britain), text books (European Commission 2005; Hertogh *et al.* 2008) and official websites (51m 2012; High Speed 2 [no date]; Railway Technology 2014; The APPG for High Speed Rail 2012).

The aim of the desk study was to identify what work had been done before the first formal public consultation. The focus of the desk study was on two themes (events in the project and events relating to external stakeholders). Events in the projects were project decisions and activities relating to initiating the project, whereas events relating to external stakeholders were associated with external stakeholder related activities, such as public consultations, disputes, communications between stakeholders and project teams. The desk study also focused on key dates in the projects' lifecycles in order to produce a project timeline that can clearly visualise both project and external stakeholder activities during their initiation phases. In addition, the impacts of lack of external stakeholder involvement on the projects were also identified.

FINDINGS AND DISCUSSION

For each of the three projects, a timeline has been produced to show the timing between key activities in the project and any associated external stakeholder events, such as consultations. The timelines clearly visualise the time lags between the beginning of the projects' initiation phases and the first formal public consultations. They also illustrate the project activities that had been done before the public consultations, and the impacts external stakeholders had on the projects during their lifecycles.

Project 1: expansion of the west coast line through the city of Lund, Sweden

In the late 1980s, the Swedish government decided to transform the west coast railway from a single to a double track railway through the city of Lund. The initial evaluation of the project started in 1989, and in 1990 the National Railroad Administration (the project owner) decided to expand the line alongside the existing route. At this stage, the only stakeholders considered were the railway companies that would manage the traffic on this line, and for them expanding along the existing single-track railway was the most rational option (Olander and Landin 2005). The first public consultation about the project was held in November 1991 after a preferred route had been chosen, and a project proposal was already developed (Olander and Landin 2008). It was the first opportunity external stakeholders had to raise their concerns about the project, which means that there was a time lag between the start of project initiation and the first public involvement in the project.

As can be seen in Figure 1, from the initial project evaluation, three years passed before the first public consultation took place. Key aspects of the project including objectives and route selection were defined during these three years without any input from the project's external stakeholders. According to Olander and Landin (2008), the decision to proceed with a project and expand along the existing line was based on making it a competitive transport alternative, and to create a better labour and housing market through improved communications. However, when this decision was made, the impact of the project on external stakeholders, especially the local residents who lived in the area surrounding the proposed route, was underestimated. Stakeholder management was a matter of one-way communication informing stakeholders about decisions made. As a consequence, the project faced active and aggressive opposition

from those local residents who argued that there had been a better alternative for the proposed route that would impact on a smaller population.

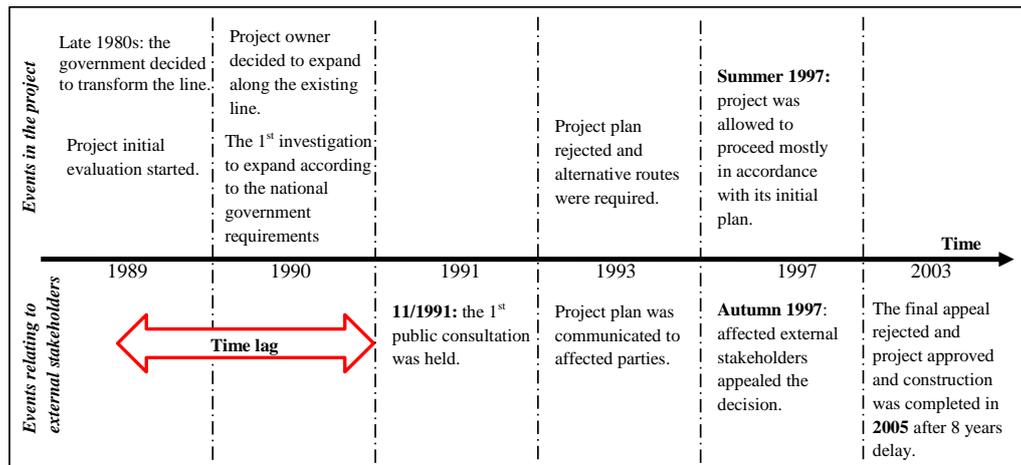


Figure 1: The time lag in project 1

As a result of lack of public involvement in the initiation process of the project, the concerned residents formed an interest group and in 1993 acted through the municipality of Lund, which was involved because a community plan was required, to raise the question for the need of alternative solutions. The municipality of Lund, in turn, through the normal planning process expressed the view that there was insufficient alternative analysis for the design and implementation of the project, and demanded investigating additional alternative solutions (Olander and Landin 2005). As a result, additional alternative solutions were investigated, but were found to be economically and technically insufficient. In 1997 the municipality therefore allowed the project to proceed mostly in accordance with the owner's original plan. However, the affected external stakeholders appealed the decision twice but lost in both instances. The ultimate result of the appeal required changes to address noise and safety concerns. Although they lost the case, external stakeholders delayed the project by eight years resulting in a significant increase in the project's indirect cost (Olander and Landin 2008).

This project was initiated entirely in accordance with the developer's requirements (The Swedish Government). There was lack of external stakeholder involvement during the initiation phase, and external stakeholders had no input into the initiation process. In fact, attention to external stakeholders was given only when planning permissions were needed. Even then, stakeholder management was a matter of informing rather than involving external stakeholders in project decisions and activities. Therefore, the project plans neither met the expectations nor addressed the concerns of external stakeholders, and were criticised as an expression of the developer's interest. The delay between the beginning of project initiation and the first public consultation prevented external stakeholders from positively contributing to the project that would impact upon them. External stakeholders had the opportunity to raise their concerns only after a preferred route was selected and project plan had already been developed.

Project 2: Betuweroute rail project, the Netherlands

In the Netherlands, at the end of 1980s, the initiative of constructing a railway line between Rotterdam harbour and the German border was put on the political agenda. The project is known as Betuweroute rail project. In 1991, the initiative was

formulated in a Dutch policy document. The Dutch parliament then authorised the investment in 1994 in spite of the controversy due to the poorly defined argument/benefits and the project’s impact on local stakeholders. Only after when the investment had been authorised and route proposals developed, did the external stakeholders have the possibility to raise concerns about the project. In the same year, 1994, citizens had their first chance to respond to the proposed preliminary route proposals (Hertogh *et al.* 2008). Figure 2 illustrates key events relating to the project initiation and its external stakeholders at an early stage of its lifecycle. It shows that external stakeholders had the chance to be heard about the project only after the investment had been authorised.

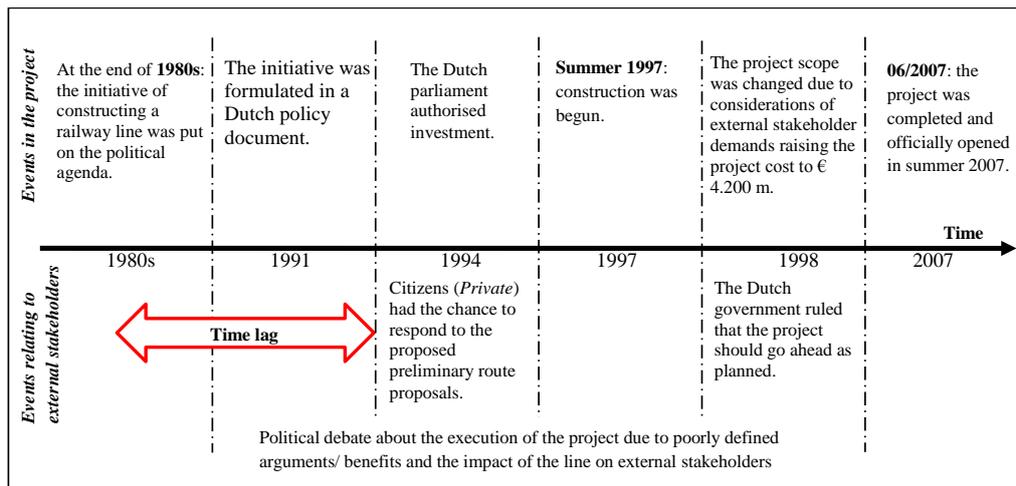


Figure 2: The time lag in project 2

As can be seen in Figure 2 above, from when the project was put on the political agenda four years passed before external stakeholders had the chance to be heard about the project. The necessity for the project and its route were decided before consulting the affected external stakeholders. Only after the Dutch parliament had already authorised investment in 1994 were affected citizens consulted about the project proposals. Regardless of its ambitious objectives of provision of a sustainable transport alternative for freight and improving the competitive position of Rotterdam harbour, the project’s plans were criticised once they entered the public arena due to the poorly defined argument/benefits and impacts of the project on the external stakeholders (Hertogh *et al.* 2008).

According to Hertogh *et al.* (2008), the project became subject to controversy in the arena of political decision-making as a result of the lack of public involvement in its initiation process. The affected external stakeholders questioned the necessity for the project and demanded mitigating measures to be taken once the first public consultation took place. As a consequence of this demand, the project scope changed raising the total project costs to approximately €4.2 billion in 1998 from the initial estimate of €1.1 billion when the first plans were presented (*ibid.*).

The project was one of the TEN-T priority axes and projects (European Commission 2005). It was initiated to meet environmental and economic benefits, but lacked considerations of impact on local external stakeholders. The late involvement of external stakeholders resulted in the necessity for the construction of the project being questioned, and mitigating measures being demanded. The time lag led to external stakeholder concerns about the project being left behind allowing the project to be initiated mostly in accordance with the requirements of its developer. As a result, the

project scope changed as demanded by its external stakeholders. This dramatically raised the project's total costs. This could have been mitigated if external stakeholders were involved in initiating the project, but unfortunately attention to affected stakeholders was given late.

Project 3: High Speed 2 (HS2) Railway, United Kingdom

The case for high speed railway in the United Kingdom has been examined since 2009, when the UK government established HS2 Ltd to research the suitability of a high speed railway line between London and the West Midlands (Department for Transport 2010). Following its establishment, the HS2 Ltd submitted proposals for high speed railway line to the UK government in 2010. The preferred option was announced in October 2010, and published by the government at the end of the same year (Railway Technology 2014). The first public consultation did not start until the government had announced its preferred route. The consultation on the proposed route then ran from February to July 2011. In January 2012, the Secretary of State for Transport decided to proceed with HS2 Ltd's recommended route between London to Birmingham (Phase 1) following analysis of the responses to the consultation. A year later, the Secretary of State announced the initial preferred routes for Phase 2, a western branch connecting Birmingham and Manchester and an eastern branch connecting Birmingham with Leeds, after HS2 Ltd had submitted their recommendations on these routes (High Speed 2 [no date]). Figure 3 illustrates the earliest stage of the project lifecycle. It highlights the main events relating to initiating the project and its external stakeholders. In this project, there is no evidence for external stakeholder input before the first public consultation.

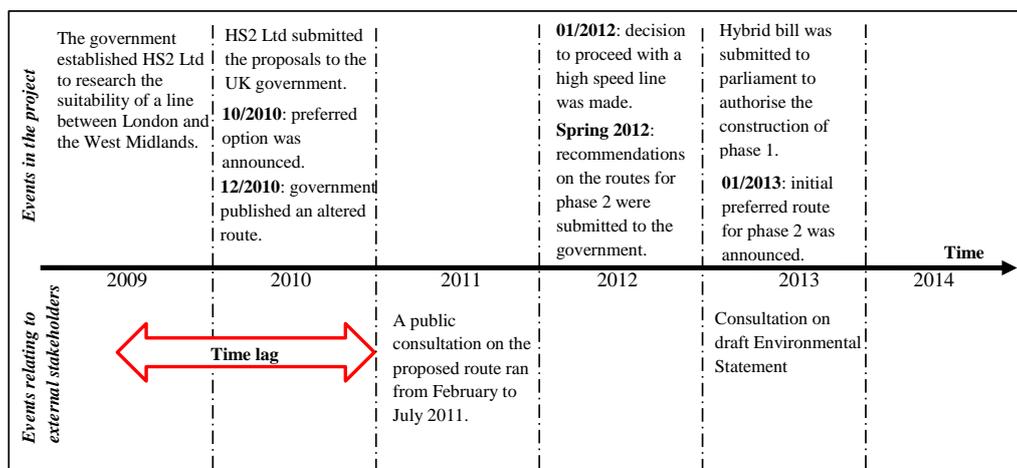


Figure 3: The time lag in project 3

As can be seen in Figure 3, HS2 Ltd had researched the suitability of a high speed railway line and submitted project proposals to the government before the start of the first public consultation. External stakeholders had the opportunity to be consulted about the project proposal after the government had already chosen and announced what it believed to be the most rational option. Moreover, key aspects of the project such as confirming the necessity for a high speed railway line and the selection of a preferred route had been defined before the first public consultation started. There is no evidence for effective external stakeholder involvement in the process of developing the project proposal. The consultation on the project asked seven questions covering the Government's overall strategy for high speed railway line, the proposed route for phase 1, its environmental appraisal, and options for supporting affected property owners (Department for Transport 2012a). However, the whole consultation

was about one option, which was the government's preferred option, and no alternative options were made available at the time. Participants in the consultation did not have the chance to be consulted about options but rather they were asked whether or not they agreed with the government's preferred route (the Y network). As a result, the project proposal has been criticised by some significant sections of the nation as an expression of the government's interests rather than the nation's interest.

Although the first public consultation was one of the largest national consultations ever undertaken by the Department for Transport (Department for Transport 2012b), external stakeholders against the project such as 51m, HS2 Action Alliance and Stop HS2 have been actively criticising the government's proposal to construct a high speed railway line since its announcement in 2010. Their argument is that there is a better alternative that can equally meet demands. They also claim that the construction of HS2 is an inappropriate way of increasing capacity as it takes far too long to deliver major capacity benefits which will not be delivered before 2033. Most of those who oppose the project believe that the project's business case is poor, and suggested other alternatives that can increase capacity much more quickly than HS2 (51m 2012). Despite active opposition, the project has been given the 'go ahead' as it also has supporters who believe that the alternatives suggested by the project opposition are unable to meet peak demand, and argue that *"it can only be accommodated by a new railway line"* (The APPG for High Speed Rail 2012: 5). A potential driver of this opposition could be the lack of effective external stakeholder involvement at a sufficiently early stage when options were still being considered.

It is unknown that whether or not the time lag will have an impact upon the project's overall performance due to its current level of development. However, the time lag led to external stakeholders being asked to support proposal that constitute opportunities to the government, but seems to be an inappropriate option to them. In this project, the lag seems to be facilitated by the planning process for dealing with proposals for Nationally Significant Infrastructure Projects (NSIPs) which was established by the planning Act 2008 (Great Britain). Here, the project developer is required to extensively consult with the affected external stakeholders of their proposals before submitting an application for development consent. However, the consultation does start until the developer has prepared their proposal and notified the Planning Inspectorate that they intend to submit an application in the future.

CONCLUSIONS

There is a time lag between the start of project initiation and the beginning of external stakeholder identification when initiating civil engineering infrastructure projects. The lag unfortunately impacts upon project success, and limits external stakeholder input into key aspects of the project defined during the project initiation phase. It also leads to misalignment of project purpose and external stakeholder expectations at an early stage of the project lifecycle. This misalignment often results in lack of buy-in from external stakeholders which in turn can limit project success.

Minimising the time lag forms a golden opportunity to solve these problems, i.e. winning external stakeholders' buy-in, facilitating alignment and eventually boosting chances of project success. This can be achieved by integrating the process of project initiation and stakeholder identification. This integration will bring together all stakeholders in the project at a sufficiently early stage of the project lifecycle to firstly agree the problem to be addressed by the project, define options, and assess the options for a consensus or near-consensus project that can be implemented with

minimal disruption and/or challenge. This integration is the subject of the author's on-going research.

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A STUDY OF THE CURRENT PRACTICE OF STAKEHOLDER MANAGEMENT IN CONSTRUCTION PROJECTS

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Over the past years, stakeholder management has been advocated as a means of increasing the propensity for successful delivery of construction projects. Previous research has focused on addressing the need for a practical guide to carry out stakeholder management in construction projects. However, full benefits expected from stakeholder management cannot be achieved without adequately addressing the following issues: stakeholder management decisions and responsibilities through the project life cycle; internal stakeholder collaboration in carrying out stakeholder management; stakeholder dynamics; and use of available techniques for stakeholder engagement. These issues were investigated using a questionnaire survey which aimed to explore the current practice of stakeholder management within the United Kingdom. The questionnaire comprised of closed and open-ended questions, the data from which were analysed using appropriate statistical techniques and thematic (content) analysis. The main finding was that stakeholder management is mostly not carried out deliberately and that there is need for internal stakeholders to collaborate in carrying out stakeholder management. Furthermore, dynamics in stakeholders' interests is perceived as important and gaining new information about the project is explanatory for that. Finally, the paper surmises that construction organisations need to make stakeholder management a part of their organisational policy and agenda.

Keywords: leadership, responsibility, stakeholder collaboration, stakeholder management.

INTRODUCTION

The lengthy process of design and execution of construction projects involves interaction, collaboration and negotiations among many stakeholders which may include but not limited to the clients, designers, contractors, local authorities and the general project environment (Cheeks, 2003; Winch, 2010). The focus of construction project management over the years has been on the processes leading to the effective planning and management of the complex series of activities involved in delivering successful projects (Morris 1994; Leung and Olomolaiye, 2010). The interaction and interrelationships that take place among the parties involved directly or indirectly in a construction project determine the overall successful completion of the project (Takim, 2009). The different parties involved both directly and indirectly on the project are referred to as the project stakeholders whose management is vital to achieving project success.

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The research presented in this paper focussed on investigating the current practice of stakeholder management in construction with respect to some important decisions and responsibilities for stakeholder management. Being part of an ongoing larger research, this is a step towards developing a comprehensive framework for stakeholder management in construction projects.

LITERATURE REVIEW

There are various but similar classifications of project stakeholders (Winch, 2010; Smith and Love, 2004; Newcombe, 2003). Winch (2010) uses the contractual relationship between stakeholders and the client to classifying construction project stakeholders into internal and external stakeholders (Figure 1). Internal stakeholders are those who have legal contractual relationship with the project owner and are grouped into demand and supply sides stakeholders. External stakeholders do not have any contractual relationship with the project owner, but have some rights and interests in the project and are grouped into private and public sides' stakeholders. Stakeholders can also be classified based on their relationships with and proximity to the project: Those directly involved in the decision making and operations of the project are considered as primary or direct stakeholders whilst those who do not have any direct relationship and are operating remotely from the project are considered secondary or indirect or outside stakeholders (Newcombe, 2003; Smith and Love, 2004).

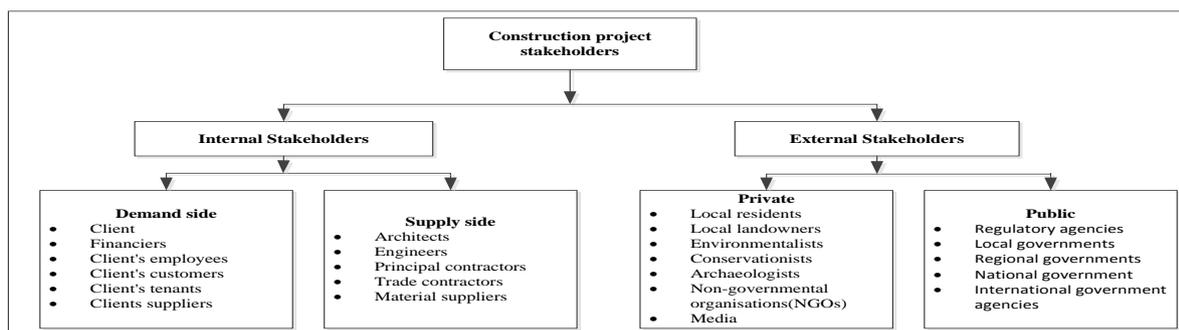


Figure 1 Stakeholder classification (Winch, 2010)

Project success has been linked to the effective and continuous engagement/management of all the project's stakeholders (Cleland, 1999; Bourne and Walker, 2005; Olander, 2007; Aaltonen *et al.*, 2008; Ward and Chapman, 2008; Chinyio and Akintoye, 2008). Likewise, construction project failures have been attributed to either lack of or inadequate stakeholder management during the project (Black, 1995; Akintoye *et al.* 2003; Bourne, 2005; Olander and Landin, 2008). Therefore, stakeholder management has been advocated as an important strategy for achieving project success in construction projects. But there is still no clear guidance on how stakeholder management can be improved to maximise the full benefits expected.

Stakeholder management is a dynamic process. Stakeholders' interests and influences are not constant and can vary from one stage to another and even from time to time in a particular stage of the project lifecycle (Cleland, 1995; Jergeas *et al.*, 2000; Olander, 2007; Aaltonen *et al.*, 2008; Ward and Chapman, 2008;). This is an indication of the dynamic relationships that exist among the stakeholders themselves as well as between the stakeholders and the project which also shows that events and actions are interdependent. How stakeholders exert their interests and concerns in construction

projects depends on their level of power which also changes as the project progresses (Pajunen, 2006; Olander, 2007). The reasons for change in stakeholders' interests during project include change of project mission, gain or loss of confidence in the project by some stakeholders, when stakeholders gain access to new/hidden information, when stakeholders are not involved or perceive they would not be involved in project decisions (Atkin and Skitmore, 2008; Olanda and Landin, 2008, Chinyio and Akintoye, 2008; Takim 2009). The stakeholders involved may have their respective expectations from the project and satisfying the expectations of project stakeholders throughout the life cycle (Inception-Design-Construction-Operation) of the project is instrumental to the successful completion of construction projects (Atkin and Skitmore, 2008; Nash *et al.*, 2010). To tackle the dynamic nature of stakeholders' interests, stakeholder involvement and management should continue throughout the entire lifecycle of the project (Takim, 2009). The reasons why stakeholders' interests may change and how they can be monitored as the project progresses have yet to be clearly understood.

Managing construction project stakeholders to achieve successful project requires team work- collaboration between the client, design and construction teams and sharing of individual skills and expertise to elicit support from all available sources. Stakeholder collaboration is a process of collective decision making among key internal stakeholders of a project to avoid or address stakeholder issues in the project. The aim of stakeholder collaboration is to build a consensus among internal stakeholders (Jamal and Getz, 1995). However, the right to participate in stakeholder collaboration does not automatically translate to the ability to perform effectively. It would therefore, be necessary to determine when stakeholders should be involved and who should coordinate stakeholder management process at different stages of the project.

The use of appropriate techniques/tools to engage project stakeholders is also instrumental to successful stakeholder management in construction projects (Yang, *et al.* 2011). Different techniques have been proposed to be used for stakeholder management including Delphi technique, strategic needs analysis, design charrette, stakeholder cycle, contingent valuation method and public hearing. The level of awareness of this techniques and how effective they are is however not covered in the literature.

Furthermore, previous research have focussed on the main steps involved in stakeholder management in construction projects including stakeholder identification, stakeholder analysis, stakeholder classification and formulating/adopting stakeholder management strategy (Newcombe, 2003; Bourne and Walker, 2005; Olander, 2007; Reed *et al.*, 2009). Some important life cycle considerations for stakeholder management in construction projects have been neglected. These include: deciding the powers and responsibility for the leadership of stakeholder management among the internal stakeholders; the need for collaboration among internal stakeholders; who should be involved in the collaboration at the various stages of construction projects and stakeholder dynamics.

RESEARCH METHOD

A questionnaire survey was designed to investigate the current practice of stakeholder management in construction projects by eliciting responses from construction professionals within United Kingdom. Professionals in architecture, construction management, quantity surveying, engineering, facility management, etc with at least

five years of relevant professional experience were targeted to participate in the survey. The questionnaire comprising closed and opened ended questions also gathered background information of the respondents in order to ensure that they have the required background and years of professional experience to take part in this survey. A minimum of 5 years relevant professional experience was set for the respondents to ensure they have participated in some projects up to completion so that they can have practical knowledge of stakeholder management issues. The respondents were asked to respond to the questions in the questionnaire based on their experience on a recently completed project in which they were involved. The questionnaire was structured into two sections. The first section collected background information of the respondents and the second section collected data on key stakeholder management issues.

The survey link was sent to 200 professionals practicing within the United Kingdom. After two reminders (at one month’s interval each) a total of 74 responses were received representing 37% of the total number of respondents to whom the survey link was emailed. Out of the 74 responses received, only 61 (30.5% of respondents contacted) were found suitable and accepted for analysis; 13 were rejected for having less than 5 years of professional experience in construction and/or for incomplete responses.

Quantitative data collected were analysed using percentages and mean ratings in IBM SPSS 20 and the qualitative data collected were analysed thematically.

DATA ANALYSIS AND RESULTS

Respondents’ profile and reliability of data: Table 1 presents the respondents’ profiles in terms of their years of professional experience and professional field of practice with all of them, having relevant experience of at least 5 years and over 78% of them having 10 years and above experience. The respondents include designers, project managers, directors, associates, project engineers, project quantity surveyors, contract administrators, clients’ representatives and facility managers. Moreover, all the targeted respondents are known to have worked on projects with multi parties and had collaborated or engaged with all or most of the parties. Prior to final questionnaire admiration, the questionnaire was pilot tested the result of which led to some amendment/adjustment to the content and structure of the questionnaire.

Table 1 Survey respondents' profiles

Professional Field	Years of Professional Experience				Total	%Total
	From 6 to 10 years	From 11 to 15 years	From 16 to 20 years	From 21 years and above		
Architecture	5	4	1	2	12	19.67
Construction Management	1	6	3	8	18	29.51
Quantity Surveying	3	3	3	5	14	22.95
Engineering	3	3	1	3	10	16.39
Facility Management	1	3	1	2	7	11.48
Total	13	19	9	20	61	100
%Total	21.31	31.15	14.75	32.79	100	

Stakeholder management decision: Asked whether stakeholder management was carried out on the project; 37.7% of the respondents said they carried out stakeholder

management and 62.3% said they did not carry out stakeholder management. Out of the 37% that said they carried out stakeholder management, 91% said no funding was provided on the projects for stakeholder management and 9% said funding was provided but did not say how much or what percentage of the project sum was committed for carrying out stakeholder management. Asked whether stakeholder management responsibility was assigned on the project, 30% said yes and 70% (of those who said they carried out stakeholder management) said no stakeholder management responsibility was assigned on the project.

Stakeholder management dynamism: The respondents were asked to indicate whether or not they noticed any changes in stakeholders' interests/disposition towards the project. The result indicates that 45 representing 73.8% of the respondents said they noticed some changes in stakeholder interests during the project whereas 16 representing 26.2% said they did not notice any change in stakeholder interests. The respondents were also asked to indicate from a list of causes identified from the literature of changes in stakeholder interests during the project. This question was intended to find out the most likely causes of change in stakeholder interests/disposition in projects. The frequency of selection of each of the causes was used for analysing this question. A quick look at the numbers will indicate that the total frequency is more than the number of respondents (61) in the survey; this is because respondents had the opportunity to choose as many causes as applicable to them. Their responses (see Figure 2) indicate that the three main reasons why stakeholders' interests changed are acquisition of information previously not available to them, gaining confidence and trust in the project and change in project mission while loss of confidence in the project team is the least likely reason. Other reasons for change in stakeholders' interests/disposition towards the project provided by the respondents include media influence and when stakeholders get to understand other stakeholder's interests on the project. Stakeholders getting to understand other stakeholders' interests on the project can be said to be the same as acquisition of new information.

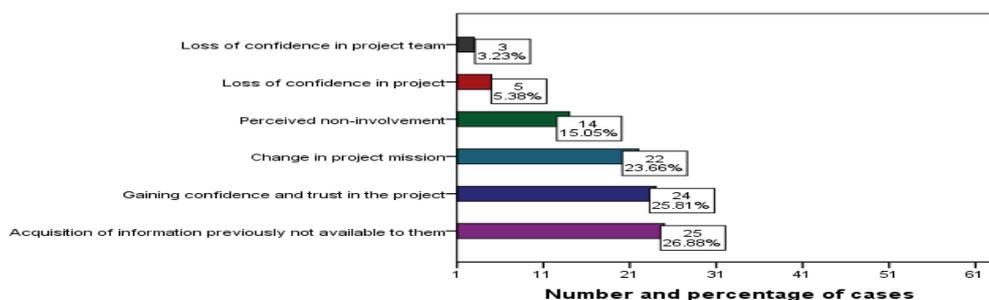


Figure 2 Causes of change in stakeholders' interests

Similarly, the respondents were asked to indicate from a list of means identified from the literature through which they monitored or tracked changes in stakeholders' interests/disposition towards the project and their answers are as shown in Figure 3 with "feedback mechanisms" being the most popular. Furthermore, their answers indicate that the other means of tracking changes in stakeholders' interests/disposition towards the project is through reports during periodic project meetings which some of them referred to as "feedback at meetings", "feedback gained at stakeholder meetings" and "informally during meetings". Some of the respondents reported that they did not monitor change in stakeholder interests/disposition towards the project at all but this is negligible as only two of the respondents shared this experience.

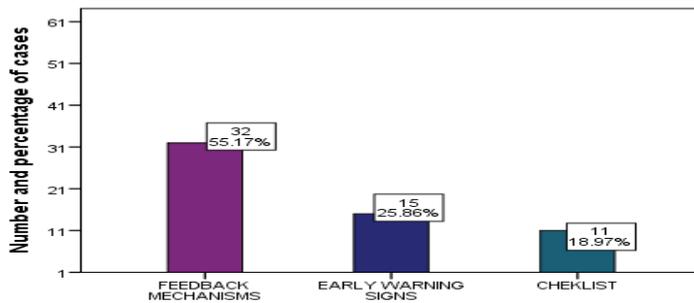


Figure 3 Means of tracking change in stakeholders' interest

Internal stakeholder collaboration: It was asked in the survey whether there is a need for collaboration among internal stakeholders in carrying out stakeholder management in construction projects. The results indicate that there is need for internal stakeholders to collaborate in carrying out stakeholder management in construction projects with 95.1% of the respondents agreeing to this. A further question asked respondents to indicate in a matrix form the internal stakeholders that should be involved in stakeholder management collaboration at the various stages of construction projects. The result obtained from this is presented in Table 2 in which the values represent percentage of respondents that selected the involvement of the respective internal stakeholders at different stages. Based on the results, internal stakeholders to be involved at different stages are indicated in bold revealing that only the client should be involved at all stages of the project with very high frequencies of selection at all the stages. Interestingly, the survey respondents are of the view that all internal stakeholders should be involved at the construction stage. The selections of internal stakeholders to be involved was based on their frequency of selection presented in Table 2 being not less than 50% of the cases involved in the data.

Table 2 Involvement of internal stakeholders in stakeholder management at different stages of construction projects

Internal Stakeholders	Inception Stage	Design Stage	Construction Stage	Operation Stage
Designer Organisation	96.7	85.0	71.7	15.0
Project Management Organisation	61.7	85.0	85.0	30.0
Project Consultant	73.3	78.3	71.7	13.3
Project QS	66.7	88.3	85.0	8.3
Contract Administrator	28.3	41.7	83.3	28.3
Main Contractor	15.0	66.7	85.0	26.7
Facility Management Organisation	40.0	76.7	58.3	83.3
Client	98.3	85.0	85.0	85.0

Stakeholder management leadership/coordination: Respondents were asked to indicate in a matrix form which internal stakeholders should be responsible for leading stakeholder management at the various stages of construction projects. The percentage frequencies of their responses are presented in Table 3. From these results the responsibilities for leading and coordinating stakeholder management in construction projects are indicated in bold. The final decision was based on the internal stakeholders with the highest percentage frequency of selection by the respondents to lead stakeholder management at the various stages in construction projects. Olander and Landin (2008) argued that “if there is no clear strategy for how to manage and

involve stakeholders in the project implementation process, the project manager will end up in a rearguard action, fending off claims from stakeholders". The suggestion that the project manager is responsible for stakeholder management is arguable; as this will depend substantially on the procurement route being used, the stage at which the project is, whether a deliberate decision is made to carry out stakeholder management and other project characteristics.

Table 3 Responsibility for leading stakeholder management at different stages of construction projects

	Inception Stage	Design Stage	Construction Stage	Operation Stage
Internal Stakeholders				
Designer Organisation	18.3	63.3	5.0	5.0
Project Management Organisation	28.3	33.3	80.0	18.3
Project Consultant	20.0	5.0	1.7	3.3
Project QS	6.7	1.7	3.3	3.3
Contract Administrator	3.3	6.7	15.0	6.7
Main Contractor	0.0	1.7	21.7	3.3
Facility Management Organisation	0.0	0.0	0.0	65.0
Client	73.3	25.0	20.0	31.7

Stakeholder engagement techniques: Six stakeholder management/engagement techniques were identified from literature review and included in the questionnaire in which respondents were asked to indicate their awareness of and rate the effectiveness of these techniques in stakeholder engagement/management in construction projects. They were asked to rate on a five point Likert scale and the mean ratings of the techniques by the respondents were used to analyse the levels of awareness and effectiveness of the techniques as shown in Table 4. The respondents were asked to rate the effectiveness of the techniques only if they are aware of them, hence their ratings represent both level of awareness and level of effectiveness. The result (Table 4) reveals that the respondents are more aware of "public hearing" with mean rating of 3.93 and think it is the most effective technique for engaging construction project stakeholders. This was closely followed by "design charrette" with mean rating of 3.90. Conversely, "Contingent Valuation Method" with mean rating of 3.38 is the least popular stakeholder engagement technique.

Table 4 Rating of stakeholder engagement/management techniques

Stakeholder Engagement Techniques	Mean	Rank
Public Hearing	3.93	1
Design Charrette	3.90	2
Strategic Needs Analysis	3.85	3
Delphi Technique	3.79	4
Stakeholder Cycle	3.46	5
Contingent Valuation Method	3.38	6

Notes: a: 1= Strongly Disagree and 5= Strongly Agree.

DISCUSSION OF RESULTS

From the results presented in the previous section, the most important reason for which stakeholders' interests/disposition towards the project change is when they acquire new information about the project. New information can cause stakeholders to

change from being supportive to opposing stakeholders or otherwise depending on the effect of the new information they have just acquired. The next important reason for change in the interests/disposition of stakeholders towards the project is when the stakeholders gain confidence in the project and project management team. The effect of this reason is positive but it can be dangerous if the level of confidence is not safeguarded and it is lost. Another reason is change in project mission outside the expectations and knowledge of some key stakeholders can cause them to oppose the project and obstruct/delay its progress. This points to the need for stakeholders to be involved in defining project mission at the early stage and in refining it at later stages when the need arise. The results also suggest that when stakeholders are not involved in project decision making, their interest/disposition towards the project can change. The implication of these findings is that project management team should make sure all relevant stakeholders are involved in defining the project mission and both positive and negative impacts of project objectives are communicated to stakeholders.

Regarding monitoring and tracking the changes of stakeholders' interests/disposition towards the project, the results revealed that the most popular and effective means of monitoring and tracking the changes in stakeholders' interests/disposition towards the project is through "*feedback mechanism*". This indicates the need for project management team to put in place feedback mechanisms when undertaking stakeholder management in construction projects.

About which internal stakeholders should be involved in stakeholder collaboration at the various stages of construction projects, the findings presented in Table 2 show that: the design organisation, project management organisation, project consultant, quantity surveyor and the client should be involved at the inception stage; all the internal stakeholders except the contract administrator should be involved at the design stage; all the internal stakeholders should be involved at the construction stage; and only the facility management organisation and client should be involved at the operation stage.

The responsibility of leading and coordinating stakeholder management at different stages presented in Table 3 indicates that the client organisation would appoint a suitable representative to lead/coordinate stakeholder management at the inception stage. In the case of an inexperienced individual client they would need to employ the services of a suitable internal stakeholder. Similarly, the design organisation would appoint a suitable member of staff to lead/coordinate stakeholder management at the design stage as would the project and facility management organisations at the construction and operation stages respectively. The results also suggest that the client and facility management organisation are the only internal stakeholders that can practically be available at the operation stage. The results presented in Table 4 suggest that "*public hearing*" and "*design charrette*" are the most popular and effective stakeholder engagement/engagement techniques. "*Strategic needs analysis*" and "*Delphi technique*" are also considered effective. This means that the choice of which techniques to use would depend on the prevailing circumstances and knowledge of the techniques by the project team. It could also depend on their reason for engaging the stakeholders and the stage of project at which the stakeholders are engaged.

CONCLUSIONS AND FURTHER RESEARCH

This aim of the research presented in this paper was to investigate the current practice of stakeholder management in construction projects in UK. From the results discussed in the foregoing section, the following conclusions can be made:

- Stakeholder management is yet to be fully embraced as a deliberate strategy in the management of construction projects in the UK.
- The challenge for embracing stakeholder management could be said to be the inability of firm or client to set aside some funds to support stakeholder management process.
- There is need for firms to assign the responsibilities for stakeholder management to specific professionals in addition to deciding to undertake stakeholder management in construction projects.
- There is a strong need for internal stakeholders to collaborate in undertaking stakeholder management in construction projects.
- Construction professionals perceive dynamics in stakeholder position as important and gaining new information is explanatory for that, but not loss of confidence in the project team.
- Public hearings and design charrettes are considered the most important stakeholder engagement instruments.
- There is need for a policy driven support for stakeholder management to be carried out in construction projects.

Further research will be carried out to identify the main components of the framework for stakeholder management in construction projects to be developed. This will involve analysing the critical success factors for stakeholder management in construction projects and the effects of procurement routes on stakeholder management process. The results presented in this paper will also be incorporated into the framework.

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REFURBISHMENT OF HIGHER EDUCATION PREMISES: STAKEHOLDER ENGAGEMENT IN THE PROCESS AND PRODUCT

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In spite of various initiatives, much of the UK university building stock is ageing and in need of modernisation both in terms of environmental performance and to respond to the changing landscape of pedagogy and andragogy. Higher educational establishments like to portray themselves as pioneers of a green campaign however decision processes may not always be as easy and straightforward as they seem. Contributing factors will include the complexity of the client brief, the difficulties of timetabling, the desire to operate democratic processes in decision-making and the inevitable compromises resulting from these often conflicting demands. Most universities will have restrictions on the budget, time and working schedules compounded by the need to carry out the construction work on sites where the normal academic activities are to continue. Many university clients will involve the end users in the process of decision-making causing an information overflow whilst some others choose not to get their employees (as the end users) involved at all. This research uses a surgery approach to an ongoing major refurbishment project to map the perceived success of the processes and construction product. The results are aimed to enable similar future projects to run with a greater perceived success, which will in turn benefit all the stakeholders.

Keywords: university sector, refurbishment, stakeholder engagement, process engagement, sustainable refurbishment.

INTRODUCTION

Much of the UK educational building stock is ageing and in need of modernisation both in terms of environmental performance and to respond to the changing landscape of pedagogy and andragogy.

Sustainable renovation is often seen as a more viable, practical and potentially affordable solution compared to complete demolition and reconstruction. Sustainable refurbishment is particularly favoured because: (1) It can provide a working environment which is fit for purpose and can positively contribute to comfort and productivity of users and staff to the same extent as a new building, (2) It can offer flexibility, agility and responsiveness to rapid and constant change in needs, requirements and preferences, and (3) It improves building performance and reduces its environmental impacts. Moreover, higher educational establishments like to portray themselves as pioneers of the green campaign. The decision processes may not

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however be easy or straightforward. Contributing factors include complexity of client brief, difficulties of timetabling, desire to operate democratic processes in decision making and inevitable compromises resulting from these often conflicting interest and demands.

On the other hand renovation projects are more complicated than new buildings and are more prone to go over schedule or budget (or both). The complexities of refurbishment projects are compounded if the intervention is to take place whilst the building is in use. Refurbishing buildings whilst occupied are more likely to require the university to embrace user participation and user satisfaction both during the process of intervention and after the construction work is concluded. Renovation may involve different levels of intervention in existing structure, services, spatial layout, internal partitioning and external envelope of a building, hence a variation of terminologies e.g. redecoration, remodelling, refit, refurbishment, reconstruction, restoration, rehabilitation, adaptation, etc. The research takes a case study approach to an ongoing major refurbishment project to map the decision processes and measures the appropriateness of the information provided to make those decisions. It aims to investigate if utilised strategies have been workable (or otherwise) and suggests what could have been done differently to improve the entire process. The results are intended to enable similar future projects to run with more predictable outcomes and better stakeholder engagement which can benefit all parties.

BACKGROUND AND LITERATURE REVIEW

Models, tools and methodologies for sustainable refurbishment decision

A multitude of research has been conducted with an aim to eventually develop a model, a methodology or a tool to help with decisions about refurbishment. Although not all of those have had a focus on energy performance or environmental impacts of building (Brandt and Rasmussen 2002, Kaklauskas 2005), most recent ones tend, almost unanimously, to have an environment-centric approach to the extent that the concept of ‘energy retrofit’ or ‘sustainable refurbishment’ has emerged. Although some researchers may have identified the ‘phenomenon of the illusion of ecological benefits’ provided by some assessment tools (Kirkpatrick 2009), there are deeper concerns about non-environmental aspects of sustainability and how they are overlooked. This paper seeks to address some of these concerns.

User engagement

Constructing effective teams, unclear boundaries between responsibilities and roles, misaligned interests, contradictory incentives, fragmentation in supply chain and disintegrated delivery hierarchy are inherent challenges the construction industry is facing (Howard 1989, Egan 1998, Kashyap *et al.* 2003, Riley *et al.* 2004). Integration is therefore believed to be an essential factor in project success. WBDG (2012) suggests: ‘...integrated design process includes the active and continuing participation of users and community members, code officials, building technologists, contractors, cost consultants, civil engineers, mechanical and electrical engineers, structural engineers, specifications specialists, and consultants from many specialised fields’ (figure 1).

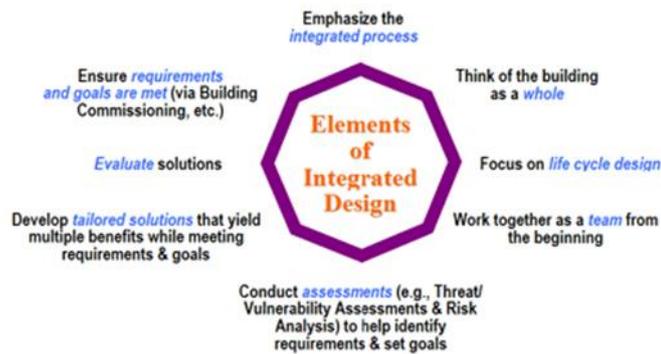


Figure 1: *Integrated Design Elements* (WBDG 2012)

The concept of integrated design finds a more comprehensive association when it infers ‘delivery’; addressing different stages of construction from conception to completion and in building’s post occupancy phases through to deconstruction hence the concept of integrated project delivery (IPD). AIA (2007) defines IPD as “*a project delivery approach that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste and maximise efficiency through all phases of design, fabrication and construction*”. User engagement with other parties has been pointed out as a major contributor in success models formulated in many disciplines (DeLone and McLean 1992, Pitt *et al.* 1995, Seddon 1997, Myers *et al.* 1997) as well as in construction industry (Lapinski *et al.* 2006).

RESEARCH DESIGN AND METHODOLOGY

This research utilises single-case study with multiple-unit analysis methodology to investigate a recent sustainable refurbishment project. A case study is an intensive investigation of a phenomenon in its natural setting, and often makes use of a variety of data sources (Benbasat *et al.* 1987). It is based on a constructivist paradigm (Stake 1995). The knowledge claims of case study research have always been criticised on the grounds of lack of generalisability. The short answer to this criticism is that “*case studies, like experiments, are generalisable to theoretical propositions and not to populations or universes. In this sense, the case study, like the experiment, does not represent a ‘sample’, and the investigator’s goal is to expand and generalise theories (analytic generalization) and not to enumerate frequencies (statistical generalization)*” (Yin 1989:21). Yin (2009:38) strengthens the methodological legitimacy of case studies by arguing that a “*fatal flaw in doing case studies is to conceive of statistical generalization as the method of generalising the results of the case study*” because cases are not sampling units and should be treated as experiments (Tsang 2013). Although primarily considered qualitative, case study research utilises both qualitative and quantitative research methods (Bryar 1999). The primary strength of case study research is its reliance on data enquiry from different sources and multiple data collection techniques. This increases the validity of findings (Ridenour and Newman, 2008) hence the approach of this research; where a multitude of other methods, including a questionnaire survey and a focus group of stakeholders’ representatives have been employed to enrich and deepen the findings, increase its construct validity, internal validity, external validity and reliability (Beverland and Lindgreen 2010).

Different units of analysis which were designed for this study include: review of the project documents, a questionnaire survey (using Likert scale in two different stages: pre- and post-move), a focus group with the representative of stakeholders (pre-move) and an interview with the members of the university, faculty and schools senior management teams (post-move). As the project is ongoing, this research is considered as in-progress, therefore this paper only reports on partial findings of the research. The following section will elaborate more on the data collection and analysis carried out to date, with no further account of what has been planned for the entire length of this research project.

DATA COLLECTION

Data collection was carried out through different phases within the selected case for this study with an aim to enrich the dataset, and to facilitate the analytic generalisation through the findings of this study. An in-depth review of the project documents (including policy and strategy documents, client brief, design brief, design intent, drawing documents as well as sustainability statement) was carried out to provide a basis for mapping user engagements.

The second stage was to circulate a questionnaire to gauge the users' opinions on six areas including communication, engagement, satisfaction, influence, disruption and finally, management of change. The questionnaire asked about both 'process' and 'product' of the project:

"The term Process has been used to refer to all activities – physical or non-physical – which have been carried out or performed during the course of the refurbishment whereas the term Product denotes the final outcome of the project, i.e. provision of envisaged, planned, designed, or otherwise, changed spatial layouts and/or spaces" (Excerpt from the survey questionnaire).

This was followed by two open questions; one on how the participant thought that any of the above aspects could have been improved and the other to provide them an opportunity to express any other opinion or comment they may have had.

The third stage was to invite a focus group formed of key user stakeholder representatives during which an open discussion was coordinated starting with some specific questions to investigate in more depth and detail how the participants felt about the conduct of the processes and the final product of this project. The focus group consisted of five staff members including 2 technical staff, 2 administrative staff and 1 member of academic staff. Each were members of up to three different stakeholder groups in the actual project (as opposed to the research) including user group, colour and soft furnishings group, steering group and logistics group. The focus group conductor was also an active member of steering group and user group but stayed neutral in their data enquiry during the meeting.

DATA ANALYSIS AND RESULTS; PRE-RELOCATION

This research is centred on a case study of the refurbishment of an academic building. The building dates back to the 1960s, is ten stories high with a concrete frame having approximately 12,000 sqm in gross floor area.

The project will cost approximately £27m and incorporates labs, lecture rooms, offices and social spaces. The design team were selected by multi-criteria competition and the contractor chosen under a framework agreement. At an early stage the

decision was taken to phase the refurbishment whilst keeping as much of the building occupied as possible.

Review of the brief, tender document and the design intent revealed the main drivers, initiatives, criteria, needs, wants and requirements with which this project came to realisation. However, not all of these maintained the same weighting through the project phases (from the way they were perceived when the project first initiated). On the top of agenda was sustainability, energy use and carbon footprint reduction. The University of Brighton commitment to the environment and the desire to score highly on the Green League table for the past few years seemed to provide a major influence. Fortunately this remained on the agenda right to the end and is still understood to be the main driver for change. Another (restricting) factor was the difficulty in provision of adequate means of escape – limiting capacity due to height and configuration of the building. Another driver for the project (evidenced from the initial client's brief) was to cater for open plan spaces with high degree of flexibility so that the internal spatial layouts could be altered swiftly based on changes in needs and requirements of different user groups over time. This however, was strongly objected by the members of academic and administrative staff backed up by some academic evidence highlighting inappropriateness of such spaces for the academic activities where issues around rising noise – with direct and indirect effects on well-being of the staff, distraction, intervention, and also confidentiality may arise. Another desire was to reconfigure the façade of the building to change the image of the school and the university and to make it more fit-for-purpose as a 21st century modern university. Due to limitation on budget and other (unverified) concerns around planning permissions and building control, this latter idea was abandoned. There were also some other criteria but with less importance which stayed more or less untouched to the end of the project. In summary documentation suggests that the project aims to:

- transform the learning experience of students
- support the university's target to cut carbon emissions by 50 per cent by 2016
- realise research ambitions
- meet sustainability targets
- make a positive difference to communities – ‘locally, globally and professionally’.

After the initial review of project documents, it was deemed important to gauge how the users felt engaged and satisfied with the process and outcome of the project as the first phase was approaching completion. A survey questionnaire was distributed to people across three schools within the Faculty of Science and Engineering in the University of Brighton via university mailing list prior to any permanent relocation. The list includes the dean of the faculty, heads of schools, senior management team, academic and research staff, administrative staff, technical support staff, and PhD students. Highlighting the confidentiality of research, the participants were given the choice to email their responses, or print them out, fill them in anonymously and place them in the researchers' pigeonholes. An online survey was intentionally avoided as it was felt that the sense of ownership would be lost. The purpose of the questionnaire was to gauge opinion from a user's point of view. Roles were classified as academic, administrative, technical staff and others. Responses were received with a distribution of 24 academics (of which one was a head of school), 4 administrative staff, 3 technical staff and 2 (PhD students). Results for the different aspects studied are presented in figure 2 for 'process' and figure 3 for 'product'.

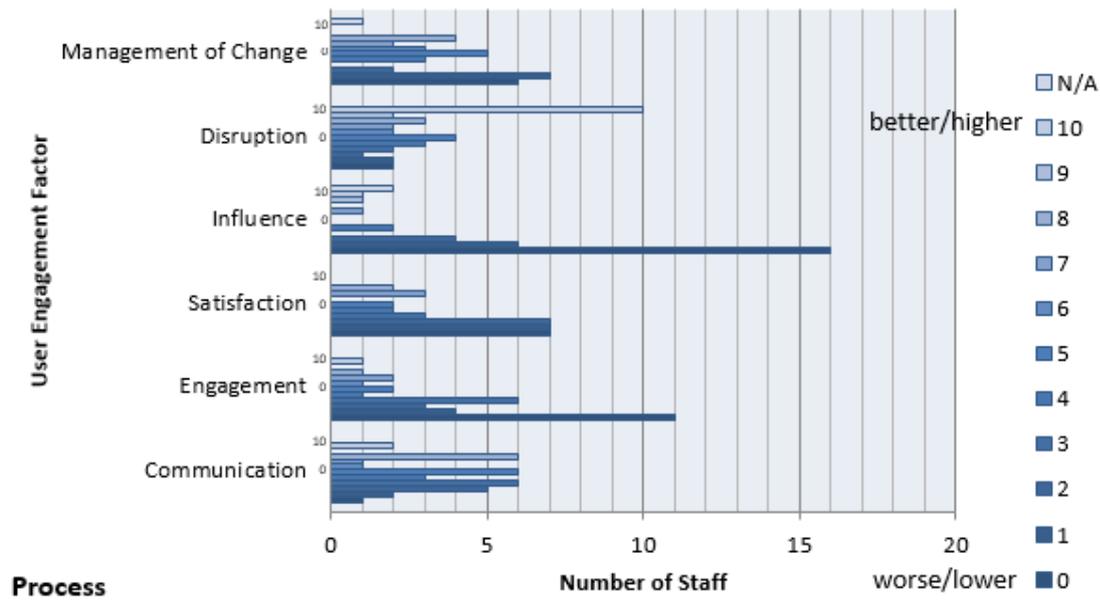


Figure 2: Users' opinions about their involvement in the process

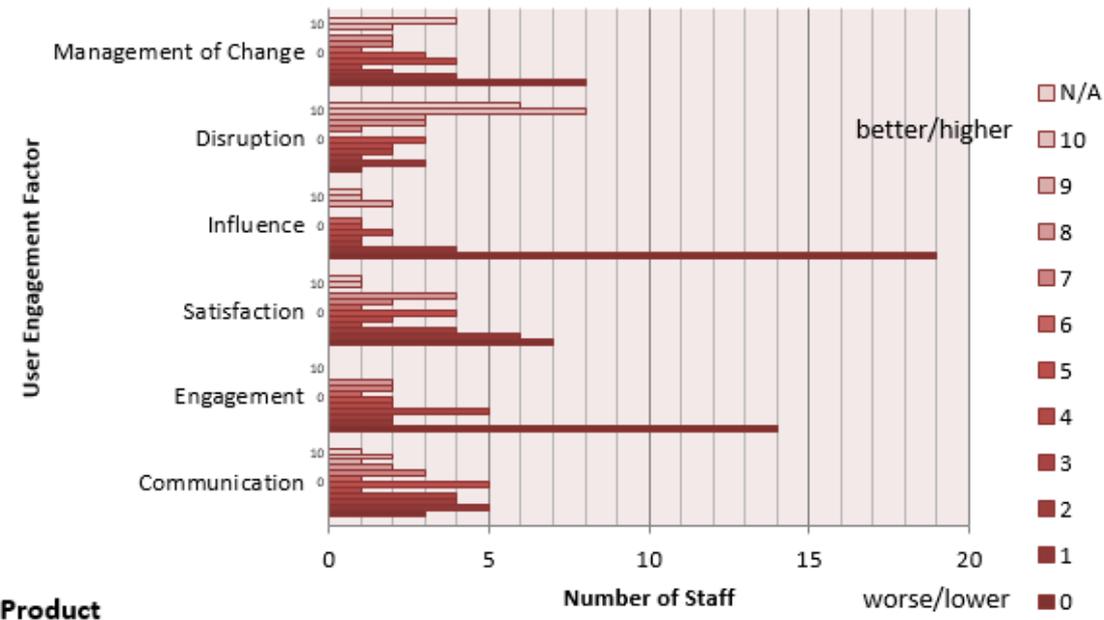


Figure 3: Users' opinions about their involvement in the product

Engagement and influence showed the poorest results for both process and the product. For engagement 11 scored 0 for the process and 14 scored 0 for the product, while influence showed an even poorer result of 16 scores for 0 in process and 19 scores for 0 in product.

Taking into account that the project is not complete yet and only one floor has been occupied (most in interim moves and due to be relocated as the project proceeds), the results of this part of the questionnaire are more based on what has been communicated with the end users through steering committees, open meetings, the university website and occasional announcements or updates. Satisfaction with the product i.e. the final design was less than average, and this is subject to change once the process of relocation is completed and the users can get a better feeling of what

they have got as their new working environment.

Opinions on communication are more evenly distributed (42% believe the information regarding the process was poorly communicated, and 30% and 27% thinking that the communication was somewhat acceptable or higher than average).

Opinions regarding management of change were not significantly better. For the process this showed 78% rated this as very low or low and 68% very low or low for the product. Quite expectedly disruption was a major concern among the participants with 79% and 60% believing that it was medium to very high for the process and the product accordingly. Those who thought disruption was handled properly belonged to participants who do not reside in the building where the refurbishment is underway, but are among those who are supposed to move in once the project is complete hence included in this study. Comments on how any of aspects of this refurbishment project could have been improved varied vastly from very one-off specific suggestions to wide-spread generic recommendations. The main areas covered include:

- Stakeholder involvement and their level of influence on design (both positive and negative)
- Review process
- Noise impact and distraction levels
- Learning from past experience (tapping into the existing knowledge gained from other refurbishment or new projects in the University of Brighton)
- Listening to the users and reflecting their opinion on the design
- Communication (verbal, meetings, steering groups, emails, website)
- Time management
- Management of change (both positive and negative)
- Logistics (both in general and particular to actual move timelines)
- Understanding and care for the nature, requirements and necessities of the work environment in academia

At next stage a focus group meeting was held to verify and dig deeper into the findings of the questionnaire survey. The results of the focus group meeting complemented the findings of the survey, some by moderating the comments from the surveys, such as:

- You can't have a building designed by everybody working in it. Once design was in place I felt able to contribute to final fit.

While there were also some critical views about both the process and product which reinforced some key findings from the survey:

- ...the raised floor finish is a massive disaster – will be changed in six months. We'll end up with carpet tiles which is one thing they didn't want
- ...in terms of the design – the light office environment – I'm really looked [looking] forward to it.
- ...dusty high level shelves/ducts – let's face it, the university cleaning spec isn't going to take that into account!
- ...we're wasting £26M unless we invest in proper cleaning – it's the most filthy building in the whole estate
- ...there's been a decorating blight
- ...issues of security and doors being left open overnight

- ...difficult for lay person – most of us will look at blueprints and just get the shape of the room. We needed a newsletter. We could have used students! We have looked at it but we don't understand it
- ...this [project] has opened up weaknesses in the communication strategy...
- ...What's interesting for me is ...very strong drive to redesign Cockcroft for students and less thought for people who were there for 8-9 hours [per day]...

There were also some very detailed problems raised:

- Window replacement (out of sequence with other refurbishment works) and the disruption as a result
- Tinted glass and the need for blinds (or not) and some controversies which arose around this issue
- Open plans or cellular offices and a long process of consultation and debates for and against the proposal
- Raised floor, the needs and necessity for them
- Concerns about the raised floor system and finish
- Serious concerns about acoustics
- Very serious concerns about communication, how it was managed, conducted and how the information was conveyed to different groups of users.

DISCUSSION OF FINDINGS AND CONCLUSION

It is interesting to contrast the far-from-satisfactory results in engagement and influence with the scores for communication which seems to have a fairly balanced distribution. This suggests that the communication process has been successful only in one direction – that is the information has been communicated from the design team to end-users in an effective way, while stakeholders do not consider it to have been successful in the other direction – that is they have not been listened to. It may also suggest that stakeholders consider there has been a 'tick-box' culture with little actual influence or effect on the process of decision-making. The university seemingly attempted to address this issue by the appointment of a high-ranked spatial planning consultant.

There is no question that due to frequent and fast changes in the client brief some of the initial provisions in the design brief and design intent have not been updated accordingly. This left some of the design decisions obsolete. This means that there is no intended 'end' left to justify the 'means'. This may also explain issues around user engagement being linked with or exacerbated by issues such as vague design intent and an occluded design decision-making process (Kelly *et al.*, 2005), inadequate information processes (Bouchlaghem *et al.* 2004), inefficient collaborative working practices (Bertelsen and Emmitt 2005), and ineffective performance monitoring (Preiser 2002). These are all areas which are subject to further investigation when the next stage of data collection (post-relocation) is carried out and the interviews with the senior management team are conducted so that the deficiencies of user engagement processes can be traced back into their roots where the solutions could have been formulated to prevent such deficiencies from the source.

In managing refurbishment of educational premises where occupants remain in place the need to effectively communicate and to achieve "buy in" from users during the construction phase would seem crucial. Satisfaction achieved during the early stages of the project (or lack of it) is likely to carry on over to the final stages and well into occupation of the final product. Views on the success of the communication process

suggest that information was communicated from the design team to end-users in an effective way but that stakeholders do not consider their views were adequately heard or addressed. Furthermore it is apparent that key design decisions were often taken with a somewhat subjective view resulting in the probability of additional and unnecessary expenditure to rectify earlier errors in decision-making.

It was found that some problems were of such trivial importance that they could have been rectified using inconsequential improvements in the process of communication with, and engaging, the end-users in the process of change. However, some other rather substantial issues which were raised during this study do not seem to have been of the same scale that could have been easily foreseen, avoided or remedied. Such problems are more likely to be addressed using a more systematic approach to user engagement. This however, is yet subject to further investigation and can be commented on once the second stage of this study is completed.

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ORGANIZATIONAL RESPONSES TO INSTITUTIONAL PRESSURES IN INTERNATIONAL INFRASTRUCTURE PROJECTS: A TRANSNATIONAL PIPELINE PROJECT CASE STUDY

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International infrastructure projects that are implemented in highly complex environments and involve collaboration among participants from multiple countries often face a variety of institutional pressures. Organizations involved in the execution of international infrastructure projects enact different strategic responses to institutional pressures and respond in a patterned way. The research explores how organizations respond strategically to institutional pressures in international infrastructure projects and how the interconnectedness between the organization under pressure and other organizations in the project influences the response strategy. A case study centred on a pipeline project in Central Asia that organizations are from China, Turkmenistan and Uzbekistan has been conducted to analyse organizations' practical strategic responses, and 4 vignettes were developed, each describing an event in this pipeline project how an organization responded to institutional pressures. Each vignette was carefully analysed by making event list with two dimensions, the organizations involved and the time line. Different vignettes were compared to find the generic narrative model or typical story. The results indicate that the high degree of interdependence and convergence of interest among the organizations lead other organizations in the project to collaborate with the organization under institutional pressures, and take an active response strategy. Besides, local stakeholder relationships can be utilized in response to institutional pressures and it is important to create relationally embedded relationships with local stakeholders. This research contributes to the knowledge of international project management by drawing upon institutional theory and using a strategic perspective to institutional pressures.

Keywords: institutional pressure, international infrastructure project, response strategy.

INTRODUCTION

The steadily growing world population promotes the countries of the world to invest in transportation, communications, energy development and other infrastructure projects. Organizations from diverse professional disciplines and different countries participate in the construction of the international infrastructure projects. However, diverse organizations from different countries have different understanding and expectations in regulations, cultural norms, and routine practices, which we refer to collectively as institutions (Scott 2012). Hence, the international projects face unique challenges in project management that they must now transcend diverging expectations of stakeholders to achieve the goal of the project (Mahalingam and Levitt

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2004) ◦ Recently, scholars have gradually recognized the importance of the dynamic interactions between the projects and their institutional contexts.

Previous studies on project management mostly focused on technical and strategic level, and took the institutional environment as given. Some empirical studies show that, in international projects, institutional differences produce institutional transaction costs, mainly cost and time impacts, when project participants are unaware of these differences (Orr and Scott 2008). Besides, empirical studies also demonstrate that local institutions of the host country, particularly political culture and industrial structure, have significant impact on project arrangement (Chi and Nicole Javernick-Will 2011). There has been a call for more research efforts to explore the dynamic interaction between large engineering projects and the institutional environment, especially the responses of the organizations to institutional challenges (Chi and Nicole Javernick-Will 2011; Ruuska *et al.* 2011; Scott 2012).

The work of Greenwood *et al.* (2010) suggests that organizations face complex institutional contexts and they respond in a patterned way. This research, drawing upon the institutional theory, explores organizational responses to institutional pressures in international infrastructure projects. The specific research questions of this paper are (1) how the organizations in international infrastructure projects respond to the institutional pressures; and (2) how the interconnectedness between the organization under pressures and other organizations in the project influences the response strategy.

LITERATURE REVIEW

Institutional pressures in international infrastructure projects

An increasing number of studies have stressed the importance of institutional context surrounding complex engineering projects and international engineering projects (Chi and Nicole Javernick-Will 2011; Mahalingam and Levitt 2007; Miller and Lessard 2000; Orr and Scott 2008). Miller and Lessard (2001) analyse the energy, transportation, water conservancy and other infrastructure projects subject to the influence of different types of risks and pressures, and find that in addition to R & D projects, other projects are under a high pressure system, including regulatory, social acceptability, and sovereign pressures. Sovereign pressures mean that a government decides to renegotiate contracts, concessions, or property rights.

Embedded in a web of international and local participants, international infrastructure projects are characterized by complex institutional differences and significant social and political complexity (Orr *et al.* 2011). Mahalingam and Levitt (2007) have identified through case study six kinds of institutional pressures in international projects that staffs are from different countries, including different information gathering techniques, conflicting aesthetic views, differences in building codes, differences in available building materials, differences in contracting practices, and differences in regulations. Chi and Nicole Javernick-Will (2011) focus on the processes through which political culture and the industrial structure of the host country influence project arrangements, and find that the political culture of the host country determines the political goals and legitimate approaches for projects, while the industrial structure restricts possible choices for projects. Although institutional pressures are well documented, few studies have explored practical approaches to respond to these pressures.

Through a survey of the extensive institutional literature, Scott (2012) define institutions broadly as including regulative, normative, and cultural-cognitive

elements that associate activities and provide stability and meaning to social life. Based on the above theory, Javernick-Will and Scott (2010) hold that institutional knowledge is a managerial strategy employed by international firms to alleviate institutional pressures, and they categorize institutional knowledge into three categories and identify fourteen main types of institutional knowledge important for international firms working on international engineering projects. For analytic purpose, it is helpful to adopt the three pillars to analyse the causes of institutional pressures.

Organizational responses to institutional demands

Early institutional theory emphasizes that the institutions are rigid, and institutions do affect organizational behaviour, but organizations are basically only subject to the demands of the institutions (Oliver 1991; Scott 2013). Oliver (1991), drawing on institutional theory and resource-dependence theory, argues that organizations do not simply comply with the demands in the face of institutional pressures, and the choices of organizations are more extensive and varied. Recently, new institutional theory increasingly focuses on organizational initiative in the face of institutional pressures (Orr and Scott 2008; Scott 2013).

Oliver (1991) proposes five types of strategic responses that organizations enact in response to pressures from the institutional environment: acquiesce, compromise, avoid, defy, and manipulate. Orr and Scott (2008) apply the typology of Oliver (1991) in analysing how institutional exceptions are resolved through an examination of 23 cases in which informants are from international engineering projects. They suggest to include the sixth category of “*education*”, a strategy that involves teaching and learning between two organizations. Orr and Levitt (2011) identify three strategies that organizations use to cope with challenges in foreign markets: increasing the supply of local knowledge, decreasing the need for local knowledge, and reducing potential impacts of local knowledge deficit. These concerted responses are common in managing the conflicts of multiple institutional pressures in international projects (Miller and Lessard 2000).

Organizations often respond to institutional influence with organizational changes including the change of decision-making rules and procedures (Scott 2013). Particularly in energy infrastructure projects, the government of the state is a powerful actor and plays an important role in enabling changes in institutional logics (Greenwood *et al.* 2010). The research of (Chi and Chen 2012) shows that in the infrastructure sector, the state can employ some policy instruments to change operation rules and patterns.

Interconnectedness and organizational responses

The typology of Oliver (1991) varies in active agency by the organization from passivity to increasing active resistance: (1) acquiescence implies a full conformity to cultural, normative or regulatory requirements of the authority that are perceived by the organization, or choose a model to imitate; (2) compromise indicates a partial compliance with institutional demands, expanding consultations and negotiations; (3) avoidance means that organizations try to hide themselves and to prevent being subjected to certain parts of the institutional demands; (4) defiance refers to active resistance to institutional pressures, and (5) manipulation suggests the organization purposefully and opportunistically cooperate with the institutional environment, influence and even control institutional environment. The scholars have tested the typology of Oliver (1991) in various areas, such as retail clothing industry, universities, iron and steel (Aaltonen and Sivonen 2009; Clemens and Douglas 2005;

Etherington and Richardson 1994; Goodstein 1994; Lamin and Zaheer 2005; Pedersen and Gwozdz 2013). In general, follow-up studies did not break Oliver's original contribution, but different industries face different kinds of institutional pressures and strategies exist some differences.

Meantime, Oliver (1991) hypothesizes variation in ten dimensions to determine choice of strategies and one of them holds that the lower the degree of interconnectedness in the institutional environment, the greater the likelihood of organizational resistance to institutional pressures. However, through case study, Aaltonen *et al.* (2010) find that stakeholder relationships enhance the project's external adaptation and promote the organization to adopt active manipulation strategy by supporting its anchoring and legitimacy in the institutional environment and by providing crucial local knowledge. Hence, this research will explore how the interconnectedness between the organization and others in the project influence the response strategy.

RESEARCH METHODOLOGY

A case study was conducted to explore how the organization in international infrastructure projects respond to the institutional pressures and how the interconnectedness between the organization and others in the project influences the response strategy. A deep and detailed investigation can be carried out through case study, analysing rich and diverse phenomenon, otherwise information may be omitted with a questionnaire (Eisenhardt 1989; Eisenhardt and Graebner 2007). Besides, a case study is apt for probing into the "how" type research question, which could offer new insights into links among variables (Yin 2003).

Case selection

The research selected the Central Asia-China Gas Pipeline Project (hereafter CAC) as the case for analysis. It is the largest among China's overseas gas projects. With a total length of 1,833 kilometres, it originates at the Turkmenistan-Uzbekistan borderline, passes through the middle of Uzbekistan, across southern of Kazakhstan and into China's Xingjiang at Horgos. A Chinese oil and gas company proposed the project and founded a dedicated project company, referred as ZY in this research, to execute the project. The pipeline was built by ZY in joint ventures with local oil and gas companies in Kazakhstan and Uzbekistan. Construction works of the Uzbek section started on 30 June 2008 and the Kazakh section started on 9 July 2008. Line A, the first of two parallel lines, was completed in 28 months and inaugurated in December 2009.

The project traverses the territories of four countries with highly divergent social, economic, political systems, and cultural traditions. As an international infrastructure project, the success of the project in the face of demanding institutional pressures makes it a valuable case that has some enlightening strategies for us to explore. Moreover, the two authors have closely worked with the project company and get credible first hand data and a deep understanding of project activities reflected in the data.

Data collection

Multiple sources of data were collected by the authors and others in the research group. 65 open-ended interviews were conducted with the Chinese managers in the parent company and the ZY who had participated in the CAC, asking them about the challenges in the project and their responses to these challenges. Among these, 55 interviews were video digitally recorded with consent for subsequent transcription and review (Eisenhardt 1989). The supplementary data include the file directory of a

comprehensive set of formal project documents produced from project initiation to project closeout by project participants, two project documentary books and project files archived in the ZY.

Data analysis

Through the careful reading and analysis of the provided data, 4 vignettes with rich details were developed. Each described an event of how an organization responds to institutional pressures in CAC. One principle in data analysis was that all information has appeared at least twice, and no contrary or inconsistent information could be founded. Table 1 summarizes important details of the 4 vignettes analysed in the present study.

Table 1: Condensed vignette summaries

No.	Key sequence of events
1	In the process of land acquisition in Kazakhstan, the owner of the project, the joint venture of companies from China and Kazakhstan, faced the pressure to get consensus with the landowners of private land. The owner asked for assistance from the local government, and land management department of that State sent an officer to help the owner going door to door to make the construction of the pipeline understood by the local people and get land use rights.
2	Getting the labour permits for entry to Kazakhstan was the great pressure that contractors from China faced. To solve this problem, the contractors got assistance from the owner, the Chinese investor, and the Chinese government departments. They form a government delegation to negotiate with the labour department of Kazakhstan, and finally received attention from the government of Kazakhstan. Restriction of labour permits was relaxed for Chinese contractors.
3	In the transportation of the pipe, the supplier encountered the pressure from the policy of the customs of Kazakhstan, because of immigration control of vehicles and the unstable policies. The owner, the parent company, and the Chinese government departments collaborated to get support form the customs of Kazakhstan. Finally, the supplier got priority in customs clearance and transportation.
4	In Uzbekistan and Kazakhstan, the technical specification has always been following Russia. Hence, the investors disagreed with Chinese investor in the diameter of the pipe. The Chinese investor invited experts from Russia, credible to investors of Uzbekistan and Kazakhstan, and persuaded them with data and cases.

Every vignette was analysed by making event list that the details of each vignette were listed in a table with two dimensions, the organizations involved and the time line (Miles and Huberman 1994). Figure 1 shows the simplified event list and the detailed information of vignette No. 1. Based on this, different vignettes were compared. The cross-vignette analysis matrix provides a factual basis for the generic narrative model or typical story that emerged from the analysis(Miles and Huberman 1994; Orr and Scott 2008).

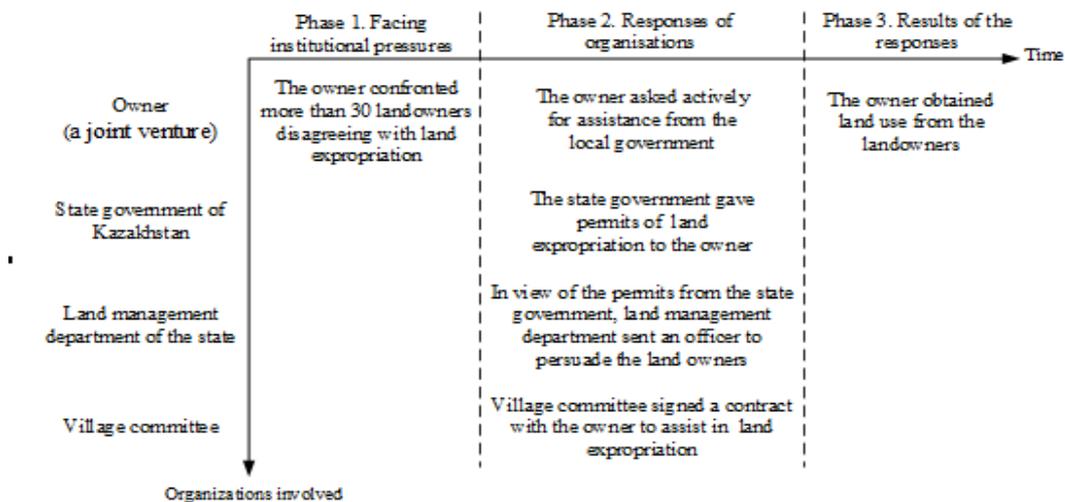


Figure 1: The simplified event list of vignette No. 1

FINDINGS AND DISCUSSION

The process of organizational responses to institutional pressures

Analysis of the four vignettes revealed a three-phase process of organizational responses to institutional pressures in international infrastructure projects. Specifically, the process of organizational responses to institutional pressures in Vignettes No. 1 is as follow.

Figure 1 describes the process that the owner dealt with land acquisition in Kazakhstan. Land acquisition was full of difficulties. In the first phase, the organization faced institutional pressures. As a Chinese manager remembered:

"[translated from Chinese] ..., land privatization in Kazakhstan means that making agreement with every landowner, signing the contract and paying them money. Moreover, the pipeline passes through densely populated areas and there are nearly 2,200 landowners..."

International projects that are implemented in highly uncertain environments inevitably face great external institutional pressures. Demands presented by external stakeholders, such as the landowners of private land, are typical examples of institutional demands (Aaltonen, 2008). There is a piece of land about 60 meters long in South Hadley which is a problem left from history because this farm land is owned by the former Soviet Union landlords. The landlords of this land are more than 30 and the owner of the project must put together all the landlords in a meeting. It took a week to gather the 30 landowners together, but the landowners refused to get paid according to the standard of the owner. This is the institutional pressure the owner confronted in land acquisition.

In the second phase, the organization under pressure responded to the challenge through the collaboration with other organizations in the CAC, such as the state government of Kazakhstan, the land management department of the state and the village committee. As a Chinese manager remembered:

"[translated from Chinese] ..., facing the demand of 30 landowners, the owner of the project did not act recklessly. They walked away from the meeting with the landowners, and sought to assistance from the local government..."

The state government gave permits of land expropriation to the owner. In view of the permits from the local government, land management department sent an officer to persuade the land owners. At last, Village committee signed a contract with the owner to assist in land expropriation. In the last phase, the owner obtained land use from the landowners

The impact of interdependence on response strategy

In the vignettes No. 1 to No. 3, the organizations under institutional pressures are interdependent with other organizations. For example, if the contractors fail to get enough labour permits and face labour shortage, the owner will suffer great economic and social losses. When the interests of other organizations are threatened, they will probably take part in active response to the institutional pressures. As the informant of vignette No. 4 recalled:

"[translated from Chinese] ..., contractors encountered various difficulties, especially under the time and heavy task demands in the CAC. Though the owner has no obligation to provide assistance to the contractors according to the contract, ZY held the belief that helping contractors equalled to helping the owner itself. ZY, as an

investor of the CAC, consulted with the local governments of Uzbekistan and Kazakhstan many times. Hence, ZY helped contractors to deal with labour contractor licenses, construction permission, and other Mechanical permission..."

Contrary to the hypothesis of Oliver (1991) that high degree of interconnectedness leads to greater possibility of organizational acquiescence to institutional pressures, the empirical data shows that the high degree of interdependence and convergence of interest among the organizations leads other organizations in the project to collaborate with the organization under institutional pressures, and hence take an active response strategy.

The impact of local stakeholder relationships on response strategy

It is clear in Figure 1 that the Chinese investor, as an entrant to the market of Kazakhstan, is pretty hard to get understanding from the local people. Local stakeholder relationships can be utilized in the response to institutional pressures. As the informant of vignette No. 1 recalled:

"[translated from Chinese] ..., the delegates of the owner took the document, which had been approved by the governor of the state, to the land management department of the state. The document approved by the governor of the state equalled to an out of order. According to the document, land acquisition in the CAC must be supported. Thus, the land management department sent a leader to find the village head and persuaded the landowners door to door..."

The Chinese investor gained knowledge actively and persistently on local practice, norm and rules. They tried to create communication channels to influence local stakeholders. As the informant of vignette No. 2 recalled:

"[translated from Chinese] ..., a delegate of the Chinese investor, in support of Chinese Embassy in Kazakhstan, consulted with the relevant departments of the government in Kazakhstan. The delegate repeated emphasised to the local government about the importance of the CAC and told them that the pipeline construction would bring benefits to the local people which was a win-win cooperation relationship. Eventually, the issue of getting the labour permits for entry to Kazakhstan got high-level attention and support from the local government..."

Local actors, such as local government, may be used as a source of local knowledge and may be engaged directly in managing institutional pressures (Aaltonen *et al.* 2010). Hence, it is important to create relationally embedded relationships with local stakeholders, which obviously requires great effort.

The competency of other organizations involved in the response strategy

In the vignette No. 4, different from other vignettes, the experts from Russia are not initially connected with organizations in the projects, but they are essential to convince the investors in Uzbekistan and Kazakhstan because of the special history in these countries. As the informant of vignette No. 4 recalled:

"[translated from Chinese] ..., as the CIS member states, Kazakhstan and Uzbekistan has nearly 50 years of practical experience in the construction and operation of natural gas pipeline. They always had a technical superiority over the Chinese engineers who have a short history of the construction and operation of natural gas pipeline. Hence, the investors of Kazakhstan and Uzbekistan disagreed with Chinese investor in the diameter of the pipe and the two sides were very hard to communicate...ZY knew that experts from Russia had great influence to the opinion of

the investors of Kazakhstan and Uzbekistan. If it was possible to convince the experts of Russia from the technical point, it would be effective to coordinate with investors from Kazakhstan and Uzbekistan..."

It indicates that the key to adopt an active response strategy to institutional pressures is to build relationship with organizations who are competent. To achieve that, a deep understanding of local history and culture is essential.

CONCLUSIONS

This research draws on the institutional theory to explore the patterned response of organizations to institutional pressures in international infrastructure projects. The results show that the high degree of interdependence and convergence of interest among the organizations lead the other organizations in the project to collaborate with the organization under institutional pressures, and take an active response strategy. Besides, local stakeholder relationships can be utilized in the response to institutional pressures and it is important to create relationally embedded relationships with local stakeholders, such as local government, which obviously requires great effort.

The limitation of the research approach is that a representative case was selected for analysis, lacking comparison with other international projects, and resulting in that the applicability of the conclusion in this research is still need to be explored. However, different vignettes were analysed under the same project background information, which contributes to that vignettes are comparable. In the future research, a comparative study with other pipeline projects at home and abroad can be conducted, which will help test the conclusions obtained in this research. In addition, future research can also explore the mechanisms of collective actions in coping with multiple institutional demands, and strategies can be employed to manage different levels of institutional demands.

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IS ANYBODY HOME? THE ROLE OF COMPANY WEBSITES FOR SMALL BUILDING CONTRACTORS IN SWEDEN

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During the last decades, being visible on the Internet has been advertised as the solution to develop businesses. Among other benefits, it should increase profitability by enlarging the number of customers and accelerating processes and communication. Indeed by 2012, 92% of the Swedish micro, small and medium sized enterprises (SMEs) had a website presenting their companies; the construction sector for once is no exception. Looking at SME building contractors we inquire into whether the announced potential of being online has been realized and, in particular if their relations to customers have improved. Referring to customer relationship management and e-business studies, we focus on 4 aspects of websites to assess their qualities: content, convenience, control and interaction. The material consists of a sample of 90 building contractors of the region of Gothenburg in Sweden. We have examined the companies' websites, checked their profile, contacted them by phone and carried out in-depth interviews with 21 of them. The results show quite diversified strategies and benefits of their use of websites. Updating the sites regularly or gaining customers seem to be the exception, and the uses of the web sites are so far rather rudimentary. If there is no surprise in the SMEs building their customers relationship on direct contact and local network, the passivity and lack of visibility towards new customers and business opportunity are nevertheless intriguing. Even more as the sector is facing a rather bad reputation in the public. Finally a close contact with clients is said to be one of the most important factors contributing to innovation which these SMEs acutely need to face the new energy regulations.

Keywords: SME, websites, customers' relations, renovation.

INTRODUCTION

Once a novelty, internet has by now transformed the way we study, work, travel, go to the doctor, socialize or love. Business relations in particular have been reconfigured and new practices have developed (Zott *et al.* 2011). During the last decades, being visible on the Internet has been advertised as the solution to develop businesses and improve contact with customers. Among others it should increase profitability by enlarging the number of clients and speeding up processes and communication (Pool *et al.* 2006). Indeed by 2012, 92% of the Swedish micro, small and medium sized enterprises (SMEs) has websites presenting their companies; and the construction sector is in line with this figure. But being present on the web is not an aim as such; it should be a mean to access new jobs and customers (Taylor and Murphy 2004). Whereas the integration of the Internet in SMEs as a tool to develop business

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opportunities has been fairly studied during the years 2000-2005, especially in term of describing potential and models to achieve these benefits, there are only few updates on the use of websites in 2014 according to our searches. In the construction sector it seems that SMEs, their clients and internet are currently either a hole in the research map or taken for granted as we could not find recent studies on the subject in the usual publications databases nor in the special construction sector bases (ITcon, Arcom, Cib, etc.). SMEs, defined as less than 250 employees (EU 2005) constitute more than 80% of the Swedish construction sector (Eurostat 2013), and consequently are important contributors to employment, economic growth and the development of a sustainable society.

Building on an ongoing research on these companies in the Southwest of Sweden, we look at how these SMEs are using websites in 2014, what changes this has brought to their relationships to customers and what might be the main barriers to optimise their use of the Internet?

SMES AND WEBSITES

According to e-business strategies (Cruz-Cunha and Varajão 2010, Pool *et al.* 2006, Zott *et al.* 2011), the company's website should provide information on goods, services or technologies. The company can demonstrate their specific knowledge competences and products using text, pictures, video clips, social networks or customers' feedback,. They can also indicate the scope of the delivery in terms of physical areas, sizes of projects, or type of clients. All this should be done to enhance the quality of companies' services to customers and to attract new customers. By collecting information on customers' needs and demands, the company can also initiate product development or innovation. By providing direct link to e-mail accounts or contact forms, the company can give potential and existing clients access to their services on a 24/7 base. In doing so, it increases the speed of interaction with customers and assures that the communication from the clients gets through. It can also increase its business potential and expand its market geographically.

Likewise for the customers the benefits are a greater accessibility and visibility to companies' products and services; the possibility to contact companies outside of the traditional opening hours; an increase in market; a price transparency as well as the possibility to compare between the different providers (Chaffey 2010).

According to previous studies regardless of sectors, SMEs have problems to benefit from their presence on-line and do not realise the potential that larger companies have succeeded to obtain (Pool *et al.* 2006, Jones *et al.* 2011). Taylor and Murphy (2004) have identified four barriers for SMEs to a successful management of the web interface: the first barrier is the content: it should be an eye-catching and convincing presentation of a product or service; the second is the convenience: it should be usable and fit customers purpose for search; the third is control: the company should define processes of control to update its website and to respond to customer inquiries; the fourth is interaction: the company should build relationships with customers and other businesses and make these relationships visible. Taylor and Murphy (2004) also mention price sensitivity and brand image as issues to be tackled. ICT organisational competence, cost as well as environmental factors of firm size and industry types do not seem to be meaningful regarding SMEs' adoption of e-business (Ifinedo 2011). Still SMEs seem to be struggling to find out how internet based relations can complement and not destroy traditional, face-to-face customer relationships (Harrigan *et al.* 2011).

BUILDING CONTRACTORS SMES

For the building contractors SMEs, their business is usually portrayed as based on a market of proximity, geographically very narrow and limited. The sector is also said to be based on local and personal network as SMEs rely on personal recommendations to get new jobs and customers. However Forman and Haugbølle (2011) found that for SMEs active in building prefab detached houses, the most effective marketing approaches was "*word of mouth*". And also the companies' own websites, closely followed by promotional material and ads at the construction site. Regarding the aspiration of these SMEs towards the future, it should not be taken for granted that all SMEs are aiming at increasing size and turn over, some are not really interested in increasing the numbers of customers or in developing their business (Barrett and Sexton 2006). In this context, where business as usual seems to be sufficient, the need to develop businesses and in particular relations to new customers does not seem to be a priority for these SMEs.

RENOVATION CONTEXT

However, following EU regulations, Sweden has now formulated ambitious national policies regarding sustainability but is challenged when facing design and implementation of solutions to reach the climate targets. In order to reshape the existing built environment towards these environmental targets there is a need for innovative solutions (Næss-Schmidt *et al.* 2012). Buildings represent 30% of the total energy consumption in Sweden (Boverket 2010). Energy renovation is therefore one of the most significant contributions to decrease energy usage (Risholt *et al.* 2013). However in order to provide sustainable solutions construction companies need to update their ways of working especially in integrating new technologies and products to their actual offers (Mokhlesian and Holmen 2012). The SMEs are said to be insufficiently equipped to develop and adapt these solutions. Small firms lack the full set of skills and resources to deal with and benefit from the upcoming increase of opportunities (Hardie and Newell, 2011).

SMEs need to reshape their practices and behaviours to attain these energy targets. However the construction related SMEs are not known to be especially active in term of innovation. It is likely though that a business as usual attitude will miss the escalating environmental performance requirements (Hardie and Newell, 2011). Hardie and Newell (2011) highlight that clients and building standards are the most important factors to incite and support these SMEs in their innovation process. In parallel, private house owners are also pressed to renovate to comply with EU's energy efficient directives (Directive 2010/31/EU). Collaboration with clients is also stated as the most important driving forces of renewal in the construction industry by Håkansson and Ingemansson (2012). Yet both authors seem to take for granted that customers are available. Increasing visibility to potential clients and marketing the company do not seem to present a potential for innovation. These are seen -though- as an essential motivation to develop a web interface.

Moreover, the renovation market is not only depending on construction related companies, large Do-it-yourself chains, magazines and TV programmes are also participating by helping clients to carry out jobs themselves. Moonlighting is also a heavy competitor to SME's jobs (Koch 2013). Once the house owners have decided for hiring a craftsman to carry the renovation work, they usually follow their

neighbours and employ the same small and medium sized enterprises (Doona and Jarlbro 2009). Yet the possibility, among other given by internet, for the customers to get access to products, solutions as well as services and advices increases their ability to make energy efficient choices and to require specific solutions (Risholt and Berker 2013). This also puts pressure on the SMEs not only to innovate and increase their portfolio of solutions but also to be knowledgeable about the various possibilities and therefore able to advocate and argue for their choices when meeting their clients. To summarise it seems that construction SMES visibility and close relation to their customers could support and benefit not only the business development of the companies but also the achievement of climate targets.

METHOD

The material used for this paper is taken from an ongoing action research project (2013-2015) aiming at developing SMEs' business models for energy renovations of detached houses. For this exploratory paper, we adopt an interpretive sociological framework using a mixed method approach combining quantitative and qualitative data (Bryman and Bell 2011). Quantitative data have been gathered through desk research when studying the 90 websites of the potential participants to the ongoing project as well as when trying to establish a first contact with them. Qualitative data have been collected during interviews, workshops and participant observation with the owners of the 21 enterprises participating in the project.

The enterprises were partly sought out from a map search engine in the Southwest region of Sweden using profession related key words and partly through snowballing (Patton, 1980) when interacting with the enterprises. An email, shortly explaining the project and letting the enterprises know they were to expect a phone call was sent out to each one. Between three and five days later a first follow up phone call was made to assess their interest. The ones expressing a positive attitude received an extended description of the project by email. A second phone call was made to confirm the companies' participation. This resulted in a thinning of potential enterprises from 90 till 24. We visited the 24 enterprises for a first interview and 21 of them accepted to be part of the project. The visits lasted of an average of 1 hour 40 minutes and part of it consisted of an open interview on their practices regarding customers. Five workshops have so far been carried out with the enterprises; besides 7 sessions of selling negotiations between craftsmen and their customers have been observed as well as twelve follow up interviews of an average of 2 hours and 30 minutes.

In the first round the companies sample counts: 52 carpenters, 11 electricians, 9 energy solution providers, 4 plumbers, 7 ventilation, 3 brick layers and 4 tile layers. All are openly active in renovation works.

In the second round it counts 16 carpenters, 2 electricians, 5 energy solution providers, and 1 brick layer

The present paper presents the preliminary results of this ongoing research however we only focus on the information concerning the use of websites. Though gathering an important number of companies, there is no claim that our sample is representative of the structure of the construction SMEs in the Southwest region of Sweden. We find our results nonetheless informative about these companies' behaviours.

FINDINGS

The presentation of the findings is divided into two sections. The first section presents the results of the survey of the websites structured by the four barriers identified by Taylor and Murphy (2004); the second the preliminary results of the interviews and workshops.

Features of the web sites

The content

The 90 websites visited provided all information about the companies sector of business and their contact information (address and telephone number) but for 30 of them there was nothing else to be found. 55 were showing pictures of their realisations but only one had provided a before and after comparison of the performed work. We did not discover any explanations of how the work would be conducted. 6 websites were offering services to their customers such as ordering material or contacting other suppliers. No estimation of cost was given regarding the type of work the company could carry out and the only pricelists we found were given by a link to their suppliers on 6 of the websites. However 14 websites were giving links to supplier's product catalogues. One site though proposed a handyman for the price of 1800 SKR per day (around 163 GBP). We did not find either estimation of the time needed to perform any standardised tasks.

Regarding the quality of their services, 33 were mentioning and showing various quality certificates they have obtained such as bathroom quality or sustainable environmental work certifications. Providing pictures of refurbishments executed for the customers can also be seen as a quality proof of the execution. To the exception of one site, none of the other websites did offer a space for customers' feedback. However connections to social networks such as Facebook or Twitter were present in 11 of the sites.

Finally regarding the impression given by the websites in terms of the companies illustrating their professionalism or their aesthetic expression, it would be worth to engage in a "*semiotic*" study as the quality of the sites varies greatly. Still there are virtually no websites which really looked homemade, the large majority offers well designed sites even if one can wonder if the fleet of the company's vans really is the best way to represent the company profile.

Convenience

Convenience for customers are supported by the functions available to simplify the clients navigation and access. 57 sites provided a direct electronic connection to the company for the customers. Either by providing an e-mail address or a small window for the customers to write their request. One site provided a scroll menu where the client could choose the kind of services s/he was looking for. None of the websites asked for the clients to provide their contact information so the company could call back.

There is very little information to gather for the potential customers. The absence of work description in term of estimation of work load, planning, execution and prices make any comparison between the different companies very difficult. However the 9 energy solution SMEs did provide general information about the different energy saving solutions which they could implement, such as geothermal heating, air source

heat pumps, solar panels etc. as well as prices related to the different systems however these prices did not cover the installation cost.

Control

The processes of control reside in updates of websites and answers to customer inquiries. Many of the sites were created in 2008, when a new possibility for subsidy to reduce cost of renovation for private persons was provided by the government. Some of the sites seem not to have been updated since. The following chart presents the update rates of the websites we have looked at. Only 17 of the companies have a regular update routine with a scope of frequency spreading from once a week to once every 3 to 4 months. Most of the companies of our samples do modify their site once or twice a year.

Table 1: Frequency of updates of the content of the web sites by type of company

Frequency	Carp.	Plumb	energy	Tile	Brick	El	Vent.	total
every 1-2 months	3	1	5			2		11
every 3-4 months	5		1					6
2 a year	12			2		3		17
1 year	25	1	1	1	3	3	5	39
>1 year	7	2	2	1		3	2	17

Regarding the answers to customers' enquiries our own experiences are saying: even if we are not customers, we saw only two companies that answer the first e-mail we sent out: one to accept and the other one to decline. This low feedback on the first e-mail questions the quality of reactivity of these companies to electronic inquiries.

However, the first round of phone calls did get a slightly better result. 11 of the carpenter companies answered on the first trial when we were calling, 8 out of them had an administrative employee doing so. All of the 9 energy solution companies answered on the first trial. On the other end of responding to clients enquires, 5 active companies never answered our calls regardless of what time of the day we tried and the number of calls we made (up to 20). For the others, it took between 2 and 12 trials before getting through.

Interaction

Interaction features focus on how the companies build relationships with customers and other businesses and make these relationships visible. There are signs of networking between companies as 47 websites are providing links to or advertising for other professional collaborative partners. The relations to customers are not visible on the websites to the exceptions of pictures of realised executions. There are no links to professional websites or customers oriented portals providing clients with support for choices of craftsman and offers.

A few websites, 10, offer the possibility to apply directly for a job in their company and 4 use the site as an advertising space for other types of businesses such as Systembolaget (the government owned chain having monopoly on providing alcohol in Sweden).

Table 2: Summary of the web sites features by type of company

Company	Carp.	Plumb	energy	Tile	Brick	El	Vent.	total
Web site features								
Info and contact	52	4	9	4	3	11	7	90
Catalogues	3	2	9					14
Prices list	2	1	2			1		6
Service to the clients	6		1			1		8
E-contact	29	2	4	4	1	7	2	49
Jobs pictures	33		5	4	3	9	1	55
Network	27	4	4	3	2	5	2	47
Quality certificates	16	1	4	2	2	5	3	33

Based on our assessment following the mentioned criteria, we order the websites in 4 groups: the first is a group of very active SMEs which gathered 6 companies who provide frequent regular updated information on their activities and offers, easy access and services for the clients as well as links to various supporting sites; the second is the active group, counting 14 members who update the website regularly and have adequate interface tools; the third group, minimum, contains 37 companies and represent the low activity group who offers electronic connection for the customers and some pictures of their realisations however without any regular updates. The last group, passive, encompasses 30 SMEs who only provide contact and sector related activity information.

Table 3: Distribution of companies' web sites in term of activities

Website	Very active	Active	Mini	Passive	Out of job	total
Companies						
Carpenter	1	8	25	15	3	52
Electrician	1	2	5	3		11
Energy	4	2		3		9
Plumber		1		3		4
ventilation			4	3		7
Brick layer			1	2		3
Tile		1	2	1		4
Total	6	14	37	30	3	90

To deduce that the last category contains the least customers' oriented companies would be a mistake as two of the carpenters belonging to this group appear to be very skilled and praised companies with a reputation spreading largely outside of the local boundaries. They have chosen to present themselves in a very a minimalist but very aesthetic fashion. Also the 21 enterprises partaking in the project are to be found in all the activity groups.

Customers and websites as described during the interviews and workshops

This section presents the preliminary results of the first interviews and workshops held with 21 of the companies.

Regarding their relations to customers, the participants express two different positions the first concerns the relations to their own customers and the second relates to the reputation of the trades for the public in general.

Regarding their own customers, they insist of the close proximity they have with them. They describe their relations as based on trust and honour and recognise the importance of the network and the dependency to their former clients to get new jobs. The companies interviewed estimate an average of 90% of new clients is linked to their existing network. For many, writing down contract with these customers is not needed as shaking hands will seal the deal. It is only when they do business with unknown clients that formal work contracts are mobilised. But they also recognise that the share of these unknown clients is increasing and that websites for the younger customers is becoming a common tool.

Regarding their trades in general, the bad reputation the sector has among the public is really an issue. As there are a few fraudsters on the market, the whole sector seems to suffer from it. The following statement from one of the SMEs' owner seems to summarise the contractors' opinions: *"For the clients we are crooks, they believe we only aim at cheating them..."*

The shadow of foreign workers or companies entering the market with low quality performance is also perceived as a threat for the professions. To remediate to the situation mouth to mouth and face to face approaches seem to be the chosen methods.

5 of the companies know for sure that their web site has provided new customers and 7 others do believe the site is bringing new business opportunities. For the others mentioning the subject seemed to create a feeling of guilt as the companies having a passive or minimally active website said they ought to do more to increase the performance of their sight. They explained the lack of activities by not having time or competence to work further with the interface.

If they expressed belief in the potential of the websites to increase their business they also expressed doubt about what to really use these websites for. At the exception of a few, the companies do not express a clear vision or strategy for their sites. They neither have a segmentation understanding of their customers nor do they know what types of information the internet users would be likely to request.

At the same time, they recognise the increase of clients' knowledge regarding solutions and possibilities as well as new technology performances. Many interviewees agreed that they prefer clearly to work with knowledgeable customers who tell what they want and have a hunch of the price. This does not however motivate them to put their own information on their web sites. Negotiations with unclear or undecided customers seem to be challenging for some of the respondents, who would rather avoid these types of interactions with their clients.

Regarding taken for granted assumptions of the local aspects of the trade, whereas several of the enterprises we have talked to prefers to work *"close"* to the enterprise (10-20 min by car), they also take on jobs 1,5 hour drive away. Several shared the following statement: *"as long as I can go to a customer, get the work done and be able to get home within the hours of the workday I am fine with it..."*

DISUCSSION AND CONCLUSION

The four barriers identified in 2004 by Taylor and Murphy seem to still be contemporary for our sample of SMEs as the companies have in general a rather poor

web site content. Though complaining about their difficult relation the public, these companies do not exploit the possibilities offered by the Internet to reassure their customers and show visibility and transparency in term of activities, prices, quality or competitive advantages. Their relation to customers seems to be more reactive than active, if the demands regarding the use of internet increase, they are prepared to answer it, but so far very few are taking the lead and proposing new services.

For the customers the benefits of the Internet based businesses are not realised as very little information are available online. This lack of information in particular regarding task descriptions and price estimations prevent the clients from benefiting of the usual advantages of using companies' websites.

A quick browsing through UK renovation SMEs web sites tends to highlight that our Swedish companies are definitely not any leaders in the usage of internet towards their customers. This could be explained by the relative stable situation of the market for the construction SMEs, though 3 companies did close down since last September. Another explanation could relate to culture and the apparent non competitiveness between enterprises active in the same business on the Swedish market. So far our general impression is that the customer relationships are something the craftsmen need to have done in order to carry out their "real" job, which is to rebuild and reinstall building components.

But the market sees new regulations and new segments of clients coming up. A large group of houses built during the 1950-1975 will need to be renovated to fit with new legislations. New generations of owners are taking over; they may not be relying so much on local network and are used to search information and services on the Internet . This group may represent a new rather voluminous segment in term of job possibilities. The SMEs participating in our research are slowly realising they may miss these developments if they overlook the potential of using the Internet.

Construction related SMEs as a group are a major economic player and associated with the new energy legislation their businesses can be a major contribution to economic growth. Going online to develop the sustainable renovation business seems to a be a fruitful solution, however our study suggests that in our sample though almost all the companies are present on the web, their manifestation is still rather rudimentary. These results correspond to other studies carried out on the use of the Internet by SMEs (Jones *et al.* 2011, Ifinedo, 2011). But the use of websites or rather lack of use can be seen as a symptom rather than a cause. These companies seem to have difficulties to engage and develop new relationships with their customers over the net. What we need is to better understand how these SMEs recognize and develop business opportunities rather than why they might or might not engage with specific technologies. As so far, new and close contacts with customers do not seem to be a priority ... sometimes it really feels like nobody's home.

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INITIAL USE OF AN IDEA CAPTURE APP IN A UK CONSTRUCTION ORGANISATION

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We report some results from an ongoing action research project to improve creativity, innovation diffusion and knowledge transfer in a large UK construction organisation and its supply-chain. Our focus is on the use of an interactive mobile and desktop app that enabled employees to submit, share, discuss and develop innovative ideas. We use longitudinal system data to determine: how many users register on the system, how many ideas are submitted, how many users actively contribute ideas, and where in the organisation ideators are based. The paper describes the background and organisational context of a company-wide initiative to promote an ‘innovation culture’ and to implement innovation management systems and processes. We describe the development and specifications of the app, associated innovation portfolio management processes, and the communication and change management activities that accompanied its launch and rollout. We discuss this analysis in terms of existing models of employee creativity and voice and previous research on suggestion schemes, ideas capture and innovation competitions in construction and other industries.

Keywords: innovation, ideas, suggestions, app.

INTRODUCTION

Attempts to improve the United Kingdom (UK) construction sector have placed considerable emphasis on innovation both as a critique of the previous position and as a mechanism for change (Construction Task Force, 1998; Gann and Salter, 2000; Winch, 1998). Sector initiatives since these publications can be seen as a response to an apparent consensus that, “*The industry needs to embrace a complete technology and innovation culture change so that research and development is seen as the core value for the future of construction and essential to business success*” (DTI, 2001). At the sector level these efforts included leveraging the government's role as a client, the establishment of innovation networks and the dissemination of demonstration projects (Constructing Excellence, 2003). Official reviews of these efforts concluded that progress had been disappointing (Wolstenholme, 2009).

Arguably, the 2008 recession has created a difficult context for innovation: on the one hand, increased competition may provide a spur to innovation (Wolstenholme, 2009). On the other, lack of slack resources and project opportunities to implement innovations may reduce innovation capacity (Sexton and Barrett, 2003). Recent UK industry transformation efforts have focussed on the development and adoption of building information modelling technologies (BIM) and related process (e.g. Bew, 2014). BIM implementation, while seen as having a role in transforming construction

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to an innovative 'high-tech' industry, also risks using the absorptive capacity of leading firms. The environment within which the organisation described in the current study operates is one in which much of the current construction growth is in the form of large civil infrastructure programmes that are typically procured on high-value, long-term collaborative framework agreements. Successfully competing for such work requires bidders to demonstrate the ability and motivation to work innovatively. And the resulting work arrangement is one that is seen to support innovation via, time, resources, and shared benefits but that also *requires* ongoing innovation.

It is in this context that construction organisations currently seek to improve and demonstrate their capacity for innovation. The research reported in this paper is part of an ongoing action research project to develop and implement systems, tools and processes to manage innovation within a large UK construction and engineering contracting organisation.

This paper has three broad aims:

1. To describe the development and launch of an 'ideas capture app'
2. To research initial use of the app using longitudinal system data to provide benchmark data on usage, specifically:
 - a. how many users register on the system,
 - b. how many ideas are submitted,
 - c. how many users actively contribute ideas, and
 - d. where in the organisation ideators are based.
3. To discuss whether the system data suggests that the implementation has been successful compared to rate of suggestion achieved in other schemes and to further consider the findings in the light of the literature on innovation in construction project firms.

INNOVATION IN CONSTRUCTION AND PROJECTS

Official and practitioner criticisms of the industry with respect to innovation are reflected in the academic literature. This has documented features such as low rate of innovation (Winch, 1998) and attributed this to structural features of the industry such as its organisation as a project-based complex product system with separate and conflicting systems integrators. Peansuapp and Walker (2006) identified numerous barriers to innovation highlighting among others lack of management support and some construction workers' personal learning capability. Further, much of the innovation that does occur happens locally on delivery projects as construction workers make numerous un-document, un-patented, problem-based changes and on-site adaptations to processes, materials and proprietary products (Slaughter; 1993, 2000). To overcome these challenges requires an innovation infrastructure – particularly to enable the parent organisation to capture the learning on projects and embed it into established practice (Gann and Salter, 2000).

Construction shares innovation challenges with other organisations that adopt a project-based mode of delivery. Project-based firms are used to managing delivery projects that operate in a complex but stable environment. In contrast, innovative development projects, while less complex, have greater uncertainty and unclear targets (Blindenbach-Driessen and van den Ende, 2006). Studies of innovation in project-based firms in multiple industries have shown that the engineering tradition of such

organisations value precision and accuracy, control of work to time/cost/quality constraints and a strong emphasis on predictability and safety. Managers in such organisations: do not typically value innovation; view slack resources as tolerable only in exceptional circumstances; believe the innovation is costly, disruptive, must be managed and is usually justifiable only when responding to externally driven changes (Keegan and Turner, 2002).

IDEAS CAPTURE SCHEMES

Ideas capture schemes include; suggestion schemes, quality circles, and innovation competitions. They are intended to ‘capture’ and ‘land’ employees’ ideas – to support the generation, sharing, capture and evaluation of those ideas (van Dijk and van den Ende, 2002). Although ideas capture schemes can have the objective of generating new ideas, those introducing such schemes generally assume that there is an existing reservoir of ideas that will otherwise remain dormant and consequently the organisation will neither benefit from them nor exploit the potential of its workers (Leach *et al*, 2006).

Frese *et al* (1999) classify ideas capture schemes into four types: Centralised suggestion schemes: a single scheme for all employees of an organisation – generally open and accepts ideas on any issue at any time. Decentralised suggestion schemes: multiple, independently run schemes within an organisation – generally open and accepts ideas on any issue at any time. Work-based systems: ‘closed’ schemes with a specific objective of solving a defined problem or issue often by a set time such as quality circles or new product development teams. Informal schemes; a system where there is no method for capture but there is a procedure for evaluating ideas.

More recently, organisations have adopted models of open innovation; crowdsourcing ideas from employees, supply-chain members, customers and the public in open ideas competitions which share characteristics with both centralised suggestion schemes and work-based systems (Majchrzaj and Malhotra, 2013). Open crowdsourcing is particularly associated with, and enabled by, distributed technology solutions incorporating the network and software for sharing ideas. These technologies are also applicable to more bounded organisation schemes although Majchrzaj and Malhotra (2013) identify three inherent tensions in suggestion schemes implemented within a crowdsourcing paradigm, namely: that such schemes simultaneously encourage collaboration and competition; that idea evolution takes time but crowd member spend little time; and creative conflict requires good relationships but members of the crowd are strangers.

Research into the operation and implementation of suggestion schemes has identified a number of factors that contribute to their effectiveness. These include: timely and sufficient feedback to those submitting ideas; reward for suggestions; commitment from managers at all levels; clear responsibility for management of the scheme and sufficient resources to do so; opportunity for employees to educate themselves to further improvements; careful planning of implementation; ensuring perception of a ‘fair’ process of evaluation; publicity and communication of the scheme and its operation (Leach *et al*, 2006; Rapp and Eklund, 2002).

CASE DESCRIPTION

This paper considers the initial use of an ideas capture system within a UK construction and engineering contracting organisation with recent annual turnovers in the region of £1 billion. It employs approximately 4,000 employees throughout the

UK on site offices, regional offices and a head office in the south-east of England. The organisation is formed from a number of relatively autonomous business units defined by product area and support functions.

Before the project that is the focus of this research, the organisation had employed a manager responsible for innovation and established a network of innovation representatives in the business units and support functions. An engineer who had been seconded to the innovation function was tasked with investigating what innovative activity was being conducted around the business and over three months, identified around forty distinct and exploitable ideas. The innovation manager, innovation representatives, and academic and other consultants used the results of this internal research to identify the requirement for a system that would allow for easier and ongoing capture of ideas. It was also recognised that such a system could form part of the wider innovation strategy for the organisation. A pilot ideas capture mobile app was developed by an external consultancy and trialled successfully within one of the support functions following which approval and funding was secured for the project form which the data in this research is taken. As with other schemes, it was assumed that a reservoir of existing ideas existed in the business units and projects – it was because of the dispersion of employees that a mobile app was adopted as the technical solution.

The broader ideas capture system consists of three main sub-systems:

- A network of innovation representatives to support the development and rollout of the system
- A mobile and desktop app that allows employees to submit, comment on and vote for ideas and to browse and search for ideas submitted by others,
- An idea implementation process in which the managers of the system provide initial feedback and allocate the idea to an innovation representative for more detailed evaluation and possible implementation.

The major events and activities in the project are summarised in Table 1.

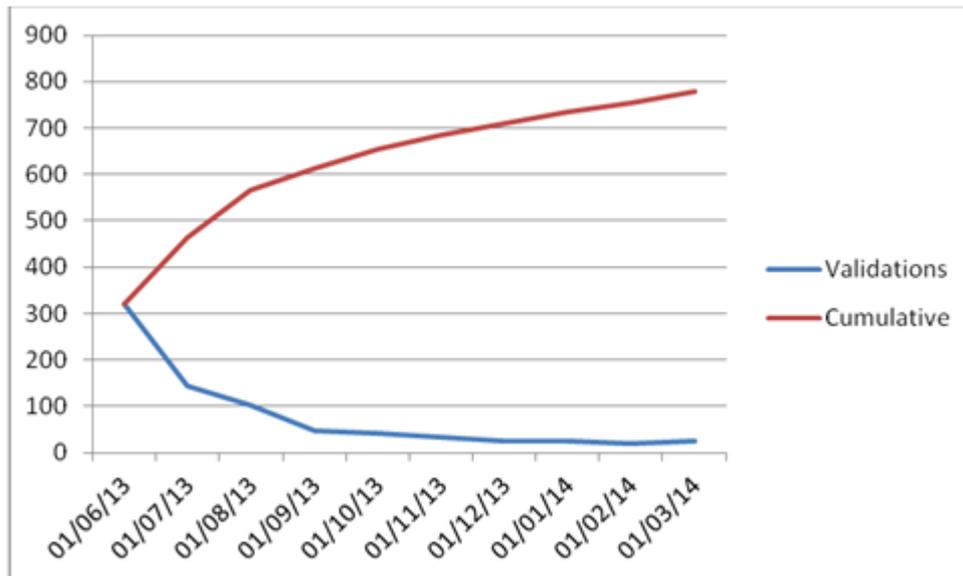
Table 1: Ideas capture app - project Timeline	
Jun 2012	Project approval secured
Oct 2012	Project Manager recruited
Nov 2012	Ongoing development and expansion of project network
Jan 2013	Beta release of ideas capture app
Feb 2013	App testing and trial App development brought in-house
Mar 2013	First collaboration with utilities framework agreement App re-design following trail
Apr 2013	Communication planning for business launch On-going meetings with innovation representatives and potential users Presentations to innovation forum, global research & development function, bid teams and management teams Development and approval of national innovation processes
May 2013	Design of branding and internal communications approvals Produce publicity materials – posters, screensavers, stickers, intranet
Jun 2013	Release 1.0 of app (submit, comment, like, search) All-staff email, intranet story, exhibition stand in reception Push of app to company i-phones UK board themed innovation day Innovation exhibition at head office including ideas capture stand
Jul 2013	Design communication workshops
Aug 2013	Legacy business unit innovation competition migrated to app Selection and implementation planning for initial ideas Development of portfolio management tools
Sep 2013	Design of release 2 of app
Oct 2013	Start implementation of selected ideas
Jan 2014	Communication workshop programme start
Feb 2104	Release 2.0 of app (idea status icons, photo/file attachments)

RESULTS: INITIAL USE OF THE IDEAS CAPTURE APP

How many users registered on the system?

During the first ten months of operation a total of 779 users were ‘validated’ on the system. This meant a user who installed the app, registered a user name and passwords and confirmed their identity by responding to a confirmation email. This represents approximately 17% of the employees of the organisation. Published benchmarks for this figure are not available but his compares unfavourably with, for example, typical response rates for organisational survey research of 50% (Baruch and Holtom, 2008). More than half of the validations were completed in the first six weeks of operation following the launch, push of the app and attendant publicity and communication activity (see Figure 1). This pattern of take-up, though anticipated, supports Leach *et al*’s (2006) conclusion that frequency of publicity is a significant factor in scheme success and suggests that significant extra effort will be necessary to achieve near-universal adoption.

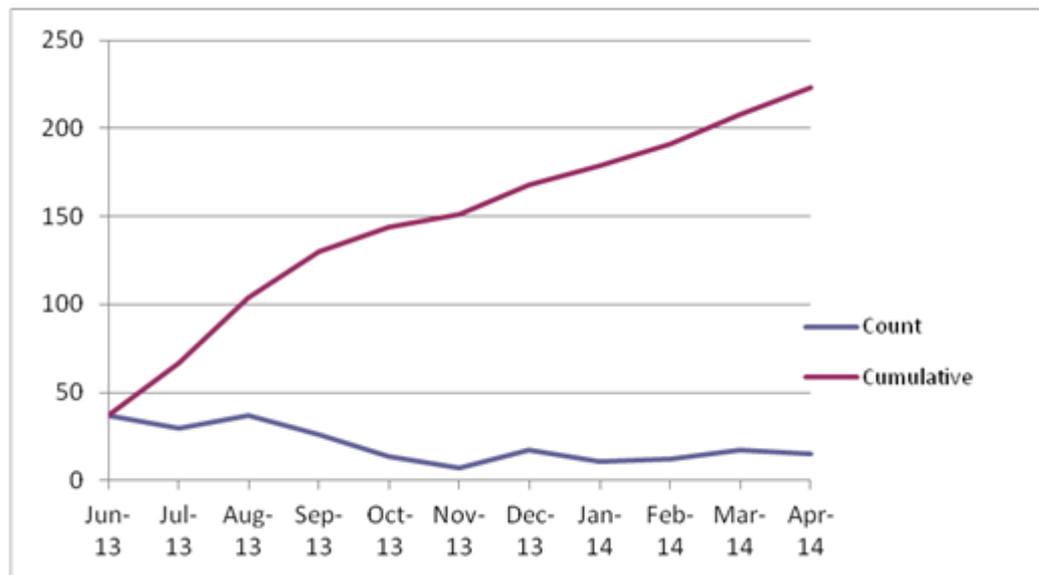
Figure 1: Monthly count and cumulative total of users validated on the system



How many ideas were submitted?

During the first ten months of operation a total of 219 ideas were submitted (see Figure 2). The cumulative total of ideas submitted appears more linear than the curve for validations. This may be explained by users submitting multiple ideas as described in the following section.

Figure 2: Monthly count and cumulative total of ideas submitted



Leach *et al* (2006) conducted a survey of 182 UK organisations that ran suggestion schemes and found a median rate of suggestions of 0.13 per employee for schemes that had operated for a median of five years. For the organisation in our research, this corresponds to an expected 100 to 130 ideas per year. Against this the figure of 219 ideas submitted in less than 10 months is a strong performance. A more conservative comparison can be made by discounting the initial surge of ideas and considering the last 6 months average which equates to 158 ideas per year. In fact in only one month

has the number of ideas submitted fallen below the rate required for the scheme to perform below the average of established schemes in other industries.

How many users actively contribute ideas?

Data was analysed further to establish how many users had contributed one of more of the 219 ideas submitted. The results of this analysis is in Table 2 which shows that 34% of those submitting ideas only submitted one and that two users submitted more than ten each.

Table 2: Number of ideas submitted per person

No of ideas submitted	Frequency	Percent
1	74	34%
2	23	21%
3	7	10%
4	8	15%
5	1	2%
6	2	5%
7	1	3%
10	1	5%
12	1	5%
219	118	100%

The figures in Table 2 are equivalent to approximately 15% of validated users having submitted ideas. This pattern is consistent with rates of participation in similar systems – e.g. Ebner at al (2009) found that in online knowledge production communities 70% of registered users never submit an idea or comment.

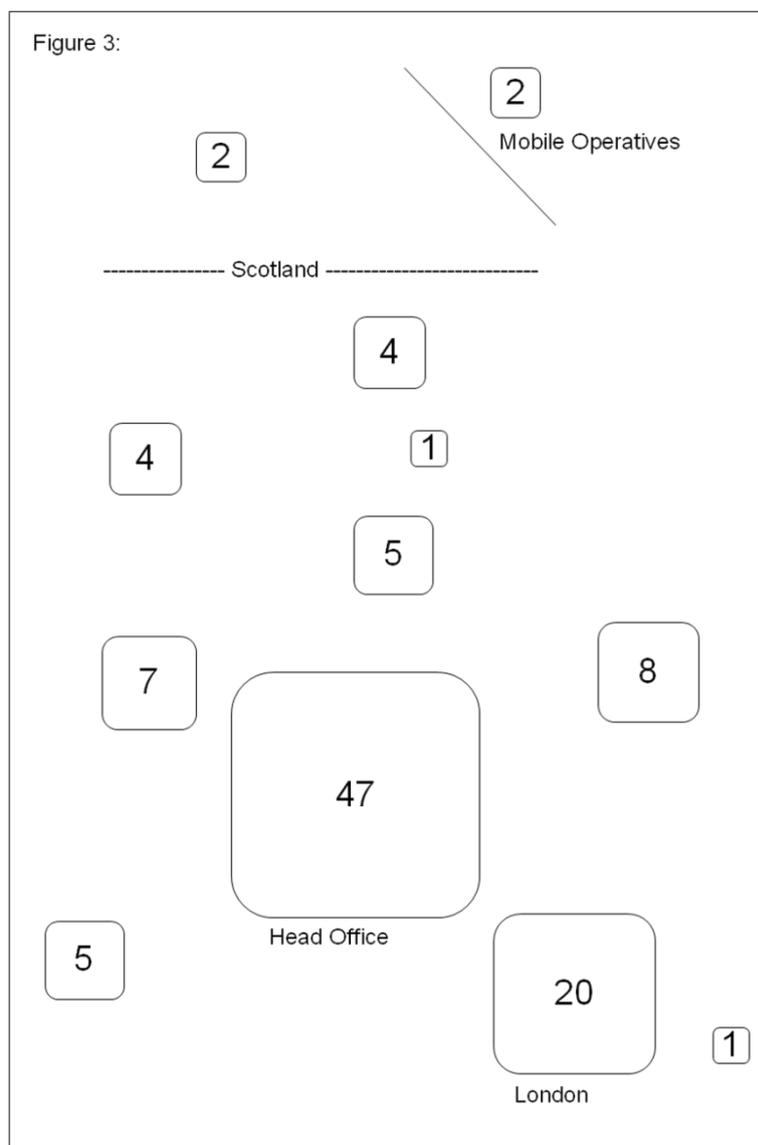
Where in the organisation are ideators based?

This question was considered from two perspectives: position in the organisational structure based on membership of business unit or support function; geographical location based on location from HR data. We acknowledge that ‘base location’ is a complex concept for construction employees and this will be the subject of further future research and analysis. Organisational position of those submitting ideas is shown in Table 3. Differences between column totals between Tables 2 and 3 are due to mismatches between ideas app and HR data sets.

Figure 3 represents the geographic dispersal of those submitting ideas. The size of the squares within the figure correspond to the number of ideators based mainly in each location. The configuration of the shapes represent the approximate geographic arrangement. Other than head office, most locations shown reflect more than one site or property.

Table 3: Organisational unit of ideators

Unit:	Frequency	Percent
Civils & groundwork	25	23%
Corporate/Support	22	20%
Utilities	21	19%
Highways/Infrastructure	12	11%
Facilities Management	12	11%
Building: Public	7	6%
Building: Private	6	6%
M&E Contacting	4	4%



The functions that had the most people submitting ideas were: civils and groundwork; corporate/support; and utilities. Future research will investigate the reasons for this. Feedback from research partners suggest that relative workload, higher proportion of directly employed workers and a stronger innovation culture than building and property could all be factors. Consideration of Figure 3 shows most clearly the

preponderance of head office employees who have submitted ideas so far. Possible reasons for this are the higher proportion of office-based and management staff, the location of the innovation managers in head office, and the centralised nature of the scheme. The latter seems significantly important for the development of the system. The ideas capture app is effectively a 'centralised suggestion scheme'. Leach *et al* (2003) found overall that decentralised schemes were more effective than centralised schemes. Tentatively, one could hypothesise that this pattern of engagement reflects findings from construction innovation research that the parent organisation adopts innovation and then implements them on projects (e.g. Gann and Salter, 2000). Further research will use evidence from the types of ideas submitted to consider whether in its initial use the scheme was interpreted by employees predominantly as a centralised head office suggestion scheme.

CONCLUSIONS AND RECCOMENDATIONS

Although not the analytical focus of this paper, Table 1 demonstrates the significant effort required to implement a suggestion scheme in a large construction organisation. Organisations considering such a scheme should ensure that the resources are in place to implement and support the system. Significantly, this includes the resources to register, evaluate and implement selected ideas.

The system data suggests that the implementation has been successful by the criteria of the number of suggestions submitted as the ideas capture app has generated above the predicted rate of suggestions in established schemes in other industries. The reduction and levelling-off of the rate of ideas has suggested a need to maintain momentum and a programme of further communications and other enhancements have been planned to facilitate this which will be the subject of further research.

Although the rate of suggestion is consistent with previous research, we are interpreting other measures of engagement as relatively low. This includes the proportion of potential users that had registered on the system, the percentage of users who had contributed and the apparent concentration of that engagement in the head office. The literature suggests that decentralised schemes can be more successful by these criteria; something that is supported by anecdotal feedback from ongoing activity to encourage the adoption and use of the system. The implementation has suggested that innovation managers need to strike a balance between maximising response rate and maintaining the benefits of centralised schemes such as administrative efficiency and cross-unit knowledge sharing.

Further research will continue to monitor the system usage data reported in this paper along with further data about views, likes and comments. Additional analysis will consider the content, quality, and characteristics of the ideas submitted.

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DIFFUSION OF DIGITAL INNOVATION IN A PROJECT-BASED FIRM: CASE STUDY OF A UK ENGINEERING FIRM

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Digital innovations are rapidly diffusing within the construction sector. With the UK government policy mandating building information modelling (BIM) by 2016, engineering firms are faced with challenges related to embedding new technologies and associated working practices for the digital delivery of major infrastructure projects. Drawing from diffusion of innovations theory, this research attempts to answer the question of: how digital innovation diffuses in the firm? It adopts a contextualist approach through in-depth case study of a large and international engineering project-based firm. The analysis of the empirical data, which was collected over four years of close interaction with the firm, provides a narrative for the diffusion of the digital innovation across the firm where both the innovation and the firm were in flux. The diffusion process has evolved through three main mechanisms: centralisation of technology management, standardisation of digital working practices, and globalisation of digital resources. This case has both theoretical and practical implications; it describes the diffusion of a digital innovation in a complex social system. This extends diffusion of innovations studies in construction, and guide engineering firms in their efforts to adopt and implement new innovations.

Keywords: digital technology, diffusion of innovation, case study, project-based firm.

INTRODUCTION

The UK government is promoting digital innovation in the construction industry by driving digital engineering and design, it aspires to have a construction industry that is efficient and technologically advanced by 2025 (Government 2013). Moreover, the recent policy calls for “*fully collaborative 3D BIM (with all project and asset information, documentation and data being electronic) as a minimum by 2016*” (Office 2011:14). In order for the Industry to meet the challenge, engineering firms working on infrastructure projects are required to embrace digital innovations such as building information modelling (BIM), including new technologies and associated working practices.

Construction is considered complex social system for innovation; aspects which accelerate innovation also found to stifle the diffusion of new technologies and practices (Dubois and Gadde 2002). Construction management scholars have identified distinct structural characteristics which differentiate construction project-based firms from other project-based firms, and influence diffusion and innovation. Examples of these characteristics are: the inter-organisational nature of construction

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projects and firms which involves multiple actors and interfaces (Winch , Harty 2005, Fellows and Liu 2012) causing the innovation to have rippled effects over multiple spheres of influences (Harty 2005), the tensions between the unique and changing project processes and the relatively stable and standardised firm processes (Gann and Salter 2000), and the double-edged project-based learning which found to be problematic and difficult to capture (Davies and Brady 2000, Scarbrough *et al.* 2004). It is, therefore, important to understand the diffusion process within the different organisational levels of the firm over time, and capture the mechanisms through which the firm facilitate the transfer of knowledge and learning about digital technologies and practices.

Understanding the innovation attributes is critical for investigating the diffusion of that innovation (Wolfe 1994). Hence, the digital innovation under study in this paper is defined as: the technologies and associated digital working practices used for the management and delivery of projects in construction. This includes technologies used for the manipulation of design, whether in the form of 3d or other visualisation techniques, and also the coordination of and collaboration around digital data through standards, workflows and processes. Building information modelling is an example of this digital innovation as it encompasses technologies and processes.

The purpose of this paper is to investigate the diffusion of digital innovation in a project-based firm. This is achieved through a contextualist approach (Pettigrew 1990) to understand the diffusion of digital technologies for project delivery in a global engineering firm which is named EngCo in this paper for confidentiality reasons. This firm's international operations evolved over the three years of field work: it is of a significant scale, with more than 10,000 staff and project-based operations on most continents. A significant proportion of the firm's work is on major infrastructure projects.

DIFFUSION OF INNOVATIONS IN CONSTRUCTION

Diffusion of innovations theory examines how new ideas move through a particular social system. While early studies of diffusion started with the analysis of the diffusion of new technologies across homogeneous population of a society (Rogers 1962, Rogers and Shoemaker 1971, Rogers 1983), more recent work examines innovation in relation to the heterogeneous organizational structures associated with firms, projects and markets (Rogers 1995, Ven *et al.* 1999, Rogers 2003, Garud, Tuertscher and Van De Ven 2013). This paradigm shift towards more complex social systems opens new doors for research, yet pose challenges to understand innovation and diffusion processes that are: "*co-evolutionary, relational, inter-temporal, and cultural*" (Garud, Tuertscher and Van De Ven 2013: 776).

Growing body of research is embracing diffusion of innovations theory in construction. Emmitt (1997) provided one of the early studies of diffusion of innovations in construction. He investigated the diffusion of new building products into architect offices, and concluded that Rogers' (1983) model of diffusion requires modifications in order to be applied in a construction context. Following the same line, Larsen and Ballal (2005) studied the social interaction across the UK construction industry through mapping three classic diffusion concepts: cohesion, structural equivalence and threshold, to Rogers' (1995) stages of the innovation diffusion process. They found that adopters of new innovations experience the three concepts in different ways at different times during the innovation diffusion process. Both Emmitt (1997) and Larsen and Ballal (2005) highlighted the importance of the

relationship between the adopters and their social system as a context for diffusion, and provided an epistemological shift that is desired to overcome the positivist view of classic diffusion research when applied into construction.

Another stream in construction management literature is concerned with the diffusion of digital innovations. For example Peansupap and Walker investigated the diffusion of intranet technology in three Australian contractors (Peansupap and Walker 2005, Peansupap and Walker 2006); they integrated diffusion of innovations model by Rogers (1995 with change management theory, and proposed a two stage model for diffusion which is based on: the initial adoption by the firm, and the actual implementation by individual users or groups within the firm. In addition to identifying six- stages process for diffusion, the authors suggested that management, individual, technology and environment considerations are critical for the diffusion of technology within the firm. Also, Taylor (2007 investigated antecedents and consequences for the diffusion of 3-D technologies in 26 design and construction firms, and proposed a framework to understand these issues at the organisation, work, technology and regulative interfaces. These Studies of the diffusion of technologies in construction found: training and technical support provided by the firm, the role of senior business managers and IT managers in driving the vision for the implementation of the innovation, technology experimentation, work distribution and standards as important factors which influence the diffusion of digital innovations in project-based firms (Peansupap and Walker 2006, Taylor 2007).

Building upon and extending this work, the research reported in this paper investigated how digital innovation diffuses in a project-based firm. It considered the reciprocal interaction between the digital innovation, the innovation champions and the project-based firm over time.

RESEARCH METHOD

The investigation of the diffusion of digital innovation in EngCo through this research followed the principles of a contextualist approach as suggested by Pettigrew (1990, by doing so, it explores the "*context, content, and process*" of diffusion together with their interconnections through time in a single case study of a project-based firm (Yin 2009). Within this contextualist approach time is emphasised to initially provide chronology of important events, and then through the analysis, it moves to more conceptual explanation of the diffusion process. Thus, the research seeks to build theory on diffusion of digital innovation from the case (Eisenhardt 1989).

The research process comprised four field work phases conducted between 2009-2013. The four phases of data collection started with exploratory study to understand the firm and technology status quo in the summer of 2010. Further understanding of the digital innovation was achieved through interpretative investigation of the use and management of the digital innovation for project work during the summer of 2011. Then in 2012 four projects case studies were conducted to investigate the diffusion of technology in projects. And finally a strategic initiative for the diffusion of BIM was observed and analysed in the period between November 2012 and March 2013. The research iterated between the literature, the data, and the analysis in a fashion that is similar to iterative grounded theory as proposed by (Orton 1997). Each data collection phase was informed by the analysis of the data collected for the phase before, and also by the literature.

The data is drawn from multiple sources of evidence. This included: 28 formal interviews with 30 professionals across the different organisational levels of the firm (with more than one interviewee for some interviews); observation and attendance of 20 meetings, of which 7 meetings were focused on research development and feedback; reviews of 1109 pages and 128 slides and 8 excel sheets which downloaded from the firm intranet or circulated by email; and 40 pages of detailed field notes recorded from the meetings and informal interaction with EngCo's employees in the main office in London, through various discussions over lunch and tea and coffee breaks. Background information about the firm was also gathered from the internet.

The collected data was qualitative and processual in nature as it concerned with multiple units and levels of analysis with ambiguous boundaries (Langley 1999). Hence, the data analysis followed qualitative approach using data reduction techniques in the form of data tables and other forms of data visualisation such as drawings and diagrams (Miles and Huberman 1994). Thematic coding was adopted, with four main themes derived from Rogers model (Rogers 2003), these were:

1. The innovation: digital innovation as defined above;
2. Communication channels: learning and diffusion of ideas and technology across the firm and its projects;
3. Time which indicates a process; and
4. The project-based firm as the social system where diffusion takes place.

Each theme code included multiple sub-codes. The coding was conducted through several iterations of coding, collecting new data, and recoding.

THE CASE STUDY FIRM; A JOURNY OF CHANGE

The data shows that, between 2009 and 2013 EngCo has gone through processes of reorganization, restructure and merger in response to unprecedented uncertainties in its operating environment, which caused by global recession and political instabilities. This has transformed EngCo from being a UK headquartered planning, design and management consulting firm in 2009/10, to a major international arm of a USA headquartered global full-service firm by 2013. This journey of organisational change is represented by a time line provided in figure 1.

EngCo was comprised of five business groups in 2009 and through 2010, these groups were: consulting, property, water and power, transport, and maritime. This is in addition to centralised corporate services such as human resources (HR) and finance among others. The Management Information Systems group was one of these centralised corporate services; it provided information and communication infrastructure across the firm. Furthermore, the firm's work was delivered from 90 offices on 8 regions across the world.

Global recession had its effects on the construction industry; as a result firms like EngCo faced numerous challenges such as:

“Shrinking and uncertain core markets; ever more demanding and cost-conscious clients; fewer, larger more complex projects; more competition and significant industry consolidation; growth opportunities in markets where we lack scale and which are distant from the centre; increasing cultural and linguistic diversity in our workforce; changing employee expectations; and scarce talent in emerging markets”.

(Source: EngCo's Group Board Director for the Middle East and Africa- power point presentation -September 2011)

Within the context of the firm work in infrastructure projects and the challenges posed by environmental uncertainties, engineering and design remained as the core capability for the firm to stay sustainable and gain competitive advantage. Consequently, EngCo ought to strengthen this core capability in light of new needs by the diverse new markets. This was found to be difficult to achieve through EngCo's organizational structure which was set in 2001.

With the objective to balance supply with demand, to achieve more regional management for the business, and to ensure better quality of project delivery, a new organizational model took effect from April 2011, this was based around: 4 regions (Asia and Australia, Americas, Europe, and the Middle East and Africa), and 3 global practice areas (tunnels and earth sciences, planning and development, and business and asset management), in addition to central corporate and support services.

Then, in 10 November 2011 EngCo was acquired by an American global firm which specialises on full-service consulting, design, construction, and operations. From April 2012 EngCo became one of that firm's companies. Following this merger the organizational structure of EngCo remained the same with three practice areas, however reorganization took place to remove duplications on roles and responsibilities, and achieve full integration between the two firms.

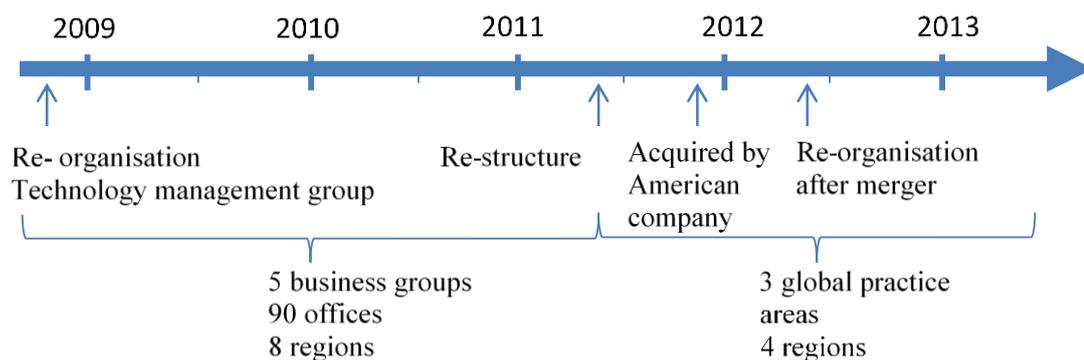


Figure 1: Timeline for EngCo's organisational change

THE DIFFUSION OF DIGITAL INNOVATION IN THE FIRM

During the firm's journey of change described above, strategic objectives and imperatives associated with the technology for project delivery have evolved in response to changes on the organizational context. The previous section provided the narrative for this change, and the next sub-sections will describe three main mechanisms which the firm adopted to diffuse the innovation while dealing with uncertainties and environmental changes. These mechanisms are: centralisation of technology management, standardisation of digital working practices, and globalisation of digital resources.

Centralisation of technology management

Increasing demands by clients and advanced developments in technologies required the firm to better develop its capabilities for digital project delivery. And while the digital innovation in the form of digital technologies and associated digital practices

for project delivery has been enacted differently and partially within the different parts of the firm, it emerged as imperative for EngCo to gather the disparate management efforts into one central resource to technologically support all the business groups in the same way the Management Information Systems group centrally maintained the firm's IT and communication infrastructure.

As a result, early adopters of technology in the Transportation Business group started to attract interest from senior management, and by the end of 2009 this group of technology managers was migrated from the business group to the centre of the firm to be part of the Information Management System group. Enhanced with a newly appointed systems architect and another technology manager, by April 2010 the recently centralised Technology Management group was comprised of 6 team members. The group Director has extensive experience on designing and implementing tools and systems for the rail sector and have background in civil engineering and CAD, moreover he has been with the firm for around 20 years. Three team members were responsible for the licensing, installation and technical support of the major software packages used for project delivery across EngCo's business groups, while two team members were assigned to support global delivery of major infrastructure projects.

As discussed by the group's director and members, the role of the new group was to coordinate and manage digital technologies for project delivery across the firm, join the fragmented systems into one central resource, champion the technology use, and raises the firm's awareness of digital technologies for project delivery in order to maintain sustainable business. In doing so it was seen as *"a group that's almost pioneering or pushing the boundaries"*.

Standardisation of digital working practices

The newly formed and centralised Technology Management group has inherited a legacy of digital systems, which it found confusing, disconnected, out of date, not validated, uncontrollable, and slow. This is explained by the systems architect interviewed in July 2010:

"There was a lot of tactical development, rather than strategic development, so these things – these systems just spurted out of the ground for a particular person or initiative and that initiative might have fallen away. The system's still there and it's just disconnected and people don't know whether they should be using it or not, so there's a bit of confusion".

(Systems Architect 2010)

To better manage the technology and overcome this fragmentation, the group started to develop what they call Digital Foundation Systems as described by the group director when interviewed in 2010:

"and therefore, we're very much into putting in what we term the foundation systems that support elevated working methodologies and also will support BIM in terms of electronic document management systems, standard file naming, the ability to search and retrieve data"

(Technology Management Director 2010)

These foundation systems are proposed to provide standardized ways of working across the different parts of the firm. It will also support Building Information Modelling (BIM) implementation.

While, technology managers within EngCo argued that some degree of standardisation of project processes is necessary to enable the firm to learn from its experience in previous projects and applying this to new projects, the proposed digital foundation systems are also designed to be flexible and scalable to meet the specific needs of the various market sectors, projects and clients within EngCo, this is explained by the systems architect in the following quote:

"So it's like you've got your list of deliverables, but what does that deliverable mean, put a weighting on that to record your percentage complete and stuff like that, so it's making sure that the tools that we're offering are flexible enough for the projects to be able to work within them"

(Systems Architect 2010)

Globalisation of digital resources

The change on organisational structure in 2011 and the merger with the American firm in 2012 both strengthened the firm efforts on diffusing the digital innovation through the building of global resources for digital delivery of projects, and to support the proposed digital foundation systems. For example, the new organizational structure in 2011 reduced EngCo's regions from 8 to 4. Within each region there were specific teams for a number of local markets. These local teams are responsible for identifying and managing the demands of the local clients and systems of that area. Moreover, it combined the five different business groups into three more integrated global practice areas, these, and in addition to global technology teams stand as a pool of global resources for skills and technical expertise to support the needs of the local markets.

The new structure which put in place in April 2011 is described by EngCo as:

"Creates what is in effect a series of local businesses - managing sales, clients and projects locally but with unrestricted access to our global skills and expertise. This is a very powerful combination and is at the heart of what we mean when we say we are 'moving the whole business closer to clients'".

(Source: Operating model booklet- March 2011- EngCo intranet)

Within this new organizational structure, technology was realised as enabler for improved engineering and design capabilities to win new projects and enter new markets, and also as a global resource to enhance projects delivery. Moreover, technologies for project work for the first time was seen as independent from the Management Information Systems, which was a major shift towards the investment on and the development of the firm digital capabilities for strategic projects and developments.

DISCUSSION AND CONCLUSIONS

The aim was to understand the diffusion of digital innovation in a project-based firm. This aim was founded on a practical need from engineering firms to meet the government discourse for an industry that is technologically driven. Building on and extending the literature in diffusion of innovations in construction, this research investigated the diffusion of digital technologies for project delivery and its associated practices in the different parts of the UK engineering project-based firm EngCo. This in-depth case study revealed how the diffusion process takes place in not only complex but also changing organisational context, an aspect which has been underexplored in previous diffusion research.

The findings of this in-depth case study provides a narrative for the diffusion of digital innovation at times of change in a complex social system where tensions between the local and central, the unique and routine, the ad-hoc and standard were dominant. The empirical study also highlights important mechanisms through which the firm diffuses the innovation.

Evidence from this case supports the role of technology managers as innovation champions who motivate new digital technologies and working practices (Peansupap and Walker 2006), or act as gate keepers to promote new innovations into the firm (Emmitt 2001), it goes even further to describe the role of the firm on formalising the efforts of these champions to enhance the diffusion process through centralisation of technology management and globalisation of digital resources.

Moreover, as project-based literature highlights the need for integration of processes across projects and with the firm (Davies and Brady 2000, Gann and Salter 2000), the use of diffusion of innovations theory to understand digital innovation in the inter-organisational context of construction in this research revealed how standardised working practices provide the required integration through the flexible infrastructure prescribed the experienced, networked and knowledgeable technology managers.

Furthermore, this study has important practical implication because it describes rather than prescribes the process through which the firm managed and diffused the digital innovation. Future avenues for research are to continue to investigate the diffusion process after the merger with the American company and better understand the effect of change on the leadership and strategy of the firm on diffusion.

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OVERCOMING BARRIERS TO INNOVATION: DEMONSTRATING AN ARGUMENT IN FAVOUR OF COMMUNICATION ARENAS

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Continuous development efforts including steady-state innovations are necessary for such purposes as of improving short-term performance. However, there is also the need to enable more radical renewal, where development efforts typically stretch beyond the single-project milieu. Supplier-led innovation towards e.g. affordable, sustainable building constitutes such an example. To open up for more radical renewal, one implication of an earlier proposed innovation-barrier/enabler model is the need for sustainable client-contractor arenas for communication, enabling the continuous re-thinking of current experience and understanding by allowing for clients' and contractors' different/conflicting meanings to surface and interact. In Swedish building such arenas seem to be lacking. Underpinning the argumentation is previous research addressing barriers for supplier-led innovation from theoretical perspectives of organizational information-processing and descriptive behavioural decision-making. To better understand the significance of suggested arenas, data were collected in three steps. First, representatives of a building company were interviewed about their personal views regarding barriers/enablers for supplier-led innovation and what primarily determine clients' accept/reject of the builder's standardized system solution. Second, the building-company representatives met with representatives from three client organizations for a round-table discussion concerning barriers to innovation and sector renewal, and means to overcome. Finally, follow-up interviews with building-company representatives sought to capture personal reflections following from foregoing discussion. Collected data were analysed in relation to the previously proposed model, thus simultaneously developing the model and making it more accessible to building practitioners. Cross-analyses of interviews and client-contractor discussion revealed multiple gaps of understanding. Furthermore, to open up for innovation challenging steady-state it is suggested that both client organizations and contractor organizations need to pay close attention to how meanings and understandings are formed and shared within as well as between organizations. A subsequent implication is the need for a more systematically employed communication arena, stretching beyond the short-term project milieu.

Keywords: client, communication, contractor, innovation

INTRODUCTION

Government reports have, for decades, called for innovation initiatives in the construction sector, and the demands for construction renewal is ever increasing in Sweden as well as in other European countries. Continuous development efforts including steady-state innovations are needed and necessary for such purposes as of

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improving short-term performance. However, following from the challenging goals set by the EU and by local governments regarding the built environment, targeting e.g. carbon dioxide emissions and energy use, more radical innovations and renewal are also called for. In Sweden, the need for better provision of affordable housing is another longstanding issue in the construction innovation debate. To meet renewal challenges like these, development efforts typically stretch beyond the single-project milieu.

Contemporary examples of innovation initiatives initiated and undertaken well beyond the single-project milieu are the supplier-led innovation initiatives loosely brought together and referred to in Sweden as "*industrialized building*", "*industrialized construction*" and "*systems building*". Unlike steady-state innovations that can be developed and implemented within single projects, building on current knowledge and being about "*doing what we do but better*" (Phillips *et al.*, 2006 p 177), industrialized building has been found to encompass novelty in many different areas (e.g. new methods of building, new forms of organization and cooperation within the building process, and new technical solutions, c.f. Engström 2012) and subsequently challenge current practice and previous experience in the Swedish building sector (see e.g. Engström and Hedgren 2012). Emerging from these circumstances are challenges relating to client decision-making and information processing. These challenges may, in turn, help to explain why the up-take of industrialized building in many countries has been slower than expected and why building-clients' ability to take a leading role in driving innovations has been called into question (as discussed by e.g. Hedgren and Stehn 2014).

Previous research addressing these challenges (e.g. Levander *et al.* 2011; Engström and Hedgren 2012) has aimed to understand and describe client information-processing practices and decision-making relating to supplier-led innovation, discussing also potential barriers to such (radical) innovations and means to overcome. The purpose of the current research efforts is to provide opportunities to test how these suggested means for overcoming barriers to innovation can be employed in practice by providing a simple, tentative communication arena in terms of a round-table client-contractor meeting. Included in the analysis are also practitioners' reflections and understandings of innovation barriers and enablers.

As the title of the paper states the intention is that of demonstrating an argument in favour of communication arenas as means for overcoming barriers to innovation. The importance of communication as a core feature in the context into which building innovations are introduced (together with inter-organizational relations, work collaborations, power distribution and the project-based nature of construction) has previously been acknowledged by Harty (2005). Moreover, communication (between individuals, functional departments, areas of expertise, organizations, etc.) is implied for all the means to overcome barriers to radical innovation suggested by the previous research discussed in this paper. Indeed, an important note to make already at the outset of this paper is that although communication arenas are argued to be means for overcoming innovation barriers or, phrased differently, to support overcoming inertia in the particular context, the intention of the argument is not to normatively point towards any such arena as "*solving the problem*". Rather, a critical position is advised, as specifically discussed in the end of this paper.

SUGGESTED MEANS TO OVERCOME BARRIERS TO INNOVATION IN CONSTRUCTION

Stemming from a tentative model presenting barriers and enablers for clients managing information to unblock supplier-led innovation (Engström 2012 p. 59) the following suggested means to better understand and overcome barriers to innovation are discussed:

- i. Enable for different meanings and interpretations to surface and interact.
- ii. Mind the impact of project framing.
- iii. Mind the gap between the main organization and the project organization.

Enable for different meanings and interpretations to surface and interact

As a decision-making approach to cope with innovations and novel decision situations, the aim to reduce uncertainty, i.e. absence or lack of information as defined by Galbraith (1973), has been strongly questioned. For example, in a conceptual paper building on decision theory, Dinur (2011) suggested that in novel decision situations mechanistic decision-making rules do not apply and to rely on cognitive rules of thumb (i.e. heuristics) based on previous experience and expertise is not advised.

For innovation and in situations of novel decisions, research taking an interpretive approach to decision making and organizational information processing (e.g. Neill and Rose 2007; Dinur 2011; Levander *et al.* 2011) has, in addition to absence/lack of information, also acknowledged the human problem of managing multiple meanings and conflicting interpretations, i.e. equivocality (Weick, 1979; Daft and Lengel 1986).

Levander *et al.* (2011) found that equivocality was a more prominent issue relating to industrialized building than was uncertainty for the clients they studied (professional Swedish multi-dwelling property owner organizations with a long-term owner interest). Furthermore, the clients did not appear to be organized to manage equivocality (*ibid*) which would according to Daft and Lengel (1986) include the seeking of clarification, problem definition and agreement through the exchange of different opinions and subjective views (rather than by the seeking of answers to explicit questions in order to reduce uncertainty). Similarly, Weick (1995) stated that confusion stemming from multiple meanings calls for social construction and invention and rich, face-to-face, communication (c.f. Daft *et al.* 1987).

Given the high level of client equivocality concerning industrial building that was identified, a subsequent suggestion by Levander *et al.* (2011) was that the current information-processing practice did not support investment decisions in new-build concerning new-to-the-client alternative for new-build such as, in this case, industrialized building. Levander *et al.* (2011) also highlighted better facilitation of client-contractor communication in the process leading up to the investment decision to support clarity, agreement on meaning and shared understanding concerning new alternatives.

Engström and Hedgren (2012) proposed that client organizations that did choose to invest in supplier-led innovations have an organization that overcomes barriers to adoption by enable equivocality to surface and interact with their decision-making process. This proposition, concurring with suggestions made by e.g. Neill and Rose (2007), was further addressed and tested by Hedgren and Stehn (2014). They found their results supporting the proposition by Engström and Hedgren (2012). Examples of practices described by client organizations interpreted by Hedgren and Stehn (2014)

as enabling equivocality to surface and interact with clients' decision-making process include; interacting with suppliers and contractors on a continuous basis; involving many different functional departments and engaging contractors early in the pre-tendering phase to exchange ideas; and support learning between projects for development and change by frequent and close dialogues between internal (cross-functional) and external participants.

From research on human decision making it has also been suggested that the more information the decision maker lacks the more likely it is that he or she will rely on heuristics i.e. simplifying strategies and cognitive rules of thumb (c.f. Tversky and Kahneman 1974) to fill in the information gaps and simplify information processing (March 1994). Generally these cognitive rules of thumb are helpful for making inferences within a given population or context to which the decision maker's experience apply. However, in situations where innovations imply a break with current knowledge and practice, the cognitive rules of thumb can be misleading.

More recently, Beamish and Biggart (2010, 2012) in their research on diffusion and failed innovation in the commercial building industry found that social heuristics i.e. shared rules of thumb for making critical decisions could be helpful for addressing psychological as well as economic and social uncertainty. On the other hand, they also concluded that for example the interactional stability that these shared models helped generating, simultaneously contributed to a situation where practitioners "*resisted novelty in exchange for consistence, predictability and social accountability*" (Beamish and Biggart, 2010 p.38).

In addition to cognitive and social rules of thumb presenting barriers to innovation Engström and Hedgren (2012) observed organizational barriers to innovation in terms of practices among Swedish construction clients that instead of facilitating the re-thinking of heuristics further sustained inertia through e.g. policies, decision criteria and project risk-management protocols. Reductionism approaches, i.e. reducing equivocality by avoiding it or making simplifications, can according to Neill and Rose (2007 p.311) "*promote inertia and tunnel vision*", and subsequently be negatively associated with clients' ability to manage information for decision making on supplier-led innovation as proposed by Engström (2012). On the other hand, Neill and Rose (2007) concluded that when the decision-making process is exposed by multiple meanings and conflicting interpretations, this can release the organization from reinforcing the status quo and thus allow for innovation beyond current frames of reference. Neill and Rose (2007 pp. 306) further suggested that "*superior decisions are best arrived at when multiple meanings can interact rather than when differing views never surface*".

Mind the impact of project framing and the gap between the main organization and the project organization

The construction sector is typically described as project-based with project activities and responsibilities de-coupled from the main (business) organization (c.f. Dubois and Gadde, 2002). Similar to the organizational barriers previously discussed, the project setting provides the framing for managers to reduce the number of conflicting meanings and interpretations which support communication during the course of the project. At the same time, fewer meanings and interpretations will surface and project management to meet the project goals may stifle innovation as discussed by e.g. Koskela and Vrijhoef (2001).

Keegan and Turner (2002) also discussed the dominant idea about the project/innovation interface that neglects minding of the innovation by remaining mainly to be concerned with managing the project correctly. On analysing the innovation-related behaviour of a client known for "*best practice*" Ivory (2005 p. 868) noted that the client behaviour of reducing risk and costs for the organization in the short-term, project context, simultaneously tended to "*weed out innovation*".

Engström and Stehn (forthcoming) also concluded from a construction project case study where a process innovation were to be implemented that the decoupling of activities and responsibilities between project development and project management created meaning-making gaps between the client business organization and client project management organization, presenting a barrier to innovation by hampering its proper implementation (see also Engström, 2012).

METHOD

To better understand the potential significance of communication arenas suggested as means to overcoming barriers to innovation, a very simple client-contractor communication arena in terms of a round-table client-contractor meeting was tested in collaboration with a Swedish building company. This activity was undertaken as part of an industry development project focussing client receptiveness of innovations when innovations are developed and introduced to the Swedish construction market by a contractor. During the length of the project (on which the researcher spent approximately 200 hours during 2012-2013), several other activities were undertaken in and together with the contractor. However, data referred on discussing the argument were collected in three steps:

5. First, five representatives of the building company were interviewed (semi-structured interviews) about their personal views regarding barriers/enablers for supplier-led innovation and what primarily determine clients' accept/reject of new-to-the-client industrialized building-system solutions. The representatives were initially selected in cooperation with the marketing manager based on them being perceived as having key-positions in relation to a targeted radical product and process innovation recently introduced to the market (fictively named here "*The New Alternative*", TNA). These key-positions included the marketing manager, the market and business manager of TNA, a marketing and sales communicator, and a person with responsibilities related to business concept development. Following from a suggestion made by the market and business manager of TNA, an additional person was included representing the part of the organization managing construction projects from initial sale to building completed, thus working directly with the implementation of TNA.
6. Second, the building-company representatives met with representatives from three client organizations who were invited by the researcher to participate in a round-table discussion concerning barriers to innovation and sector renewal, and means to overcome. The client organizations were selected by the market and business manager of TNA to represent three different clients, i.e. an in-house client, a private developer and a public client. All clients were represented in the round-table discussion by two persons each.
7. Finally, follow-up interviews (semi-structured) with building-company representatives after the round-table discussion sought to capture personal reflections following from discussion during foregoing steps, including both previous interview talks and the round-table client-contractor communication.

Collected data were analysed in relation to the previously proposed model comparing interviews and client-contractor discussion and relating reflections made by respondents to the three parts of the argument (i-iii) as presented above.

RESULTS AND ANALYSIS

Enable for different meanings and interpretations to surface and interact

During the interviews with the contractor representatives, their views of the clients' views were discussed. As clients during the workshop shared their different understandings on innovation in general and about TNA more specifically, conflicting interpretations generated questions which, in turn, were reflected upon from multiple perspectives. The round-table discussion revealed that some of the assumptions that the contractor representatives had articulated during the interviews about clients and what they were perceived to value did not properly match what the clients themselves highlighted during the round-table discussion. Cross-analyses of interviews and client-contractor discussion revealed multiple gaps of understanding. One example that all the contractor representatives reflected upon during the follow-up interviews were how they had, in different ways, simplified the view of client value and how they had lacked deeper insight into why clients actually value the things they say they value. These reflections implied that the contractor representatives had developed a new understanding following from the round-table discussion.

The marketing manager also reflected on the perceived conservatism previously (during the interview) having been attributed to clients. After listening to and discussing with the clients and the other contractor representatives during the round-table discussion the marketing manager concluded that when introducing innovations they themselves in the contractor organization are also exposed to a great deal of uncertainty and tend to make interpretations and draw conclusions based on previous experiences. *"We think we know things and act accordingly. It prevents us from actually asking questions and to challenge our assumptions"*.

Furthermore, during the round-table discussion client value was addressed from both the perspective of the TNA and the clients' businesses in a more general sense. For example, different interpretations and meanings of functional requirements came to be highlighted. When moving back and forth between the general functional requirements, the expected solutions (based on clients previous experience) and the reasons for clients to expect adaptations of the contractors offer (communicated through potential future costs or losses expected by clients if the solution is not provided) a revised understanding of client requirements emerged. One of the contractor participants in particular reflected on how previously having had difficulties understanding why small adjustments beyond the TNA offer would be *"such a big thing for the client"*. From the contractor and TNA perspectives, these required adjustments were understood as mainly emerging during the project causing implementation problems and, in the end, contributing to very little added value to the client. However, as became apparent during the round-table discussion, some of the specific requirements were not emerging project specific needs but generic and, in fact, associated with highly valued business related functions, including for example the management of future costs. Insights like these triggered questions during the round-table discussion (and afterwards) which were stretching well beyond the specific, single project, e.g. questions regarding potential future directions for the continuous development of TNA and strategies for future market-niche approaches.

"Tradition" and "building culture" enforced by "everyone, from the joiner to the engineering expert, doing what we have always done in the same way" was a barrier to innovation being highlighted at the end of the round-table discussion. As a response to how this barrier best could be overcome, the participants suggested that; "a continuous dialogue between clients, contractors and other stakeholders, including different roles, areas of expertise and responsibilities is needed"; and "good examples needs to be shared and discussed". As the participants perceived such dialog to scarcely happen on any regular basis, the opportunities for it to happen in the future was also discussed. One suggestion was that "there is a new generation of project managers and builders emerging who are potentially representing a new building practice and new values where change and development is considered to be something positive [as opposed to a threat]". The suggestions made for improvements resembles well those practices understood to enable for equivocality to surface and interact with clients' decision process, also being the practice employed by early adopters of innovation in the study by Hedgren and Stehn (2014).

Mind the impact of project framing and the gap between the main organization and the project organization

At the end of the round-table discussion, two of the client representatives concluded that in order to support supplier-led innovation within contractor organizations, as well as supporting innovation in their own organization, they *"could be much better at frequently communicating to contractors our vision and what we value from a client business perspective "*. One of the client representatives added that the same goes for internal communication since people from different functional departments have different knowledge and understanding of building, project management and business-related things.

A reflection made by the marketing manager, the market and business manager of TNA and by the marketing and sales communicator during follow-up interviews were that rather than associating emerging questions and detected meaning conflicts as being part of a vital process of learning from project experience to support further developments of the innovation, they all thought that project management personnel rather seem to associate emerging questions during implementation of TNA with innovation shortcomings. This since the traditional alternative (bespoke services as opposed to a predefined building product offer) newer would have caused project management having to manage these communications, inflicting with project progress according to plan by calling for engagements with both clients and representatives from their own business organization. The round-table participants also agreed on that they missed having hands-on project personnel participating in the discussion to access their perspectives and understanding.

Client-contractor communication was also further discussed from the perspective of different representatives with different roles and responsibilities within the client and contractor organization. The importance of *"within client-organization communication"* was highlighted in order to bridge the gap between client personnel working in the project organization and those working in the business organization. A similar gap was also recognized in the contractor organization and, as the marketing manager concluded, taken together this presents a multiplicity of client-contractor interfaces where communication takes place and different understandings and meanings probably surface and interact. Although, not in any well-coordinated way.

A couple of other experiences from the round-table discussion further support the above notion. One reflection made by the marketing and sales communicator was that it became very clear that some of the client and contractor representatives had been interacting and discussing some of the issues relating to the topic of the round-table discussion previously during a construction project. They appeared to share some understanding from project interaction that the others lacked. *"It also becomes clear to me now how seldom we [in the business part of the organization] actually sit down and talk with clients"* the marketing representative concluded.

From a collective contractor-participant perspective, the round-table discussion and the interpretations of the TNA made by clients woke questions concerning how the innovation actually is understood by other functions in their own organization and subsequently communicated to clients. And the other way around, how the TNA as understood and communicated by clients impacts on the project organization's understanding of the innovation. These reflections in turn led on to further discussions concerning the communication infrastructure within the contractor organization.

The final reflection made and discussed during the round-table discussion was that experience, although generally regarded as something positive, not always is. *"What is the right experience, one must ask, previous building experience can be a barrier to innovation and change"*. During the follow-up interviews the marketing and sales communicator concluded that it was the client represented by people with very little previous experience from building that were closest to the market and sales communicator's own understanding of the innovation discussed.

CONCLUSIONS AND DISCUSSION

Even this very simple communication arena demonstrated that by enabling people with different perspectives to meet and for their different interpretations to surface and interact, taken for granted assumptions can be questioned and new questions can emerge. This in turn can facilitate for new answers to be sought and rules-of-thumb to be revised.

From the interviews and the round-table discussion it also became clear that the client-contractor interface is not just one interface but several. The schematic illustration of client-contractor interfaces in figure 1 was created to illustrate the gaps of understanding, meaning-making and interpretations highlighted during interviews and client-contractor round-table discussion. The round-table discussion revealed the perception among client and contractor representatives that there is a need for some sort of communication infrastructure (or communication arenas) to bridge the gaps between the business organization and the project organization within the client organization, as well as within the contractor organization.

To open up for innovation challenging steady-state it is suggested that both client organizations and contractor organizations need to pay close attention to how meanings and understandings are formed and shared within as well as between organizations. However, for renewal to take place limited, ad hoc activities are not enough. A subsequent implication is the need for a more systematically employed communication arena, stretching beyond the short-term project milieu. However, facilitating for communication that enables for multiple meanings and conflicting interpretations to interact does not necessarily mean that barriers to innovation are overcome. While the round-table discussion proved to support a more common understanding of things discussed, and even to support development of some new

understandings, bridging gaps between different roles, functional departments and people belonging to the main (or business) organization and others belonging to the project organization is not easily facilitated for within the current fragmented construction context.

To dig deeper into the matters discussed in this paper, institutional theory of innovation and organizational learning theories might provide powerful tools to support further understanding of the development and adoption of supply-led innovations in building.

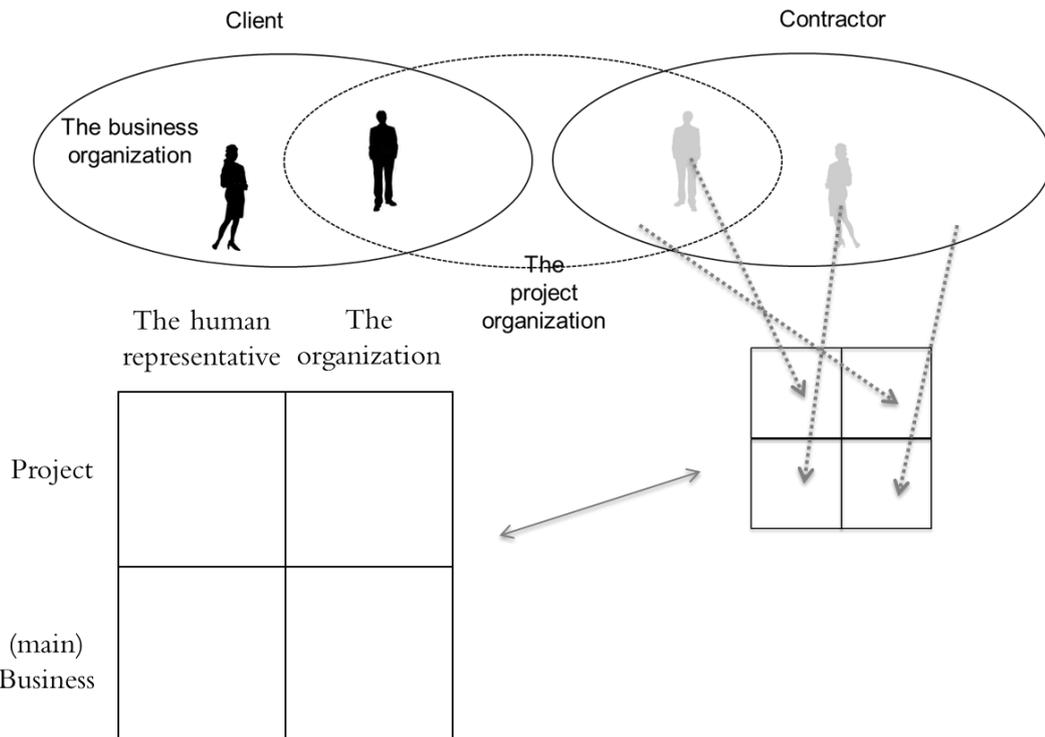


Figure 1: Client-contractor interface as not one but several interfaces.

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DELIVERING SCHOOL BUILDINGS USING OFF- SITE CONSTRUCTION: STAKEHOLDERS PERCEPTIONS

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Following the calls from the OECD and the James review for the increase in the use of standardisation and modern methods of construction in the delivery of new school buildings. The paper sought to appraise the views of both construction and educational professionals on the use of standardised schools delivered predominantly by the use of off-site techniques and modern methods of construction. 120 questionnaire surveys were issued, to both construction and education professionals located with the north of England eliciting their views on the use of modern methods of construction. Fifty completed questionnaires were returned, representing a response rate of 42%. Analysis of the completed questionnaires revealed that the majority of the respondents support the use of both standardised schools and modern construction techniques. Whilst bespoke school design and stakeholder engagement remains important, the respondents suggested improved pedagogical outcomes, enhanced comfort, value for money and a reduction in the number of defects would be critical to the eventual success of the project. To conclude the research revealed that both the construction and education professionals surveyed are not adverse to the adoption of modern methods of construction or the use of standardised school designs proposed in the James Review.

Keywords: modern methods of construction, off-site construction, education.

INTRODUCTION

Over the last fifteen years successive reports (Egan, 1998; Wolstenholme, 2009) have called for the increased adoption of standardisation and off-site manufacture through the construction industry. Following the publication of the Government Construction Strategy (Cabinet Office 2011) which mandates the public sector to achieve significant time and cost efficiencies between 2011 and 2020. Together with the highly influential James Review which again called for the adoption of standardisation and off-site manufacture. The latest Department for Education (2014), design guidance strongly encourages the use of both standardised design and off-site manufacture for all future capital school building projects as the primary way of achieving both value for money and the government's construction targets. Taken together with the realisation that budget caps imposed by the Department of Education (2014) would make it difficult if not impossible to deliver new school buildings without some level standardisation and off-site manufacture would appear inevitable.

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The influential James Review together with subsequent design guidance published by the Department for Education (2014) strongly encourages the use of both standardised design and off-site manufacture for all future capital school building projects. It was therefore resolved to investigate how both construction and education professionals view the use of standardised schools, delivered predominantly using modern construction techniques to evaluate whether the rhetoric of the James Review can be realistically achieved in practice. The paper is structured so that relevant literature related to modern construction techniques, and off-site construction methods is reviewed to establish current levels of knowledge and make the case for further empirical data to be collected through a questionnaire survey. The work concludes that both construction and education professionals would welcome an increased use of off-site manufacture to further enhance the quality of new school buildings.

CONTEXT

Modern Methods of Construction (MMC) are being widely used in the UK particularly for housing as they can represent a saving in both project duration and material usage whilst also producing higher standards of quality (LABC 2013). This combination of benefits, led both Barker (2004) and Callcutt (2007) to call for the increased use of MMC's in the UK housing sector has a potential solution to the delivery of the government's new homes target by 2020. Yet, the work of LABC (2013) suggested that the benefits of using MMC's are not restricted to the domestic market, however, they may not be sufficiently adaptable to cope with the complexities of more flamboyant architectural styles or the specific requirement of some local authority planning policy documents, in which case, standardised designs and enhanced planning guidance may be needed.

Defining modern methods of construction

MMC is a universal term used within the construction industry to describe any method of building other than those considered traditional, namely standard brick and block cavity construction with or without a steel or concrete frame. However, Kempton (2009) avows there is significant difficulty defining MMC's within the current construction management literature. Indeed Kempton (ibid) identifies that a number of other terms are commonly used by construction professionals, when referring to MMC's, these include offsite construction, offsite manufacture, modular construction and prefabrication. Vokes and Brennan (2013) further suggest the terms identified by Kempton (2009) are often substituted interchangeably with each other in both the academic literature and construction practice. Despite this confusion, the BRE (2009) advances a highly generic definition, asserting that modern methods of construction can be seen as "*a range of processes and technologies which involve prefabrication, offsite assembly and various forms of supply chain specifications*". Despite the lack of a universal definition for offsite construction, Goodier and Gibb (2007) suggest there are only four widely accepted categories of off-site manufacture (see figure 1) stemming from other manufacturing industries (Vokes and Brennan 2013).

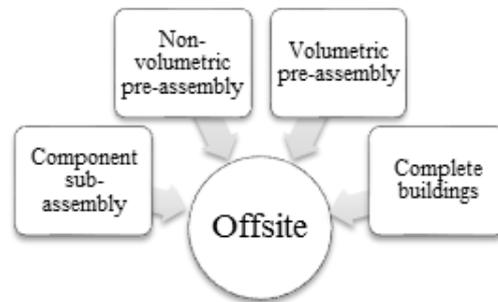


Figure 1: Four categories of off-site manufacture after Vokes and Brennan (2013)

The four main categories highlighted by Goodier and Gibb (2007) are complete buildings, volumetric pre assembly, non-volumetric pre assembly and component sub-assemblies, these categories are further defined in table 1.

Table 1: The four main categories of off-site manufacture (Vokes and Brennan 2013)

Category	Description
Complete buildings	Units that enclose usable space and actually form part of the completed building or structure (units may or may not incorporate modular coordinated dimensions); typically fully factory finished internally (and possibly also externally).
Volumetric pre-assembly	Units that enclose usable space that are then installed within or onto a building or structure; typically fully finished internally.
Non-volumetric preassembly	Large category of items that the designer has chosen to assemble in a factory before installation; units do not enclose usable space; applications may be skeletal, planar or complex.
Component Sub-Assemblies	Relatively small scale items that are invariably assembled offsite, such as light fittings, doors, windows, door furniture

Historical development of MMC

The use of offsite construction in the UK dates back to Roman times, however, it is most commonly associated with the pre-fabricated post war construction of the 1950s (Vokes and Brennan 2013). Waskett's (2001) influential review charts the early origins of prefabrication in the UK, importantly the review documents the combined pressures of slum clearance, materials shortages and post-war ruin had significantly affected housing supply, faced with increased short-term demand the government bowed to political pressure and adopted pre-fabrication as a stop gap to ease supply-side shortages. A view reinforced by Taylor (2010) who opined that despite arguments to the contrary, prefabricated housing was no cheaper over its life cycle than traditionally built housing; it simply provided a fast and efficient solution. Indeed once the market reached equilibrium and materials shortages eased constructors reverted to traditional approaches (Waskett 2011). In his evaluation of post-war prefabricated housing for Council of Mortgage Lenders Ross (2002) opined that in itself the housing was adequate, however, disasters such as Rowen Point and the concerns over quality documented by World in Action, led to a demise of confidence in non-traditional housing, together with the inability to retrofit such properties for modern living they quickly became obsolete.

However, today the use of off-site construction is largely driven by technological advances within the sector, with modern methods of construction described as the “*new products and technologies*” that result in “*delivery methods which set out to improve product and process*” (CIC, 2013). With the BRE (2003) asserting that

MMC's have the potential to introduce greater efficiencies into the construction process, through innovation in building design and management. However, Taylor (2010) opines that the use of factory based systems, typically associated with MMC's are not particularly suitable for one off buildings, suggesting design standardisation would also be needed.

Despite these limitations, the UK construction sector has increasingly adopted off-site manufacture, with 12% of all construction output now taking place in a factory or other off-site facility (Taylor 2010). However, this figure remains highly subjective as the actual value of offsite construction varies depending on the method and definition used to measure the industry. Gambin (2012) for instance suggests the true estimate to be nearer 7%. Yet, even at Gambin's lower estimate this still equates to an economic contribution in excess of £6bn (Vokes and Brennan 2013). A contribution which is likely to rise significantly over the forthcoming decade as the construction industry recovers from recession and the long term implications of a lack of training and skills development start to impact.

Use of MMC's in educational buildings

The time constraints and other restrictions associated with building schools require designers to adopt innovative approaches that are intended to increase the speed and efficiency. This can be achieved using MMCs and offsite construction given the numerous benefits MMCs offer, including enhanced quality, faster construction time, together with reductions in both construction waste and the number of defects discovered at handover. These benefits led to the Organisation for Economic Co-operation and Development (2011) to undertake a comprehensive evaluation of the use of MMCs for the construction of new schools throughout the world. The review concluded that the UK is significantly behind other nations who have actively promoted the use of off-site manufacture and standardised design. The benefits of using MMCs for school building are however, highlighted in the work of Pons *et al* (2010) who's mixed method evaluation of 200 schools constructed in the Spanish region of Catalonia using industrialised technologies discovered that the adoption of modern construction methods reduced the construction project duration and delivering a higher quality of finish whilst also reducing the environmental impact of the building. However, in the longer term, the work concluded that the use of modern methods of construction had neither enhanced nor detracted from the overall pedagogical performance of the building users. Despite the apparent lack of pedagogical benefit the James Review of England's school building programme for the Department for Education concluded that the use of modern construction methods is now a necessity given the budgetary and time savings achievable.

The literature reviewed above has examined the growth in the use of modern methods of construction, whilst identifying that the UK is significantly behind the rest of the world in their use for the delivery of new school buildings. As a result this study resolved to evaluate the perceptions of both construction and education professionals towards the increasing use of modern methods of construction.

RESEARCH DESIGN

Punch (1998) indicated that the research approach adopted for a study needed to reflect the nature of the research problems identified and the research paradigm used in previous work on a topic. Given the aims of the work established as a result of the literature reviewed above and the nature of previous work in the topic area it was

resolved to adopt a pragmatic research approach. A quantitative research design was developed that made use of a measuring instrument to collect data from a large number of practitioners. Creswell's (2003) rationale for the selection of appropriate quantitative tools indicated that a questionnaire survey was the most appropriate data collection tool for this study.

The questionnaire survey was issued to a sample of construction professionals (n=60) and teachers (n=60), working in both primary and secondary schools throughout the North of England. Due to the resource constraints of the researchers, the sample was one of convenience, defined by Bettanglia (2008) as a nonprobability sample in which people are sampled simply because they are 'convenient' sources of data for the researchers. As such the sample consisted of construction professionals and teachers with whom the third author had already established contact. In total 50 usable questionnaires were returned, giving a response rate of 42 per cent. The respondents included 26 construction professionals and 24 education professionals consisting of teachers, deputy head and head teachers. This response rate was achieved following an initial posting and follow-up e-mail communication.

MAIN FINDINGS

The importance of bespoke design in school projects

One of the first areas the questionnaire sought to evaluate related to the views of both construction and education professionals on the move away from the bespoke design of school building programmes, recommended by the James Review (James, 2011). Based on anecdotal evidence from a range of articles in the education press, it was hypothesised that neither teachers nor construction professionals would be supportive of such a move. Question six addressed this by asking respondents to consider and rate the following statement "*Bespoke design and individuality are important in school design*" with strongly agree, coded 5 and strongly disagree coded 1.

The modal response obtained from both groups of professionals was: "*disagree*". These results suggest that the majority of the sample feel that bespoke design is integral to the delivery of new school buildings. Given this finding counters the evidence provided in the James Review, it was resolved to investigate whether a significant difference existed between the two groups and whether any observed difference had occurred by chance. A null hypothesis was developed that predicted that there would be no significant difference between the two groups of professionals relating to the importance of bespoke design. A Mann-Whitney U test was conducted to evaluate the hypothesis; the results of the test were in the expected direction and statistically significant, $z=-2.635$, $p<0.01$. Construction professionals had an average rank of 30.46, while educational professionals had an average rank of 20.13 and so the analysis revealed the null hypothesis could be rejected. As such this work can conclude that despite the growing body of evidence supporting the adoption of standardised construction techniques, both construction and education professionals remain dismissive of the techniques used in an educational setting.

Role of stakeholders in the design of schools.

Engaging wider stakeholders in the design of new school buildings has been a major focus of major capital investment schemes since the commencement of the BSF program which strongly advocated the use of participatory design processes (Woolner, 2009). As such, this survey collected data from two respondent groups looking at the importance of involving pupils and other stakeholders in the design of new school

buildings through a participatory design process. Using a five point likert scale, with the mid-range response being "neither agree nor disagree", survey respondents were asked to rate the importance of teacher and pupil involvement in the design of school buildings. As figure 2 shows, of the 26 construction professionals responding to the survey, only 53% ranked stakeholder involvement as either important or very important, whereas 92% of the 24 teachers responding to the survey felt stakeholder involvement was either important or very important.

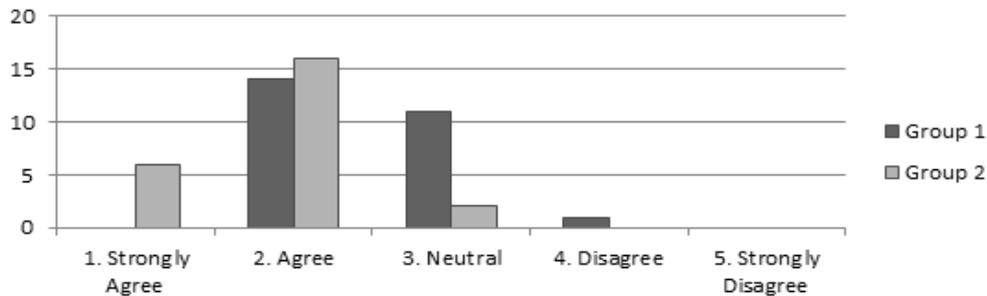


Figure 2: The importance of stakeholder involvement in school design

These results show that, whilst the majority of the teachers (group 1) surveyed felt encouraging stakeholder involvement in the design of school buildings was important, this however, this view was not as strongly supported by the construction professionals (group 2) surveyed.

It was therefore resolved to investigate whether this possible association was statistically significant. A null hypothesis was developed that predicted there would be no significant relationship between the respondents' role and their views of the involvement of stakeholder involvement in the design of school buildings. A Cramer's V test was conducted to establish if any significant relationship existed. The value of the coefficient revealed a modest association ($V=0.516$) and the significance was less than 0.05 ($p<0.01$) indicating that the null hypothesis could be rejected. Suggesting that despite teachers identifying that they and their pupils should play a significant role in the design of new school buildings, this view was not supported by construction professionals engaged to deliver such projects.

Using standardisation and off-site construction for educational buildings

The latest Department for Education (2014) design guidance strongly encourages the use of standardised design and off-site manufacture for all future capital school building projects as the primary way of achieving both value for money and the government's construction targets. In light of this, a key area of this study was to evaluate whether education and construction professionals support the use of off-site, standardised school buildings.

To answer this objective the questionnaire initially sought to evaluate the two groups understanding of 'prefabricated, standardised construction'. Based on anecdotal evidence discovered during the review of the literature it was suspected that construction professionals would exhibit a strong awareness and understanding of 'prefabricated, standardised construction'. Whereas the researchers suspected that due to their lack of specialist construction knowledge, the teachers surveyed would be unfamiliar with either approach. It was therefore hypothesised that construction professionals, would have a greater understanding of offsite construction. Question number eight addressed this area by asking the respondents to rate the following statement "I understand the meaning of both standardised and off-site construction?"

Five possible responses were offered ranging from "strongly agree" through to "strongly disagree". As figure 3 shows, all the respondents to the survey felt they had a good understanding of 'standardised and off-site construction methods' suggesting the null hypothesis cannot be rejected.

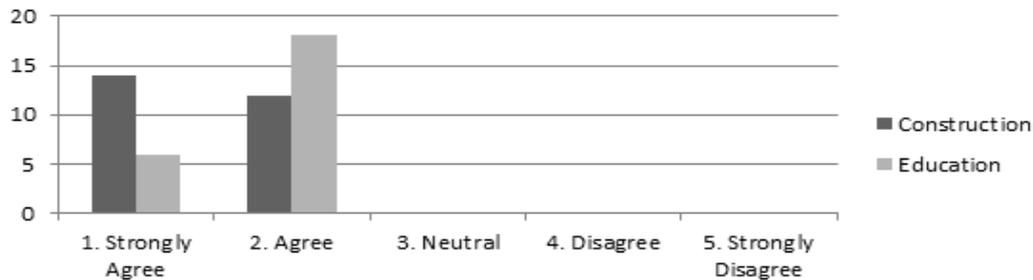


Figure 3: Survey respondents understanding of standardised and off-site construction

Finally it was resolved to investigate whether this understanding of off-site and standardised construction would influence either groups' propensity to support increasing levels of standardisation and off-site manufacture in the delivery of school buildings. Of the 50 professionals responding to the survey only 5 disagreed with the statement "Off-site, standardised construction techniques should be used for the delivery of new school buildings". The survey showed that 81% of construction and 63% of education professionals would welcome the increased use of modern construction practices if they formed part of a bespoke design.

Given the strength of support for off-site construction it was resolved to investigate whether these observations had indeed influenced the results reported earlier. The null hypotheses predicted there would be no significant relationship between the use of modern construction methods and the perceived need to deliver more new school buildings. A Cramer's V test was conducted to establish if any significant relationship existed, with the alpha set at 0.05. The value of the coefficient revealed a modest association ($V=0.312$), however the significance was above the alpha ($p<0.18$) suggesting the null hypothesis cannot be rejected. Allowing the researchers to conclude that despite the governments' assertion that all new school buildings would need to embrace some level of standardisation and off-site manufacture this was not influencing the respondent's support of modern methods of construction.

Success criteria for school buildings

Given the strong link between knowledge generation, educational attainment and buildings identified in the literature, a key area of investigation for this study was to evaluate the importance of a number of success criteria emerging from Barrett *et al's* (2012) work reviewing classroom design, the James Review (2011) and the Department of Education's (2014) school design guidance. These included: (1) the use of bespoke designs for schools, (2) internal comfort including: heating, acoustics, air quality, levels of natural light etc, (3) sustainability, (4) educational achievement and finally (5) value for money.

To identify how important these factors are to the delivery of new school buildings, the survey asked respondents to score each of the listed factors on a scale of 1 to 5, where 1 was the least and 5 was the most important. From the responses, a total score for each factor was calculated and then ranked accordingly with the factor in position one deemed to be the most important as shown in tables 2 and 3.

As table 2 and 3 show; improved results, internal comfort and value for money were seen as essential outcomes for any capital development project, with both groups ranking improvements in educational attainment as the most important measure of success for finished school buildings (122 and 117). However, despite the earlier analysis highlighting the importance of bespoke design, neither group of respondents felt adopting a bespoke design would influence the eventual success of the project.

Despite the apparent levels of agreement between the two groups towards of the five success criteria, it was nevertheless resolved to establish whether a significant difference existed between the two groups' opinions of success to see whether their professional outlook or experience of school buildings affected the way they viewed success using a further Mann-Whitney U test. For the majority of the variables, the test revealed an insignificant difference between the groups suggesting a consensus of opinion as to the importance of the majority of the success measures. However, the scores for 'internal comfort' revealed a statistically significant difference between the two groups ($z=-1.991$, $p=0.047$) with teachers suggesting internal comfort to be a far more important measure of success.

Table 2: Ranking of Success Criteria by Construction Professionals

	(1)	(2)	(3)	(4)	(5)	Cumulative total	Ranking
Improved Results	0	1	1	3	21	122	1
Value for Money	3	6	5	9	3	81	2
Sustainability	1	8	7	9	1	79	3
Comfort	1	6	13	5	1	71	4
Bespoke Design	21	5	0	0	0	37	5

Table 3: Ranking of Success Criteria by Teaching Staff

	(1)	(2)	(3)	(4)	(5)	Cumulative total	Ranking
Improved Results	0	0	1	1	22	117	1
Comfort	0	4	7	11	2	83	2
Value for Money	3	11	3	6	1	63	3
Sustainability	6	4	9	5	0	61	4
Bespoke Design	15	5	4	0	0	37	5

DISCUSSION

Whilst the paper is unable to reach firm conclusions on the use of off-site manufacture and standardised school designs due to the limitations associated with the small sample size. The findings from the study reveal that, contrary to expectations, the gap between the rhetoric communicated through both the influential James Review and the subsequent Department for Education (2014), design guidance, which strongly encourages the use of both standardised design and off-site manufacture for all future capital school building projects and the realities of practice, is reducing. With 63% of teachers and 81% of construction professionals responding to the survey supporting the use of some level of off-site manufacture as part of any new school building on the proviso that off-site manufacturing is adopted alongside a bespoke design. This

finding, however, contradicts the more generalised findings reported by Wolstenholme (2009) in his review of progress since the highly influential Egan report. Wolstenholme observed a very low uptake of off-site manufacture especially in the housing sector despite the calls for increasing engagement with off-site techniques to accelerate supply (Barker 2004) and enhance quality and customer satisfaction (Callcut 2007) appear to have failed due to the end clients continued lack of understanding. This suggested the client represented a substantial barrier to an increased use of off-site manufacture. However, this study suggests these barriers are starting to be overcome, with education professionals responding to the survey demonstrating an increased willingness to embrace off-site manufacture.

However, despite this commitment to off-site manufacturing, the second key recommendation from the James Review relating to the adoption of standardised school designs continues to represent a major gap between the governments' rhetoric and the realities of practice. Despite the appraisal of standardised schools designs within this survey focusing mainly on stakeholder engagement, given this remains a major legislative requirement under the Education Act 2002. Analysis of data revealed that whilst construction professionals were dismissive of stakeholder involvement in school delivery, 93% of education professionals responding did identify stakeholder involvement to be an important aspect of project delivery. A view supported by Higgins *et al's* (2005) exhaustive review of literature which concluded, that on balance, school pupils and staff can play a significant and positive role in the delivery of effective learning environments, which may be lost if standardised designs are implemented. Yet despite the strength of support for bespoke design, on the grounds of stakeholder engagement, neither group of respondents felt adopting a bespoke design would ultimately be important to the eventual success or otherwise of the project. Instead the respondents suggested the buildings ability to enhance educational attainment, internal comfort and the projects ability to deliver value for money would be more significant measures of success.

CONCLUSIONS

The paper sought to appraise the views of both construction and educational professionals on the use of standardised schools delivered predominantly by the use of off-site modern methods of construction techniques. Whilst the majority of the respondents felt a bespoke school design undertaken in consultation with various stakeholders remains important issues such as improved results, enhanced comfort and value for money are more critical to eventual success. Albeit the traditional methods of construction are still seen to be the preferred method, the respondents are not adverse to the use of standardised construction and off-site manufacture if the end product enhances the overall quality of the learning environment and ultimately enhances educational attainment. Finally, given the limitations of both the data collection strategy and sample size, the results obtained cannot be deemed to be representative of the population as a whole but merely of the sample.

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A CONCEPTUAL MODEL FOR IMPROVING CONSTRUCTION SUPPLY CHAIN PERFORMANCE

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Over the years, the UK construction industry through several reports and enquires has been admonished to change its business approaches. Research points to the industry's adversarial culture and disjointed relationships as the major hindrance in achieving collaboration and improved performance within construction supply chains. Common factors include the traditional construction procurement strategies driven by a win-lose mentality, competitive buyer-supplier relationships - pitting one supplier against another in order to achieve the optimum buy, and most significantly, loosely disseminated nature of information applications and exchange among project participants. Within this adversarial context, engagement with Building Information Modelling (BIM) and its philosophy is showing potential positive outcomes with regards to information exchange and collaborative working practices. This paper is based on a larger ongoing research project which aims to design a BIM-driven conceptual model for advancing collaboration and improved supply chain performance in UK construction projects. The research suggests that full deployment of the BIM concept possibly will greatly diminish the adversarial culture in the industry through promotion of collaborative working ideals. In turn, this will result in enhanced project supply chain performance thus, aligning with the objectives of the UK Government's construction strategy for 2016. Following this proposition, this paper based on a critical review of literature presents the essential elements required for the design of the proposed conceptual model, and its contributions to the construction management discipline.

Keywords: adversarial culture, building information modelling, collaboration, supply chain management.

INTRODUCTION

A number of supply chain management (SCM) definitions are provided in the literature (Flynn *et al.* 2010, Mentzer *et al.* 2001). These definitions commonly relate to the concept of integration which bridges the gaps between partner organisations, and facilitates efficient coordination of supply chain activities and collaborative working. Consequently, Xue *et al.* (2007) describes construction supply chain management as the integration of key construction business processes, which focuses on how firms make the most of their suppliers' processes, technologies, and capabilities with the ultimate goal of improving construction performance and adding client value at less cost. Adopted as suitable for construction supply chain management within the context of this research, this definition uncovers the failings in the present-day business practices and relationships between project stakeholders in the United Kingdom (UK) construction sector resulting in several inefficiencies.

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There is thus a significant gap between the conceptual SCM perspective and the dominant traditional supply chain management practices in the industry termed as an adversarial culture (Akintan and Morledge 2013). Culture in the context of the construction industry is described as the characteristics of the industry, its approaches to construction, competence of craftsmen and people who work in the industry, and goals and values of the organisation within which they work (Ankrah *et al.* 2009). In other words, it is about 'how things are done' in the industry.

Studies suggest that potentials exist in the use of integrated collaborative technologies (ICTs) to drive collaborative working in construction supply chains (Kapogiannis 2013, Ramanathan *et al.* 2011). Moreover, it is reported that BIM implementation is offering encouraging signs with regards to the advancement of collaborative working among construction supply chain members (Owen *et al.* 2013). Subsequent to this prospect, the UK Government launched its 2016 Building Information Modelling (BIM) adoption strategy (Cabinet-Office 2011). However, it is yet unclear how BIM and its characteristics relate with the dynamics of construction supply chain management towards enhanced collaboration and performance. Hence this ongoing research proposes a BIM-driven conceptual model which reflects the interplay between the comprehensive deployment of BIM and the development of a collaborative culture, culminating in enhanced performance in UK construction supply chains. The conceptual model is targeted at key projects' supply chain participants, within the domains of main contractor and subcontractor organisations. Contractually, main contractors are responsible for the successful delivery of projects. However, they rely on subcontractors to accomplish their work (Clarke and Herrmann 2004). To achieve high levels of success in their responsibilities, they must therefore develop enduring relationships with their key subcontractors and suppliers (Hook 2012). Subcontractors on the other hand need to appreciate the underlying benefits of collaborative working.

The unfolding sections of this paper provide a brief review of the practices in UK construction supply chains. This is followed by critical reviews of: the concept of supply chain collaboration and its basic principles; and BIM and its characteristics in relation to construction supply chain collaboration. Finally, the key elements required for the design of the conceptual model, and the contributions of the research project to the Construction Management discipline are presented.

CONSTRUCTION SUPPLY CHAIN MANAGEMENT IN THE UK

Over the decades, the UK construction industry has been criticised for its business approaches through several reports and enquiries. McGeorge and Zou (2013) outline some of these documents which include: the Simon Report, the Emmerson Report, the Banwell Report, the Latham Report, and the Egan Report. These reports, particularly the Latham (1994) and Egan (1998) highlight the low performance of the industry in forms such as: failure to meet client satisfaction, low profit margins, focus only on price not quality, unpredictability of project delivery within time, and budget overruns. The challenge in achieving closer integration and collaboration - key features of SCM - has been majorly attributed to the traditional adversarial culture among project stakeholders (Akintan and Morledge 2013, Latham 1994, MohammadHasanzadeh *et al.* 2014, Ross 2011). To a large extent, this adversarial culture underpins business practices and relationship management, which are problematic for the advancement of collaborative working.

Adversarialism in construction supply chains

The prevalence of poor information sharing, disputes, and fragmentation in construction supply chains has been attributed to their adversarial culture (Akintan and Morledge 2013, Latham 1994, MohammadHasanzadeh *et al.* 2014, Ross 2011). For instance, Briscoe *et al.* (2001) argue that over the years, fragmentation – a consequence of the appointment of a large number of relatively small and disparate specialist contractors and suppliers for projects, with essentially arms-length relationships in place – has hindered the development of a unified approach to project delivery and team continuity between main contractors and key subcontractors. This is blamed for the low clients' satisfaction in traditionally procured projects (Xue *et al.* 2007). Other consequences of the adversarial culture include marginal use of collaborative technologies, poor joint-problem solving, difficulty in resolving claims, and a win-lose climate (Bishop *et al.* 2008, Chan *et al.* 2008). Hence, several studies and reports emphasise the need for a radical change in approaches towards construction supply chain relationships (Egan 1998, Latham 1994, Akintan and Morledge 2013, Pryke *et al.* 2014).

The adversarial culture inherent in UK construction supply chains is problematic principally to main contractor and subcontractor organisations. Main contractors' potential leading role and responsibilities in the delivery of projects have been widely acknowledged (Akintan and Morledge 2013, Clarke and Herrmann 2004). Hence, main contractors wield huge influence on the organisation of projects and the management of subcontractors' quality of work. Therefore, the inefficiencies and underperformance that are widespread in construction projects as a result of adversarial relationships and opportunism reflect the low SCM maturity of main contractors and their inability to play the essential role of supply chain managers. Furthermore, Kale and Arditi (2001) suggest that the quality of the relationship between main contractors and subcontractors influence the ability of main contractors to perform on projects, which inevitably has a direct impact on projects' outcomes. On the side of subcontractors, the scepticism and mistrust expressed towards collaborative working initiatives instigated by main contractors (Dainty *et al.* 2001) could simply reflect a lack of understanding of the implications of collaboration for all project participants and for the effectiveness of the overall project (Bygballe *et al.* 2010).

Nevertheless, it could be argued that adversarialism and opportunism in some situations appear as the appropriate relationship strategy to adopt. Prevailing economic conditions influence contractual partners to act – for very rational economic reasons – in more traditional, adversarial and exploitative ways (Bresnen and Marshall 2000, Pryke *et al.* 2014). Hence, collaboration is considered as the anomaly instead of adversarialism. However, these perspectives are driven by the narrower concern to simply reduce costs, or to pass costs and risks to those further down the project supply chain all in a bid to maximise profits (Bresnen and Marshall 2000, Dainty *et al.* 2001). In the face of such strong economic imperatives and well established traditions and interests, collaboration cannot offer an easy solution to the problems of adversarialism and opportunism inherent in the UK construction business environment. All the same, collaborative relationships could to a large extent inspire project stakeholders to work as a unified team, with more attention invested on optimal solutions that bring added value to the facility users, reliable steady profits for supply chain participants, and sustained whole-life performance to the clients.

A CRITICAL REVIEW OF SUPPLY CHAIN COLLABORATION

By definition, collaboration implies two or more independent organisations working jointly to plan and execute supply chain operations (Cao and Zhang 2010, Simatupang and Sridharan 2008), providing substantial benefits to the collaborating organisations. Potential benefits include high degrees of communication and integration between parties on a project, early involvement of key subcontractors (stakeholders) which improves articulation between the diverse phases of the project, effective platforms for inter-organisational and inter-project knowledge transfer and collective learning (Construction Excellence 2004), and increase in the propensity to develop trust (Kwon and Suh 2004). Overall cost of projects can be significantly reduced through good (collaborative) procurement practices in the UK (HM Government 2008).

There is a general view amongst project stakeholders that collaboration presents suitable ways towards overcoming problems and improving the overall performance of the construction industry. Regardless of the extensive interest and efforts to implement partnering initiatives culminating in collaborative working in the construction supply chains, there are suggestions that collaboration has no direct impact on project performance. For instance, a study by Nystrom (2007) shows no clear differences in project performance when comparing the performances of ten partnering projects with ten similar non-partnering ones. Nevertheless, Nystrom has not considered the implications of adopting robust ICTs such as BIM which is showing potentials for advancing collaborative working practices and improved performance in construction projects (Christian *et al.* 2011, Owen *et al.* 2013). There is therefore an understandable need to investigate how such technologies influence collaboration and project performance.

The basic principles of the collaboration concept found in the literature include: collaborative behaviour and attitude (Ha *et al.* 2011, Pusha and Mathew 2010, Soosay *et al.* 2008), collaborative culture (Barratt 2004, Kumar and Banejee 2014), and collaborative advantage (Cao and Zhang 2010, Cao and Zhang 2011, Vangen and Huxham 2006).

Collaborative behaviour and attitude

Collaborative behaviour and attitude refer to informal interactions described as embedded relationships, integration, strong ties, or strong coupling (Pusha and Mathew 2010). Such behaviours and attitudes are unstructured and are considered to have an affective nature of inter-departmental or inter-organisational relationships. Key examples of such behaviours and attitudes are informal communication (Pusha and Mathew 2010), and commitment to a win-win situation (Eriksson 2008). Channels for this type of communication are also informal in nature such as impromptu phone calls, chats, unstructured or informal emails, and contact without prior appointment (Pusha and Mathew 2010:442).

Informal communication facilitates the exchange of ideas, visions and innovative solutions (Cheng *et al.* 2000). This in turn would encourage partnering organisations on a project to jointly participate in planning and objectives setting. Consequently, individual organisations are able to deploy their cooperative efforts in order to generate common and compatible expectations in the project delivery. With such shared expectations in place, partners' commitment to the mutually generated objectives is easily achievable. Eriksson (2008) affirm that joint objectives facilitate the development of a win-win situation in which all project participants are striving

together to accomplish the same goals. Since attitudes and behaviours drive the development of a distinctive culture within organisations and industries at large, enhancement of collaborative behaviours and attitudes could positively influence the development of a collaborative culture.

Collaborative culture

A collaborative culture defines how individuals, teams, functions, and indeed organisations in a collaborative working arrangement act, share, and relate to each other (Kumar and Banerjee 2014). Therefore, a collaborative paradigm is important as it impacts on all aspects of collaborative working, without which higher levels of collaboration are unattainable.

Most frequently appearing elements of a collaborative culture found in the literature on supply chain collaboration can be summarised as: open communication, information sharing, joint decision making and trust (Ha *et al.* 2011:61). These basic elements assist collaborating supply chain members to create and sustain business environments necessary for working together and improving performance. However, it is pertinent to note that it is indeed a huge challenge to achieve cultural transformation within an organisation, *let alone* across organisations. Unlike variables such as structures and reward systems that can be manipulated to accomplish desired changes, this is not the case for cultural transformation (Beer *et al.* 1990).

Collaborative advantage

The predominant objectives for developing collaborative relationships and culture in a supply chain are to have the ability to execute business activities effectively at the least possible cost, enhance profitability for all participants, and deliver better value to the customer. Collaborative advantage relates to the strategic positioning achieved over the competition primarily through collaboration between supply chain participants. It is the synergistic benefits of collaborative working that would not have been achieved by any individual firm working alone (Vangen and Huxham 2003). Cao and Zhang (2011) posit that value delivery through collaboration could take the form of cost savings through the transfer of best practices. They conceptualise the idea of collaborative advantage into five sub-components which include: process efficiency, offering flexibility, business synergy, quality, and innovation. The expectation is that these will guarantee a competitive edge for and performance improvements in supply chains.

BIM AND ITS BASIC CHARACTERISTICS

BIM is a digital representation of the physical and functional characteristics of a facility; a shared knowledge resource for information about a facility that forms a reliable basis for decisions during its lifecycle (NBIMS 2013). Project stakeholders from diverse professions feed critical data and information into a single shared data environment. The outcome is a 3D coordinated and reliable design information and model that provides an understanding of the facility's behaviour prior to construction (Froese 2010). In order to enhance coordination and planning, there is scope for integrating time and cost data into 3D BIM i.e. 4D and 5D (Greeman 2011).

BIM adoption in the 'Sutter Health' project – a healthcare provider in California, United States - aided the integration of people, systems, business structures and practices into a process that collaboratively harnessed the ability of all stakeholders to mitigate waste and optimize efficiency at all phases of the project (Christian *et al.* 2011). Expecting similar outcomes, the UK Government initiated its BIM strategy

which mandates that all awarded contracts over £5M will require the supply chain members to work collaboratively using fully collaborative 3D BIM (Cabinet-Office 2011). However, challenges in implementing BIM in UK construction projects have been highlighted. Key issues include dealing with the resistance to change, and achieving the required integration and interoperability between the Structural and the Mechanical, Electrical and Plumbing (MEP) designers and engineers (for details, see Arayici *et al.* 2011).

Basic characteristics of BIM with potentials for construction supply chain collaboration include:

Communication and information sharing

BIM promotes rich information exchange and processing activities facilitated by cross-functional and cross-organisational communication. It offers platforms for improving communication and collaborative working with computer applications able to directly use and exchange building information (Arayici *et al.* 2011, Bryde *et al.* 2013, and Singh *et al.* 2011). In a sense, the increasing interest in BIM can be attributed to the development of new project management frameworks such as Integrated Project delivery (IPD), which depend on closer collaboration and effective communication (Eastman *et al.* 2011). Such levels of communication and information exchange are vital in the building of trust and emergence of collaborative behaviours (Ha *et al.* 2011, Kwon and Suh 2004).

Coordination and cooperation

Inter-organisational information systems offer possible approaches to manage integration, cooperation, and coordination challenges encountered in construction (Maunula 2008). So, with the multi-disciplinary collaborative working supported by the extensive use of BIM, effective resources allocation, and flow of materials and related information are achieved with much ease. Bryde *et al.* (2013) asserts that the coordination of complex project systems is perhaps the most popular application of BIM at present.

Joint decision making and problem solving

Considering the diversity of professions working together on a BIM-based project, the 3D BIM facilitates the management of all aspects of the composed model in a manner that any possible conflicts can be exposed and resolved while still in the planning phase of the project (Grilo and Jardim-Goncalves 2010). Consequently, it is possible to get the actual construction 'right at first time' thereby eliminating redesign and rework situations. This approach relies on the alignment of project activities through joint decision making and joint problem solving (Cao and Zhang 2010, Ramanathan *et al.* 2011, Simatupang and Sridharan 2005, Soosay *et al.* 2008).

Project data and information management

Often times, construction organisations rely on information provided by other project partners to progress their activities in the project delivery effort. Hence, it is required that such data and information be accurate, accessible, and available in formats that are compatible and inter-connected for interoperability. BIM holds integrated building information in a single repository ensuring consistency, accuracy and accessibility of data and information (Arayici 2008). Consequently, the potential benefits of BIM are delivered via the shared utilisation and value added creation of integrated data. This is considered as having interoperability, and is described as the seamless exchange and use of building data and information between multiple applications over any or all disciplines, and over any or all lifecycle phases of a building development (Arayici

2008). Therefore, regardless of the type of computer application used, data and information are mutually accessible by the discrete organisations working together on the project. This is achieved by the use of standard data exchange languages. Currently, the International Foundations Classes (IFC) published by the International Alliance for Interoperability (IAI) and city Geographic Markup Language (cityGML) is the only open global standard (Arayici 2008).

PROVISIONAL FINDINGS

The review so far suggests that the collapse of the traditional adversarial culture inherent in the UK construction industry could enhance the industry's overall performance and competitiveness. Research affirm that openness and trust which engender integration and a collaborative culture can be successfully achieved over a shorter time through formal processes, tools and techniques specifically engineered to achieve them (Brensnen and Marshall 2000, and Owen *et al.* 2013). Thus, in spite of the culture of distrust within the industry, early adoption of BIM is showing a collapse of traditional adversarial relationships, even in projects where there are no collaborative legal frameworks (Owen *et al.* 2013). This ongoing research therefore suggests a conceptual model which reflects the interaction between BIM characteristics and basic supply chain collaboration principles resulting in improved construction supply chain performance. Key elements and related variables essential for the design of the proposed model have been identified from literature, and are presented in Table 1.

Table 1: Elements and associated variables of the proposed conceptual model

Elements	Variables	Elements	Variables
Collaborative behaviour and attitude	Informal communication, commitment to a win-win situation	BIM	Coordination, cooperation
Collaborative culture	Information sharing, joint decision making, trust	Project data and information management	Integration, interoperability
Collaborative advantage	Innovation capabilities, process efficiency, flexibility offering, quality offering, business synergy		
Project supply chain performance	Cost reduction, lead/delivery time reduction, quality enhancement, revenue enhancement		

CONCLUSION

This paper has presented a brief review of the UK construction supply chains' adversarial culture and its adverse impact on the development of collaboration and performance. It is the view of this ongoing research project that successful BIM adoption will provide the much required drive towards collaborative working among construction supply chain members. It advocates that BIM use will have a significant positive association with the development of a collaborative culture culminating in improved construction supply chain performance. Therefore, it proposes a BIM-driven conceptual model; and through a review of relevant literature, has identified the key elements and variables required for the design of the proposed model. As contributions to the Construction Management discipline, this research will provide strategic approaches towards developing a collaborative culture in UK construction

supply chains, and a clear understanding of the relationship between BIM adoption, collaborative culture, and project supply chain performance.

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PARTNERING PRACTICES: AN INVESTIGATION OF INFLUENCES ON PROJECT SUCCESS

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Historically, traditional procurement systems have resulted in low levels of client satisfaction, owing mostly to poor cost and time predictability. Alternative approaches, including partnering and collaborative working have consequently been developed. This paper examines whether such collaborative approaches can deliver improvements in project procurement and management, and considers the extent to which partnering practices influence the success of building projects. Project success in this regard is measured in terms of cost predictability, programme implications, quality control, health and safety, risk management, teamwork and communications. A focus is made on the importance and influence of contractor selection processes within collaborative procurement, and what constitutes best practice in this regard. Exploratory interviews were conducted with a group of construction project managers who have had extensive experience with both collaboratively and traditionally procured construction projects. Coding and analysis of the resultant data indicated that collaborative procurement routes do have many advantages over traditional adversarial routes in most cases, but not all. Practitioners regarded the individuals deployed on projects having more influence on success than choice of procurement method. Projects were categorised as suitable or unsuitable for modern innovative procurement methods, dependent on a number of determining factors. There is support for the premise that partnering practices can potentially yield more benefits where projects are highly complex. Early supply chain involvement in design is required, and robust contractor selection processes are vital for collaborative procurement to be successful. Further research is proposed to expand the knowledge base around the range of suitable projects which may benefit from partnering approaches to procurement, in order to facilitate decisions in practice.

Keywords: collaboration, contractor selection, partnering, procurement.

INTRODUCTION

Perceived benefits of collaborative working could emanate from the early intervention of contractors, and include: early starts on sites, utilisation of contractors' management skills, buildability, contractors' procurement knowledge, supply chain knowledge, contractors' health and safety expertise, dispute avoidance, clients involvement in the procurement of subcontractors, reduced tender costs and improved team working between contractors and design teams (Latham 1994; Egan 1998; Tam 2000; Egan 2002; Hackett *et al* 2007). However some clients still consider that open and competitive procurement systems, that truly market test prices, are the only way to assure stakeholders of the lowest possible initial capital cost (Ross 2011); and in

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this economic context, 'partnering has not lived up to expectations' (Gadde and Dubois 2010).

Using value for money, quality, duration and cost predictability as key performance indicators, this study seeks to explore whether collaborative procurement routes deliver improvements and more successful outcomes for projects. Whilst there is a wealth of previous studies relating to partnering, this research is designed to be unique in specifically considering the importance and influence of contractor selection processes, barriers to successful implementation and the suitability of partnering for different project types.

LITERATURE REVIEW

Background to Partnering

The choice of procurement strategies on projects has long been a contentious issue within the construction industry. Banwell (1964) and Emerson (1962) outlined deficiencies within traditionally procurement methods and made recommendations for change, which included bridging the gap between design and construction and encouraging early contractor involvement in areas such as value management and buildability.

There is an argument that when companies enter into highly complex, uncertain and potentially risky projects as relative strangers, it is not surprising that in traditional procurement systems conflict and disputes frequently arise (Chan *et al.* 2004). Partnering, collaborative approaches and integrated teams seek to avoid conflict and disputes by increasing levels of co-operation and developing organisational relationships built on trust (Larsen 1997). It was thought that such early collaboration minimises disputes, reduces tender costs and improves team working practices (Egan 1998). Furthermore the benefits of collaboration have been argued to include an increase in profits brought about by sharing expertise, knowledge, ideas, innovation, best practice, and promoting efficiencies and improvements in decision making (Hansen and Nohria 2004). More recently, the Governments' Construction 2025 report "Industry Strategy: Government and Industry in Partnership" (HM Government 2013) emphasises the need for incentivising the extent and degree of collaboration on building projects, thus stimulating innovation and successful outcomes. The report also identifies low levels of innovation, low investment and uncertain demand as potential causes of limited collaboration and team integration. It finds that fractious qualities are embedded in the UK construction industry, emanating from low vertical integration and poor levels of design and management interface in the supply chain; thus limiting the scope for knowledge sharing across projects, hampering familiarisation and learning from experience.

Partnering has, however, attracted its critics and it is recognised that such collaborative approaches do not provide guaranteed mechanisms for successful projects (Marshall and Bresnen 2000). Morgan (2009), for instance, explains that on major capital projects, procurement routes that promote alliances and partnerships are not always appropriate and open to abuse owing to the scale of the commercial interests involved. Perhaps these perceived risks of abuse could explain why such collaborative working practices appear to be losing popularity in recent years (Challender *et al.* 2013).

The importance of the selection processes has been well documented in previous literature when using collaborative procurement strategies to enable the appointment

of the most appropriate contractors; thus permitting the realisation of benefits of partnering through pro-activity, building team spirit, lateral thinking and exploring alternatives (The National Joint Consultative Committee 1996; Critchlow 1998; Government Procurement Group 1999). More recently the Governments' Construction 2025 report (HM Government 2013) reinforces this view and advocates that selection processes should carefully evaluate contractors' experience, skills, resources and expertise rather than simply appointing contractors on lowest tender price.

METHODOLOGY

Explorative in-depth semi-structured interviews (Gillham 2005) were held with six construction project managers from both contracting and professional consulting backgrounds in the Northwest of England from late 2012 to early 2013. This was intended as a sample of convenience and only project managers who could demonstrate considerable experience in partnering were included. This size of sample does not indicate universal findings but does provide insight into the perceptions of those construction professionals working in partnering arrangements.

A qualitative analytical approach was used to explore key themes, understandings and attitudes of those who work within this environment on a daily basis (Flick 2009). In order to obtain feedback on the data collection tool, and tease out any difficulties with the way it was designed and administered an initial pilot study was implemented.

The interviews were digitally recorded, transcribed verbatim and subsequently coded and sorted (Silverman 2001; Langdrige 2005). Examples of the main qualitative codes included contractor selection process, potential barriers to collaborative working, value for money and quality control. The raw data was then summarised in tables; codes were listed, themes developed, content analysis data presented, key literature sources identified, data consistencies and inconsistencies noted and propositions made (Taylor and Bogdan 1998). The table became a plan to develop a narrative to construct a contemporary picture of partnering and those influences on its success.

FINDINGS AND DISCUSSION

Although partnering can potentially create a less antagonistic and stressful working environment, facilitating better individual performance, and arguably better team and project performance according to the review of literature, it is still met with some scepticism from some of the construction professionals interviewed. Suspicion of realisable benefits has emerged from the research accordingly. For example, cost savings for clients from collaborative working are perceived by some of those interviewed as being exaggerated over time and certainly have not been realised on all projects. Whilst shared ethos built upon trust between partners is supported theoretically, according to those interviewed, rarely is there realisation in practice. Whilst the project managers found partnering can facilitate successful projects in some instances the study also uncovered negative experiences in sharing information, inequitable working relationships and prompt payment initiatives, leading to organisational mistrust in some extreme cases. Table 1 summarises the study findings based on similarities and inconsistencies with data from the review of literature and the narrative below offers potential explanations for these.

Table 1: *Qualitative themes and data analysis*

Qualitative Themes	Literature Source	Observation, Proposition or Explanation	Data Inconsistencies	Data Similarities
Measurable Project Outcomes: Cost Predictability Reduced Programme Quality Control	Latham (1994) HM Government (2013) Egan(1998) Hacket et al (2013) Ross (2011)	Value engineering from early contractor input could lower construction costs, especially on large complex projects. Collaboration can increase fitness for purpose and client satisfaction.	Partnering can in some cases result in higher tender costs through less competition. Cost savings over exaggerated in the past. Project partnering less effective than strategic partnering.	Greater familiarity with clients requirements Lower tender prices. Potential cost savings and shorter programme timescales.
Teamwork	Latham (1994) Egan (1998) Chan et al (2004)	Change of culture to partnering will increase fairness, teamwork and performance.	Choice of team more important than procurement route. Less scope on smaller projects.	Partnering can instil improved teamwork, job satisfaction and more effective relationships.
Client/Contractor Interface	Erikson et al (2010) Thurajah et al (2006)	Selection of contractor paramount to client/contractor interface and overall project success	Collaboration can occur naturally outside partnering arrangements.	Robust selection processes to choose right partnering contractor for the project is critical.
Project Risks	Walker (2009) Marshall and Bresnen (2000)	Mitigation of project risks through early contractor dialogue/interface.	Reliance on trust could increase commercial risks in some cases.	Health and safety risks can be potentially 'designed out' through contractor's expertise.
Working Relationships	Critchlow (1998) Larsen (1997)	Reduced conflict and less emphasis on commercial approaches.	Blame culture may still exist if partners are not fully committed to collaboration. Partners may still not wish to share commercially sensitive information.	Confrontation is reduced and claims can be more effectively managed. Partnering provides to right context for building longer term relationships.
Importance and Reliance on Trust	Larsen (1997) Thurajah et al. (2006) Cheung et al (2001)	More trusting relationships under partnering can improve communication, cooperation and problem solving.	Trust is equally important in traditional arrangements. Inequitable working relationships compromise trust.	Trust enhances collaboration and bonds teams together. Closer working relationships can provide right context for trust.

Construction Cost Predictability, Value for Money and Client Risk

Most of the practitioners did support the some of the findings of Egan (1998) and Latham (1994) on improved cost predictability in partnering practices, which may

partly stem from establishing clients' requirements more comprehensively, especially at tender stage. They believed that early design intervention introducing innovation and considering alternative design options at the outset could potentially give rise to considerable cost savings in some cases but not all. Certainly on smaller scale projects of less than £5million they felt that potential reports of significant cost savings had become exaggerated over time. However, practitioners did concede that there is greater scope for value engineering on larger and more complex projects where, for example, specialist supply chain advice on sophisticated and specialist mechanical and electrical installations or working within live environments is required at an early stage. Another example was given by one of the project managers who referred to a new cladding system being introduced on a large high rise office project where potentially high costs associated with increased health and safety risks were prevalent. Recommendations provided by the specialist subcontractor on this project brought buildability benefits and associated cost savings.

There was a belief from those interviewed that collaborative processes in partnering arrangements can potentially provide more effective open book mechanisms for developing final contract sums with contractors, to ensure that tendering processes are fully transparent, fair and appropriate in most cases. They outlined that there are still too many instances of contractors in traditional contracts inflating the value of claims for variations. For this reason collaborative working under partnering may offer an alternative procurement route in managing such claims to lessen risks of overspend and potential contractual disputes. In this way commercial issues could possibly be identified earlier and addressed accordingly to avoid potential delays and protracted disputes through early dialogue and communication.

Some of the interviewees did, however, not share previously positive views of the other project managers and reported that collaborative working has been tainted by inequitable working arrangements which potentially give little or no benefits to partnering organisations. In some cases, anecdotal evidence was presented of organisations that suffered financially under partnering and such reports could reinforce fears and anxieties over risks within the industry, promoting a reluctance to move away from traditional working methods. Arguably this disparity of power between clients and other organisations may have allowed the former to use the power derived from scarcity of work in the construction sector to use a 'take it or leave it approach' and potentially to intimidate contractors into accepting unfair returns under the banner of a collaborative arrangement. The temptation to abuse power by construction clients to secure gains at the expense of others, appears to possibly have become too much to resist in some cases. The project managers felt that such a shift in philosophy during operational partnering frameworks, renders organisations highly vulnerable to exploitation as they are virtually held to ransom; to accept revised or reduced terms, or be cast back into 'the other' competitive cut-throat market place. Such exploitation through partnering frameworks may increase the risk of this procurement option, reducing its attractiveness and contributing to a reduction in willing partners. Other concerns emerged from the study including the potential fears or unwillingness of partners to share information that could be regarded as commercially sensitive in some cases.

Programme Timescales and Quality Control

The construction project managers generally agreed that specialist input and value engineered solutions at an early stage could shorten pre-tender periods whilst

enhancing quality control and greater client satisfaction. They also concurred with Walker (2009) and Erikson *et al* (2010) that procurement routes should be tailored to the nature of projects especially with the growing trend for more demanding deadlines and project outcomes in recent years where traditional procurement routes may be deemed less effective and unsuitable. Views were also presented that partnering could be more successful than traditional procurement routes where health and safety issues on projects represent greater risks to programme and quality. This was explained through the intervention of contractors at preliminary design stages with the associated benefits of early dialogue to address and overcome such issues.

The project managers reported that partnering on longer projects, which potentially involve sophisticated and challenging phasing and programming to best suit specific employer's requirements, could potentially offer more scope than traditional procurement routes in reducing overall project durations. This was explained in terms of enhanced teamwork and contractors working alongside clients with common objectives to achieve phased handover dates; especially when working within live building environments, where disruption to the overall end-users' operations is a key issue. In this way they concurred that construction programme timescales could possibly be improved at the early design stages by working with contractors to specify the most suitable and conducive materials and construction techniques to suit the nature of projects. Furthermore through improved team integration they considered that partnering has the potential to raise levels of quality and performance through reduced conflict, allow more efficient deployment of resources, increase job satisfaction and facilitate fewer defects on completion.

Suitability to Different Types of Building Project; Complexity and Specialism

The project managers concluded that partnering is best suited to large or complex projects where, in the early stages especially, the expertise of contractors in value engineering and project logistics would be extremely beneficial. As an example, one of the project managers interviewed referred to a refurbishment scheme on a museum which incorporated a sophisticated and complex mechanical and electrical installation. It was explained that the building services were designed around the specialist's requirements for a technologically advanced building management system. For this reason, partnering presented the most appropriate and suitable option to ensure that early interfaces of specialists' expertise were introduced early in the life of that particular project. Conversely where projects are less complicated the project managers deduced that benefits from partnering may be significantly reduced, since early contractors' specialist advice may represent essential rather than desirable inputs. This tends to confirm findings from Hackett *et al* (2007) and Egan (1998) that for some simpler projects, collaborative procurement routes may not be a suitable option, particularly where contractors and subcontractor's expertise and inputs in the early design are less critical.

The duration of projects may also have some influence over the success of partnering in practice. For instance one of the practitioners advised that shorter projects do not facilitate enough time to build strong working relationships and for partners to become familiar with each other's ways of working. Furthermore there was a view that more controlled financial management on projects through partnering and collaborative working could be achieved on projects with longer contract durations. The explanation for this was that longer projects can give rise to more variations as clients' requirements change over time and partnering can facilitate more cost effective

solutions than under traditionally procured contracts accordingly. One practitioner also suggested that longer projects provide more time for reflection on alternative building systems and ways of working which could provide the most suitable context for value engineering. It was also felt that when managing clusters of many projects of short duration strategic partnering may be more desirable than project partnering, as trust can be generated within encouraging contexts, where the developmental nature of this collaborative process aligns with the long-term vision of integrated teams.

Importance of the Contractor Selection Process and Appointing a 'Trustworthy Partner'

A surprising outcome to the research is the suggestion that the choice of contractors and the individuals deployed on projects was felt by the project managers to be more important than the choice of procurement routes. This clearly needs more testing and validation since it seems to contradict certain aspects of Egan (1998) and Latham (1994). It can perhaps be explained through the sense of teamwork that can be maximised, from having the right team members appointed on projects and the benefits that emanate from this. They also reiterated that traditionally procured projects have had extremely successful results from teamwork even though contractors may have had little influence on the design processes. For this reason trust between the team members was regarded by the practitioners as a major key factor irrespective of the nature and particulars of projects and procurement routes. Notwithstanding this, the study suggests that having the right contractor on board is more crucial in partnering arrangements, owing to teamwork and shared philosophies, than in more traditional procurement routes. Perhaps this indicates therefore that the quality of collaboration can be reinforced or weakened, depending on the behaviour, approaches and attitudes of organisations and individual participants. Clearly the contractor selection process is important in terms of evaluating these criteria, alongside expertise, experience and specialism, in choosing the right partner. The study also found that the selection process should incorporate robust selection criteria, interviewing, short listing, and quality assurances measures to ensure that the resources and specialism of contractors are suitable for the project. They all concurred that having the wrong contractors on board especially at early design stages could severely jeopardise the success of projects. One practitioner felt that, in partnering, having 'aligned cultural synergies' was one of the most important criteria to evaluate in this regard and concurred that 'if organisations and individuals working within partnering agreements are not working as one collective project team or committed to the same beliefs, values and objectives then such projects will be severely compromised from the start.' This again demonstrates the importance and reliance on choice of suitable contractors for the benefits of partnering to be realised fully.

The interviewees all agreed that a 'culture' of trust allows projects to move forward effectively, and creates an environment where problems can be shared and therefore solved more easily. In this regard, they believe that trust is not something that can be engineered through contractual conditions, nor through procurement routes alone, but needs to be developed, built up and earned over time. Notwithstanding this, they concurred that where trust is compromised, this could lead to a downward cycle of trust where working relationships may become untenable. The study also highlighted the belief from those interviewed that the perceived return to short-term contracts and the constant quest for lowest initial bid price perhaps could be jeopardising the development of trust between organisations. However, where long-term organisational

collaboration is a potential future work-stream, the development of trust within such relationships may become 'incentivised' and consequently active in practice.

The study suggests that possibly the strength of trust is more dependent on individual personal relationships, developed from mutual respect, rather than simply 'good' working relationships. According to those interviewed trust generated from previous relationships and dealings between individuals at senior levels is regarded as critical in the cascading of trust throughout organisations, and between those currently operating partnering arrangements. Not surprisingly at an operational level, 'human' factors such as integrity, honesty, consistency, reliability and competency are regarded as important in facilitating trust and good collaborative working. Such factors are suggested by Thuraumarah *et al* (2006) and Coulson-Thomas (2005) and confirmed by the interviewees, to be vital for the greater integration of project teams. Yet, hard factors are also put forward by those interviewed as crucial in the partnering process: experience, technical ability, education and competence of individuals, management systems, resources, and commitment of the organisations.

CONCLUSIONS

There is an overriding consensus of opinion in the study that partnering can certainly bring about improved cost certainty, reduced project durations, improvements in quality of build and benefits to project management and construction innovation in some contexts but not all. The project managers strongly felt that assessing the suitability of projects to partnering is critical to realising the potential benefits in practice. Certainly on very complex projects it was generally accepted that the early intervention of contractors, subcontractors and suppliers through partnering was essential in many cases to encourage project success where more traditional forms of contract, based on separation of design and construction may be mostly unsuitable. It was found that other less tangible and softer outcomes that could be used as key performance indicators to measure success of a given project through partnering arrangements. These include motivation, teambuilding, trust and respect and were felt to be more likely to be generated through partnering and creating the right environment for successful projects. Perhaps the most surprising outcome from this study is that the practitioners regarded the individuals deployed on projects having more influence on success than the choices of partnering per se. They believe that both traditional and collaborative procurement could both produce successful outcomes provided that the right individuals are employed, with suitable experience, expertise, motivation and proactive attitudes to team working.

The study clearly highlights barriers to successful implementation of partnering including factors related to fairness, cooperation and sharing information. Perhaps BIM as a management tool in encouraging greater collaboration could assist in changing the culture of the UK construction industry and facilitate integration across the whole supply chain to address perceived deficiencies.

Certain elements of best practices for partnering have been highlighted in this study. These include ensuring that the nature of the project and partnering are appropriately matched as a test of suitability and compatibility and choosing the most suitable contractors through a robust selection process. This will then hopefully ensure the right choice of partners who are committed to 'the spirit of partnering' and not just those individuals and organisations that 'pay lip service' to its philosophies and values. Without this commitment it was felt that partners will feel propelled to 'collaborate' by

the terms of the contract only which could risk reversion back to old traditional adversarial behaviours.

One of the limitations of this study is clearly that it was based on a very small sample of interviewees. This has reduced the reliability and validity of the study and the study findings clearly are not representative of the population at large accordingly. This study is related to the early stages of a PhD and it is intended that further qualitative work with a larger sample and broader range of experienced construction professionals may need to be undertaken to interpret existing data more effectively.

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THE IMPACT OF SUPPLIER DEVELOPMENT INITIATIVES ON KEY PERFORMANCE INDICATORS

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It is frequently posited that supplier development and long term partnerships are an effective way of gaining a competitive edge. However, due to the lack of regularity in demand patterns in project based industries, some researchers have questioned the effectiveness of such initiatives. Exploiting a unique and interesting longitudinal dataset gathered from a global construction company's archival records, the aim of this paper is to analyse the impact of supplier development initiatives on Key Performance Indicators (KPIs). Supplier KPIs, recorded on a database, are analysed for a range of suppliers from the 1990s to 2013. Suppliers are organised into relational categories for the analysis, including 'long term strategic partners', 'some partnerships arrangements' and 'little partnership arrangements'. The highest performing group was the long term strategic partners, in both average performance scores and the consistency of those scores. We also conclude that suppliers with limited partnering arrangements perform less well on the project 'close out' KPI.

Keywords: supplier development, performance measure, relationship, supply chain management.

INTRODUCTION

Japanese approaches have had a large impact on how many firms consider the role of suppliers. This includes the rationalisation of the supply base to focus on a number of closer partnerships ([Lamming, 1993](#); [Liker and Wu, 2000](#)), a movement away from price-based criteria to other performance criteria ([van Weele, 2010](#)), and a focus on active development of suppliers ([Krause et al., 2007](#); [Modi and Mabert, 2007](#)). Much has also been written on the design and implementation of performance measurement systems to support such shifts ([Neely et al., 1995](#); [Simpson et al., 2002](#)). The extent to which all these approaches are capable of being directly transferred to construction organisations is an on-going source of debate ([Briscoe and Dainty, 2005](#); [Fernie and Tennant, 2013](#); [Kagioglou et al., 2001](#); [O'Brian et al., 2009](#)).

Technological and societal trends have also led to an increasing awareness of the potential for governments and organizations to collect, analyse and act on large datasets. Boyd and Crawford ([2012](#)) note that the era of 'Big Data' is underway. They further note that while such an era offers unprecedented opportunities, there are a number of assumptions and potential biases that must be considered in a critical way. We must take a more considered approach before taking the 'leap of faith' in big data.

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Retailers such as Tesco, Walmart and Amazon are often cited as pioneers of 'analytics', whereby they collect and analyse masses of data from customers and suppliers in order to learn more about their markets and manage their operations more effectively ([Davenport and Harris, 2013](#)). Examples from the construction sector are much less forthcoming.

Integrating the threads of supplier development, supplier performance measurement and 'big data' together, this paper exploits a unique and interesting longitudinal performance dataset gathered from a global construction company's archival records. The aim is to analyse the impact of supplier development initiatives on Key Performance Indicators (KPIs). In doing so, we provide some critical discussion of the challenges involved in collecting, analysing, interpreting and using such data.

LITERATURE REVIEW

Supplier Development and Portfolio Models

A range of studies have bemoaned the lack of progress with respect to supply chain management in the construction industry ([Akintoye et al., 2000](#); [Barker and Naim, 2008](#); [Briscoe and Dainty, 2005](#)), and a recent article suggests that the diffusion can at best be described as 'non adoption' ([Fernie and Tennant, 2013](#)). It is likely that a range of structural and cultural problems make the direct application of such approaches difficult ([Dubois and Gadde, 2002](#)). Numerous studies have reported the use of preferred supplier arrangements, framework agreements and approved lists ([Gosling et al., 2010](#); [Tennant and Fernie, 2012](#); [Thorpe et al., 2003](#)). Such models have much in common with the portfolio management models proposed in purchasing literature. The premise of portfolio models is that organisations should and can manage an array of supplier relationships, each serving different needs ([Kraljic, 1983](#); [Wagner and Johnson, 2004](#)). An underlying assumption is that partnership activity has the potential to minimize the destructive potential of conflict, and leverage the respective strengths of the partners ([Spekman, 1988](#)).

Table 1 offers an overview of a range of categorisation for partnership types. Most describe a scale of relationships spanning from loose, 'arms-length' relationships to close partnerships. This links with notions of discrete and relational exchanges in relational contracting theory, whereby one time spot interactions are treated very differently to ongoing interactions ([Cox, 1996](#); [Wagner and Boutellier, 2002](#)). Presenting relationships as a spectrum or continuum promotes the view that a healthy 'balance' across partnerships categories is effective ([Gosling et al., 2010](#)). The movement to develop and maintain strategic partnerships is not without critique though, and it has been noted that many companies mishandle them, and do not have the strategic thinking and management capabilities do make them work ([van Weele, 2010](#); [Wagner and Boutellier, 2002](#)). van Weele (2010) refers to 'the myth of partnership' and argues that successful partnerships are quite rare and are often the result of "muddling through, disappointments and perseverance" (p222).

Within the construction management literature, a range of barriers have been discussed in relation to the attainment of close partnership arrangements. Such barriers include the scepticism over the motives behind supply chain management practices by SMEs ([Dainty et al., 2001](#)), fragmentation and structural issues within the construction industry ([Dubois and Gadde, 2002](#)), power relationships and regimes ([Fernie and Tennant, 2013](#)), as well as the nature and regularity of demand patterns ([Gosling and Naim, 2009](#); [Ireland, 2004](#)). Effective partnerships, it appears, are far

from assured. Despite the aforementioned critique, recognition that suppliers play a crucial part in the production systems, and that they can be actively managed and improved, has a long history ([Leenders, 1966](#)). Efforts in this area are often termed 'supplier development', which has been defined as any effort by an industrial buying firm to improve the performance or capability of its suppliers ([Krause, 1999](#)). In subsequent work ([Krause et al., 2007](#); [Krause et al., 2000](#)), which has been developed by Modi and Mabert ([2007](#)), four supplier development strategies have been shown to be effective:

- Competitive Pressure. The use of market forces and benchmarking (e.g. multiple sourcing)
- Evaluation and Certification Systems. Management of the current and expected performance through evaluation and feedback (e.g. supplier scorecards).
- Incentives. Motivating desired performance through incentive schemes (e.g. awards).
- Direct Involvement. Proactive approaches through direct means (e.g. financial or human investment) ([Adapted from Modi and Mabert, 2007](#))

Table 1: Comparison of Partnership Types from different sources

Cox (1996)	Lysons and Farrington (adapted from Johnson 1997)	Gosling et al. 2010	Wagner and Boutellier 2002
Adversarial	Competitive Leverage	Approved	Arm's length
Preferred	Preferred Suppliers	Preferred	
Single Sourcing	Performance Partnerships		Partnership
Network Sourcing			
Strategic Alliances	Strategic Alliances	Strategic Partnerships	Strategic Partnership
Internal, mergers, acquisitions	Co-business Integration		

Measuring supplier performance

As outlined in the foregoing section, the growing emphasis on the development of strategic partners has led researchers to consider the role of supplier evaluation and performance measurement. Tan *et al.* ([1999](#)) indicate that regular assessment of suppliers is positively related to a range of competitive dimensions. Despite this, Simpson *et al.* ([2002](#)) found that a surprising 45% of firms, across a range of industries, had no formal method in place for evaluating suppliers. Carter ([1995](#)) outlines the seven C's as a guide to supplier evaluation, which are competency, capacity, commitment, control systems, cash resources, cost and consistency. Popular purchasing textbooks give further general guidance in this area ([Lysons and Farrington, 2012](#); [van Weele, 2010](#)), but there appears to be no agreed standard protocol as to what to measure, and the ideal frequency of measurement.

Construction companies have, typically, focused on measuring client objectives on cost, time and quality for individual projects ([Dainty et al., 2003](#); [Ward et al., 1991](#)). A number of authors have noted that such traditional measures of the construction

project are insufficient, and have argued that the scope should be extended to different areas ([Dainty et al., 2003](#); [Kagioglou et al., 2001](#)). Wegelius-Lehtonen (2001) argued that the focus of measurement for construction companies could be at three levels. The first relates to the general environment and their own performance at company level, the second level relates to individual project performance, and the third is concerned with subcontractors and suppliers. This paper is primarily concerned with the latter category.

THE PERFORMANCE DATASET AND CASE CONTEXT

This paper interrogates a comprehensive data set gathered from a global construction company's archival records and reports the analysis of historical performance data of the case company's supply base. The archive includes supplier performance data from 1990 to the present. The company was formed in 1990, and has maintained growth, even during the recession, and has won a range of awards relating to its supply chain practices. The company operates in a range of sectors, but has been particularly successful in managing the construction of iconic and headquarter commercial offices. The data relates specifically to this sector. Before the dataset is described and analysed, it is important to outline how performance of suppliers is undertaken at the case company. Project teams assign measurement scores across a number of different KPIs when a supplier has completed their contribution to a particular project, which is written up as a report allowing space for qualitative commentary. Performance may be graded 0, 1, 2 or 3 where the latter represents the highest score. The different KPIs are as follows:

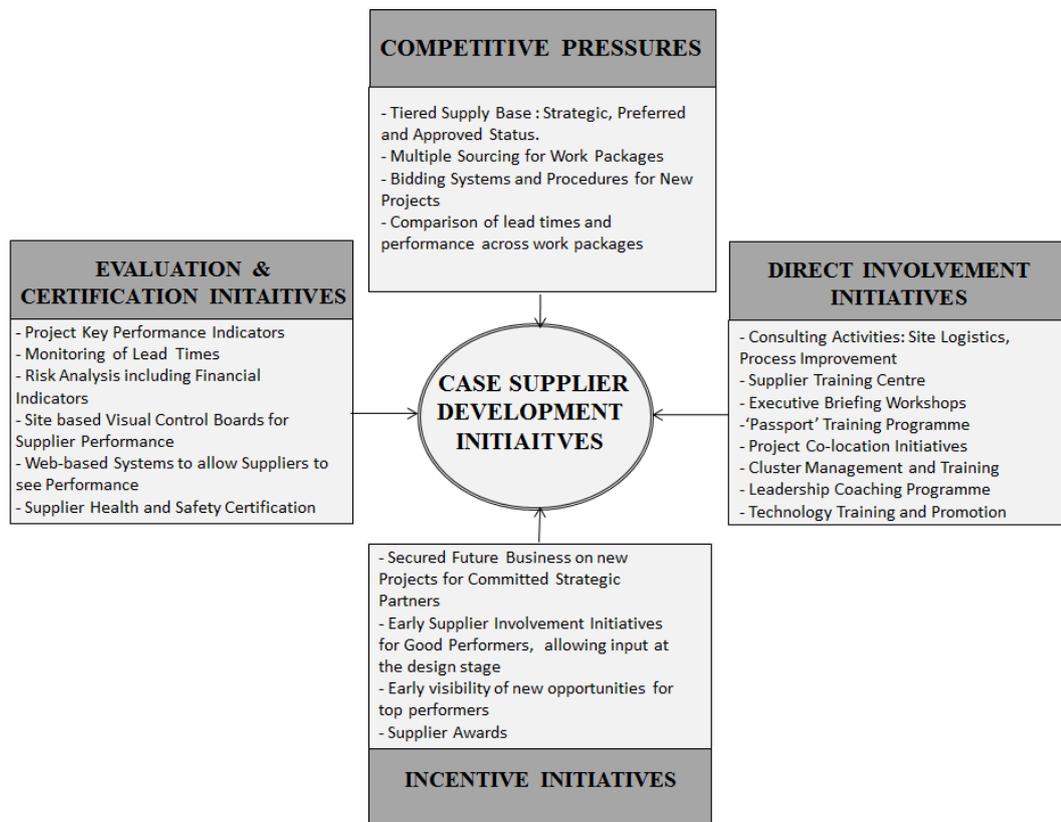
- Health and Safety - Based on adherence to documentation and work place standards, communication standards and accident records
- Programme - Based on reliability and presentation of programmes, as well as achieving programme goals.
- Financial - Based on attitude towards change instructions, presentation of accounts and timeliness for settling accounts
- Quality - Based on workmanship, defects and snagging records
- Design - Based on completeness in relation to programme, buildability, interface management and change management.
- Management - Based on organisation/supervision on site, communication and exchange of information, proactive motivation and attitude, as well as progress reports.
- Close out - Timely completion of work, management of final accounts, management of issues raised at completion.

Once reports are received by the project team, they are uploaded to a bespoke system and expressed as a percentage score. Suppliers are then able to log on to the system and observe performance figures and trends for all projects that they have contributed to. It should be noted that this is only one part of the company's performance management system, and we will return to critique the process of measurement in the discussion section, as this is important for appreciating the limitations of the study. In total, there are 98 suppliers included in the database and, since 1990, these suppliers have made 1334 contributions to various projects.

ANALYSIS OF SUPPLIER DEVELOPMENT INITIATIVES AND PARTNERSHIP TYPES

The initiatives are pertinent to the dataset depending on the partnership category employed. Direct involvement initiatives are more likely to be undertaken with close or strategic partnerships, incentive and evaluation initiatives are more focused on intermediate partnership types (e.g. preferred suppliers) and competitive pressures are aimed at more transactional relationships (e.g. approved suppliers). Hence, strategic partners receive training of various types, benefit from consulting expertise and may be offered co-location opportunities. Approved suppliers are much more likely to experience pressures of competitive bidding and rigorous benchmarking and comparison.

Figure 1: Supplier Development Initiatives at the Case Company



In order to explore the impact of supplier development initiatives, suppliers were categorised into three groups. The first type would have been vetted in terms of health and safety, as well as with references and financial checks. No direct investment is made with this category. The second type is classed as 'some partnership arrangements'. This group acknowledges that the realities of partnering are very often complicated, especially in a longitudinal setting where suppliers can float in and out of different relationship categories at different points, and can result in 'relationship strength–performance spirals' (Autry and Golicic, 2010). To qualify as part of this category, suppliers must have been listed as a strategic supplier at some point within the history of the dataset. The third type is classed as long term strategic partners. These suppliers are listed as strategic partners for at least 5 years. Table 2 shows that the number of suppliers for the different types are 52, 33 and 13 respectively. Long term partners have completed many more projects, on average, than other groups at just over 26, while suppliers with little partnerships arrangements average just under 8

projects. Table 3 shows the general sectors of suppliers within the database, and also gives a breakdown of the partnership types within these general sectors.

Table 2: Summary of data for different partnership types

Partnership Type	Average Number of Projects Completed per Supplier	No of Suppliers
1 - Little Partnership Arrangements	26.54	52
2 – Some Partnership Arrangement	17.55	33
3 – Long Term Strategic Partner	7.88	13

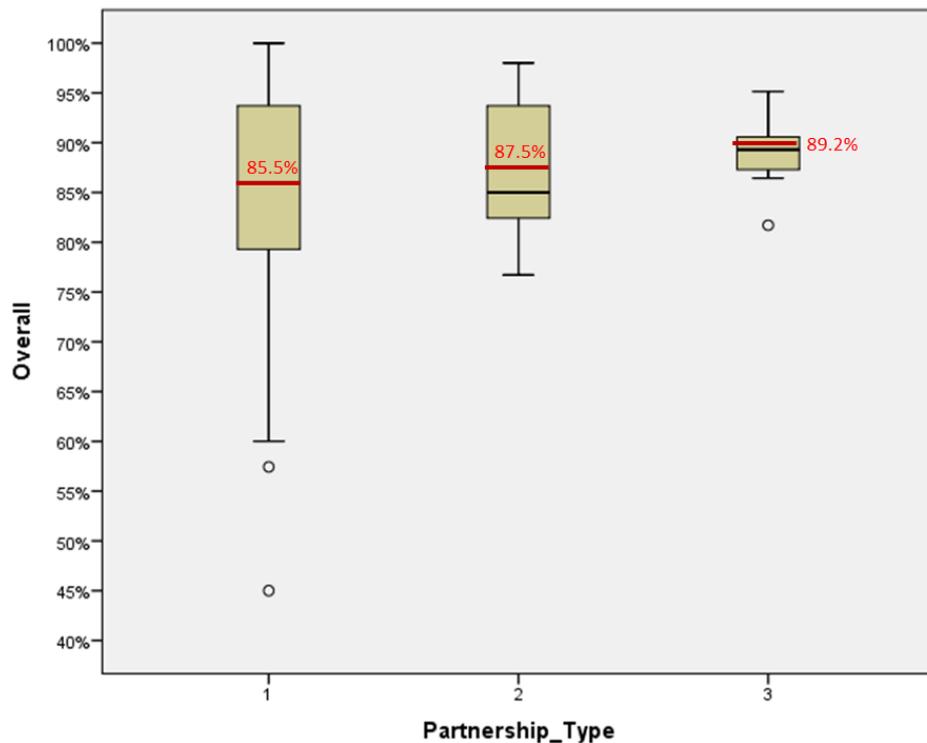
Table 3: Overview of sectors in the database with breakdown of partnership types

Sector	Total	Type	Type	Type
		1	2	3
Building Completion / Finalisation	35	21	12	2
Mechanical / Electrical / Installation Activities	28	9	14	5
Structural Works	20	12	5	3
Demolition / Site Preparation / Groundworks	9	7	1	1
Support / Specialist Service	6	3	1	2
Total	98	52	33	13

ANALYSIS OF PERFORMANCE MEASURES

The link between performance and partnerships has been analysed in a number of papers ([Krause et al., 2007](#); [Modi and Mabert, 2007](#); [Tan et al., 1999](#)), and based on these studies we would expect a higher average, and more consistent performance as the tighter the partnership becomes. The analysis begins with an overview of the total mean performance, giving a single figure for each supplier across all projects and metrics. A box plot for this is shown in Figure 2, where the mean score for each partnership types is indicated via the red line. The box plot shows that group 3, long term strategic partners, are more consistent in terms of the range of performance measures. Partnership type 1 suppliers have a much greater range of performance. Strategic partners median and mean are slightly higher than the other groups. The top performing supplier is a fit out and finishing subcontractor specialising in decorative and protective coatings services including general decoration, spray applied finishes, protective and hygienic coatings and special paint effects. The supplier averages 95.14% across the range of KPIs, and has contributed to 37 different projects. The supplier has also undertaken continuous training initiatives with the case company, and joint investment has been made in new paint systems and technologies.

Figure 2: Box plot comparison for the three different partnerships types

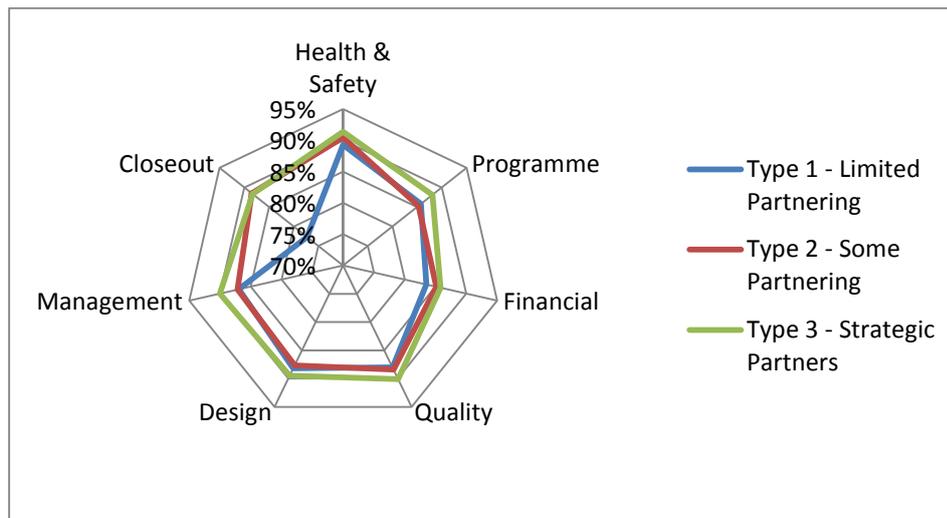


While Figure 2 gives a broad overview of performance for the three partnership types, it does not give insight into individual measures. Figure 3 presents a radar plot for mean scores of the different partnership types across each of the different individual KPIs. It shows that type 3, long term strategic partners outperform on all individual KPIs apart from close out, where they are equal with type 2 suppliers. Type 3 suppliers perform slightly worse than type 2 on financial and much worse on close out. The poor performance of type 1 suppliers on the close out measure presents an interesting discussion point. This could be the result of a lack of understanding of processes and standards creating a build-up of snags and outstanding issues creating difficulties during the final stages. Furthermore, if there is no loyalty or certainty of future work between parties, there may be less incentive and leverage to ensure issues are 'closed out' effectively.

DISCUSSION

Before the findings are discussed in more depth, it is important to critique some of the characteristics of the dataset analysed. Firstly, the timing and frequency of measurement where Simpson *et al.* (2002) report a wide range of practice in this respect. They note that some buying organisations measure suppliers regularly while others only do so on an annual basis. In our construction case, suppliers are evaluated after their input on a particular project. It should be noted that this approach has been criticised as being a 'lagging' measure (Kagioglou *et al.*, 2001), which has limited ability to feed-forward into project improvements. The case company does operate monthly KPI figures with Type 1 suppliers in order to complement project measures, which is an area for investigation in the future.

Figure 3: Spider plot to show performance across different categories and specific KPIs



A further area for discussion is the relative importance of different KPIs. In the analysis presented the measures are considered as equally important. The case company has considered at length the possibility that individual KPIs may have different significance to the overall performance of a project. They concluded that projects present many different scenarios, potentially requiring different weightings for the range of KPIs. This brings to the fore the difficulties of a one size fits all model for constructions projects. Simpson *et al.* (2002) found that the majority of buying companies considered quality to be the most important of the measures. Another important issue that has been highlighted in the literature is the level of inclusion of different parties within the supplier measurement process. It is possible that the buying organisation may undertake evaluations alone, the supplier may undertake the evaluation alone, or that it may be done jointly. Simpson *et al.* (2002) reported that only 19% of companies in the sample included both parties (buyer and supplier) in the measurement process. In this case, rankings were assigned by project teams without supplier involvement, although feedback meetings are intended to be collaborative, and suppliers have access to the performance data through a web system. This also raises the issue of consistency between project teams when performing ratings.

CONCLUSION

The findings suggest that groups of suppliers in close partnership types have higher average performance scores, and the spread or range of performance scores decreases, giving more consistency from project to project. We also conclude that suppliers with limited partnering arrangements perform less well on the 'close out' KPI. Through the analysis and exploration of a longitudinal dataset, the paper supports literature linking supplier development initiatives with improved performance, and offers some encouragement for other construction organizations embarking on their own supplier development programmes. In doing so, we also present critique of a performance measurement system for suppliers, giving insight into some of the challenges of collecting and managing such a system. These findings add to the debate in relation to the use of collaborative partnerships in the construction industry. Hopefully, the findings also encourage other researchers to seek insight through the analysis of big data collected from an empirical setting. There are a number of limitations. It is unclear if supplier development initiatives are effective beyond the boundaries of the case and sector in question (i.e. commercial buildings). Furthermore, the significance

of the performance differences between different partnership types needs further analysis.

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AN IMPROVEMENT STRATEGY FOR THE DEFECTS AND REWORK MANAGEMENT PROCESS WITHIN AN SME: AN ACTION RESEARCH APPROACH

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Irish construction reported strong growth towards the end of 2013, after years of industry recession. Following a property led economic collapse which started in 2007 construction output fell by circa eighty percent. Many construction companies went out of business; those remaining are strongly focused on their bottom line and increasing efficiency to ensure survival. Defects and rework, common in construction, are both wasteful and a cost that can be avoided, thus presenting an obvious target for improvement. A regional SME main contractor collaborated on a project to improve the efficiency of their current processes for the identification, management and elimination of defects and rework in their supply chain. An action research strategy was employed on several field projects, to investigate the problems faced by the company in this area and to develop an improvement plan. Action research involves a five stage problem solving cycle (1) problem diagnosing; (2) action planning; (3) action taking; (4) evaluation of results; (5) specification of learning. Action planning elements emerging from the cycle (at stage 2) are presented here. They are very wide ranging and include; process standardisation; sign off procedures; use of ICT as a collaborative platform; freeware information repository; cost modelling; benchmarks for improvement; planning workshops; root cause analysis of defects and subsequent development of learning materials. Preliminary results indicate a sophisticated understanding of the defects and rework process across the supply-chain, but a general lack of forum and opportunity to contribute to improvement. The results indicate a wide diversity of abilities and resources in SMEs, including human, capital and technological, meaning one size fits all solutions to efficiency improvements are difficult to attain. Prescriptions thus need to be both simple to implement and flexible. The results here offer detailed reflective insight into best practice in designing improvement plans of this nature.

Keywords: action research, defects, rework, supply chain management.

INTRODUCTION

Construction in Ireland, suffered a significant collapse following a property led bubble in 2007. Figures indicate the value of construction production declined by over 77% by 2013 (CSO, 2013). This situation led to a spiral of bankruptcy, unemployment and bad debt with the industry in recession for nearly five years (CSO, 2013). Data from 2014 shows some growth, but the recovery is patchy, geographically and by sector (Ulster Bank, 2014). The number of contractor's reduced by circa 40% by 2011. Those remaining are overwhelmingly SME with only 11 companies classified as large using EU classifications (EU 2003/361). As part of a wider PhD study, a collaborative

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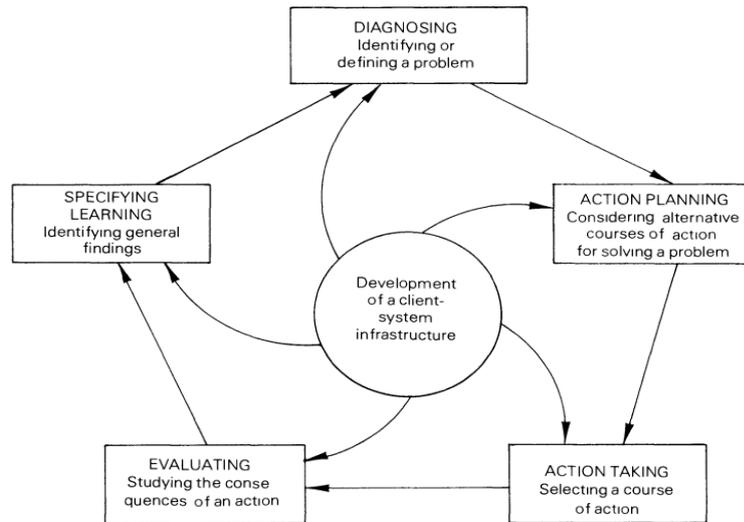
Action Research (AR) project is in progress with an SME regional contractor, who suffered substantial reverses of fortune during the downturn. The PhD research problem is focused on solving the contractor's ongoing problems with detection, management and elimination of defects and rework at the conclusion of projects. This phenomenon, known as 'snagging' in the industry, is a term little found in literature (Sommerville *et al*, 2004). A wider time view is however required as defects are both created and discovered at many stages of the production process, not just at project conclusion (Love and Edwards, 2004; Koskela *et al*, 2006).

The literature is confused in terms of the cost of defects and rework. A consensus however exists that in many cases it is 5% or more of total project cost (TPC) (Love, 2002; Taggart *et al*, 2014). The phenomenon of defects and rework is enduring, costly, wasteful and avoidable, providing justification for the academic aims of the study. The work also contributes towards solving the contractor's practical issues of delay, extra costs and late payments resulting from defects and reworks in an austere economy. Governmental reports suggest growth potential of 100% is sustainable for the industry in the medium term (Forfás, 2013). Should the status quo endure, we may speculate that the level of defects and rework, will likewise 'recover' by 100%, representing a significant missed opportunity for the industry and wider economy. The study collaboratively seeks to help the SME with its immediate problems and contribute to theory by dissemination of the results (Robson, 2002; Baskerville and Myers, 2004).

RESEARCH STRATEGY

An AR strategy is appropriate since it is suited to complex social situations with many factors at play in terms of human, technological, information and social-cultural variables (McKay and Marshall, 2001). In many cases these variables are impossible to disaggregate in any meaningful way, mitigating against the use of more traditional research approaches (Seymour *et al*; 1997). The roots of AR are generally traced to Kurt Lewin who felt the most important aim of social science should be to contribute to change for the betterment of society and its institutions (Lewin, 1946). Engendering learning through change is a fundamental element of AR (Altrichter *et al*, 2002). AR should also assist practitioners in developing their own self-help competencies (Susman and Evered, 1978). Many contributors are concerned by a lack of relevance to industry in current traditional academic research, suggesting it promotes description and explanation at the expense of problem solving (AlSehaimi *et al*, 2013). AR seeks to redress this balance by linking new knowledge to practical situations (Bresnen and Marshall, 2001). AR is widely conceptualised as a 'cycle' or 'spiral'. A popular representation is shown in figure 1. Stages entail; (1) diagnosing, the problem scope; (2) action planning, an improvement plan; (3) action taking, implementing the plan; (4) evaluating, the implementation consequences; and, (5) specify learning from the process (Susman and Evered, 1978). If the achieved solution is not satisfactory, further iterations take place to refine the process. A common criticism of AR is that it sacrifices scientific rigour in pursuit of practical relevance. This argument, has diminished in recent years, but still ensues. Strong argument for the scientific validity of AR can be found in Susman and Evered, (1978) and Reason and Bradbury, (2001). This paper seeks to further that discussion by considering how theory and practice can be linked when analysis of emergent improvement data takes place in an AR cycle.

Figure 1 - The Action Research Cycle - Susman and Evered, (1978, p588)



The remainder of this paper focuses on the action planning stage (stage two) of the study. The initial diagnosing stage, (stage one) is fully described elsewhere (Taggart *et al*, 2014). To aid reader understanding a brief summary of stage one is given below. Future papers will report on the remaining, implementation stages of the AR cycle.

FIELD STUDY DISCUSSION

Stage one entailed understanding of the current processes used by the SME to identify, manage and eliminate defects. This involved participative involvement on a field project constructing a health board building value circa €1.4 million. A range of research methods were used including; (1) un-structured observation; (2) photographing activities; (3) semi-structured interviews with stakeholder; (4) informal conversations on site; (5) analysis of documentation; and, (6) group discussion (Taggart *et al*, 2014). Results indicated the process being used was sub-optimal when compared to best practice suggested by literature. Participants demonstrated a sophisticated understanding of the root causes of the defects and suggested simple, cost effective methods to avoid future repetition. However they were never typically invited to collaborate in any meaningful way in defects reduction initiatives. Participants also showed an understanding of the possible benefits and a desire for more collaborative ways of working. However they suggested that the processes needed to support this was not currently present (Taggart *et al*, 2014).

ACTION PLANNING (STAGE TWO)

Five improvement areas emerged from stage one; (1) adoption of collaborative supply chain approaches; (2) adoption of a standardised management process; (3) adoption of cost effective IT solutions appropriate to SME; (4) adoption of simple costs modelling; and, (5) a focus on learning and continuous improvement. Noting the perilous economic context, any initiatives were required to both reduce defects whilst being rigorously balanced against any increased management process costs (such as inspections for example). Thus solutions need to be simple to implement and flexible. Following stakeholder discussions, 13 specific suggestions emerged where snagging process improvement might be found (Table 1).

Table 1-Suggested process improvement elements

Code	Suggested Improvement Element	Area of Interest
E1	Adoption of standard collection template for snagging data	2
E2	Co-ordination of the process across design team and contractor	1
E3	Requirement that Sub-cons sign off work as ready for next trade	1, 2
E4	Adoption of IT solutions for data collection and manipulation	3
E5	Issue snag lists sorted by responsible firm	2
E6	Use of electronic repository to share snagging data	3, 5
E7	Develop simple cost model to capture snagging costs	4
E8	Introduction of benchmark targets for defects reduction	1, 5
E9	Introduction stakeholder workshops to examine defect root causes	1, 5
E10	Develop visual communications materials as teaching aid	5
E11	Use of electronic repository as shared knowledge base	5
E12	Introduction of stakeholder workshops focused on avoidance	1, 5
E13	Introduction of toolbox talks / induction on quality issues	1, 5

At stage two of the AR cycle, the emergent improvement suggestions have direct relevance to the participants as they have contributed to their development. However significant methodological questions are posed concerning the validity of this output and nature of the knowledge being generated by these actions. Robson, (2002) found AR to be a very flexible approach and this very flexibility poses issues for claiming purely scientific or statistical validity. Schön, (1995) suggests a generalisation for AR that is not of the 'covering law' variety, but frames the problem and the strategies of actions for its solution, allowing both the problem and solution to be carried over to other similar situations, providing an analytic or theoretical generalisation (Robson, 2002).

Using an AR approach, typical research output creates a tested and grounded technological rule, its knowledge justification comes from a saturation of evidence that the rule actually works in practice (van Aken, 2004). AR emphasises the utility aspect of the future process from the participant's perspective, whilst generating new knowledge to guide practice gained from the act of modification of the current state (Järvinen, 2005). Susman and Evered, (1978) contend AR is a different type of science with a different epistemology, producing a different kind of knowledge. This knowledge is contingent to a particular situation and develops the capacity of participants to solve their own problems whilst contributing to theoretical knowledge. The goals of AR are to make the resultant improvement actions more effective while simultaneously building up a body of scientific knowledge (Coughlan and Coughlan, 2002). AR is essentially a pragmatic strategy, since its core paradigm is that the 'truth' to be found is based upon the utility of the research (Azhar *et al*, 2010).

Robson (2002) classified the three main threats to validity when using AR as; (1) lack of complete and accurate description; (2) researcher bias / pre-conceptions; and, (3) failure to consider alternative explanations or understandings. As a counterbalance to these it is essential to adopt coherent research frameworks to increase the rigour and

hence the validity of the work undertaken. As part of the wider PhD methodological validation a guidance framework for AR developed by Eden and Huxham, (1996), was adopted. This provides twelve guiding contentions for the justification of AR. The contentions are in terms of internal, external (project) and external (wider generalisation) validity. At this planning stage (two) of the AR cycle, it is appropriate to consider their contention seven; 'A very high degree of method and orderliness is required in reflecting about the emergent research context of the involvement' (Eden and Huxham, 1996, p84). This wider theoretical consideration of proposed practice improvements guards against bias by forcing reflection from differing perspectives.

To address these threats, a theoretical model for systematic reflection upon the emerging improvement ideas in stage two (table 1) was followed, using 'four critically reflective lenses' (Brookfield, 1995). This model proposes critical reflection on the assumptions we make (in this case about the improvement suggestions). Brookfield arranged this reflection using four lenses; (1) Our autobiography as teacher and learner; (2) Our students eyes (in this case, the research participants); (3) our (expert) colleagues experiences; and, (4) theoretical literature. Faced with problems, we often find that the foundations of our subsequent actions are laid in our autobiographies. Brookfield argues that all teachers make paradigmatic assumptions and have instinctive reasoning's and need to understand these when interpreting data from our students, colleagues and literature. Critical reflection is thus widely accepted in the literature as a critical component of good research, but is particularly relevant to AR (Baskerville and Myers, 2004).

RESULTS - REFLECTIONS ON STAGE TWO

This descriptive results summary is necessarily truncated by the paper space but illustrates reflective data which may change and improve the plan, emanating from the four lenses reflective process. Coughlan and Coughlan, 2002, suggest AR researchers need a prior breadth of situational understanding. The field researcher (author 1) has extensive experience as a construction manager, balanced by additional academic and business management experience, enabling a broad range of reflective contributions. Caution is however needed not to simply import the researcher's assumptions about what context is relevant to this situation (Silverman, 2000). Extensive field notes were kept by the researcher, allowing systematic personal reflection on the development of the improvement plan ideas as they emerged. However Schön, (1995) notes significant limitations on the degree of rigour that can be achieved by purely autobiographical reflections and strongly advises extensive reflections using the remainder of the reflective lenses.

To assess the participant's reflections (Lens 2) a semi-structured interview template was prepared by the author, seeking opinions and insights on the ideas listed in table 1. Supply chain Interviewee's (9) included architect, quantity surveyor, engineer, site management staff and sub-contractor supervisors. Additionally to address Lens 3, discussions took place with a senior quality manager (QM) from a major contractor unconnected to the SME, using the same interview template. Finally a summary review of literature pertaining to the thirteen elements was undertaken (Lens 4).

Using an AR approach the review of existing literature was thus partly driven by the emerging practice, rather than the more traditional research sequencing where practice normally follows an examination of theory.

In regard to collaboration; participants espoused support for more 'collaboration' as an improvement tool, but were not uniform in what form this would take. A coordinated snagging process across contractor and design team (E2) found agreement that this would be beneficial. The site manager agreed in principle, but felt it would be very difficult, due to contractual practicalities, a view shared by the QS who felt an 'attitudinal' change was needed for this approach to work. Sub-contractors signing off their own work as ready for the next trade (E3) also found general support. Some participants had experience of this and noted in principle it is a good idea, but, two factors disrupt its use; firstly a congestion of sub-contractors towards the end of most projects meaning numerous sign-offs that are difficult to manage and secondly; if there is programme pressure sub-contractors will 'cheat' saying they are finished when they are not. Workshops focused on the prevention of defects (E12) and root cause analysis of defects (E9) also received support in principle, many participants had previous experience of such workshops. Their overall reflection on these was however mainly negative. Comments included; 'The focus from the main-contractors is always programme, not quality'; 'You can never get everyone important in the same place for workshops', The nature of construction procurement also means that sub-contractors are appointed at different times in the process, meaning meetings at the appropriate time are often impossible. Participants generally supported 'collaboration' which concurs with literature (Akintoye *et al.*, 2000). Björnfort and Torjussen (2012) found that collaboration by SMEs is mainly informally arranged, resonating with this study. Literature mainly discusses collaboration as a far more formal concept, usually involving larger companies. Love *et al.*, (2004) noted resistance by designers to collaboration as it erodes their traditional powers. Designers here displayed a more open-minded attitude towards collaboration, which can be tested in stage 3 of the cycle.

Adoption of a standardised method of data collection (E1) received strong support. Some operational concerns were however noted. Respondents agreed that it was a good idea to have a 'checklist' when snagging, they were concerned about the large size of any potential database of snag descriptions and felt any checklist would have to be very simple in use to find favour. The architect noted inexperienced staff may miss defects that were not on the standard list / template. Issuance of individual snag lists to sub-contractors showing only their own defects (E5) split the group without any consensus. Opinion ranged from avid support to those who noted that defects rectification often has a collaborative element. To those who thought seeing the 'big picture' was beneficial to the supply chain. One sub-contractor made the startling admission that he often 'left some snags for the architect to find'. Explaining his rationale, he stated that if things were 'too perfect', it encouraged the architect to become 'picky' in adding inconsequential items to the snag list, whereas some obvious snags found during the inspection would satisfy both the inspector and the process.

Use of IT solutions to make collection and distribution of snagging data (E4) was firmly supported by all. Comments typically included 'It will happen anyway' and 'it is a given'. Concerns voiced typically focused on practical issues such as older workers learning technology; cost; security; training issues; and device reliability. The painting sub-contractor noted his workforce was largely transient in response to supply and demand peaks, so his training costs would be repetitive without any obvious benefit. The QM commented that companies were often discussed under common headings such as 'SME' whereas SMEs in reality were very variable in terms of their expertise, ranging from the technologically sophisticated, to those making little use of IT.

Electronic repositories, so that information could be easily shared in terms of both snagging data (E6) and learning (E11) were also popular, with all stakeholders stating they were prepared to use them. Surprisingly none of the interviewee's had previously used them. The architect was concerned about ownership of the materials / data in repositories, further noting that post contract reviews are now a common requirement in quality management systems, but 'are rarely done in any detail or well'. Reflecting on literature Harland *et al*, (2007) found SMEs tend to play a watching game, their horizon is short-term, and in terms of IT integration / use they tend only to respond to customer demand, rather than be innovators (Fink, 1998). Harland also notes the dominant role of SME owner managers, particularly in regard to IT purchase and the desire of SMEs to maintain close personal direct contact with their customers in preference to e-business or electronic communication methods.

Capturing the cost of defects and rework in this process with a simple cost model (E7) produced a consensus of sorts. A large majority of respondents felt this would be very interesting and useful information to have. They also stated it would be almost impossible to gain a true understanding / model of cost given the typical contractual arrangements. Responses included; 'A very difficult thing, very complicated'. 'You are up against the secret nature of the QS and commercial sensitivity' 'People will not share that kind of information'. The interviewee's were asked their opinion of typical defects and rework costs as related to total project costs? Many responded that they had no idea as it was outside their area. The painter said it would be between 10% / 12% of his tender cost on this project; the site manager suggested 5% but much more in many cases and the SMEs QS did not know for sure. Subsequently the researcher and SME have commenced field trial experiments to test various templates to capture defects and rework costs. These insights help to demonstrate why the literature in this area is very confused with no obvious standardisation of metrics (Fayek, *et al*, 2004). Reported defects costs range from 3% to 23% of total project cost (TPC) (Love *et al*, 2004). Love (2002) also suggests that many costs are hidden in the operational process and in some cases defects and rework costs range up to 25% of TPC. Given the opinions of the Irish construction community, expressed here, his suspicions may indeed be well founded.

Finally learning and continuous improvement (CI) was reflected upon. Benchmarking improvement targets (E8) caused some difficulty in that none of the participants had any personal knowledge of them. When their use was explained some people gave guarded support, but were otherwise unsure about their use. Use of visual management techniques (E10) was again a mystery to most, however they all clearly understood their use in a health and safety management context and were open minded in its potential for improving quality and prepared to try it out. Creating a knowledge data base (E11) was widely supported. Many interviewees had experience of similar defects problems being repeated from job to job and felt learning from such problems must be possible. The site manager noted that the SME had carried out two similar projects previously but he has not been aware of any learning from them. He felt a 'lessons learned' review would be very useful if presented in a suitable and usable way. Although continuous improvement was a key factor of the SMEs quality assurance system, little feedback learning was ever seen recycled into the field. Use of toolbox talks for quality (E13) found wide support. All participants had experienced such talks in relation to health and safety, feeling that they worked well, but none had experienced them for quality matters. The architect particularly felt that toolbox briefing is an excellent way to avoid defects and was always willing to provide

briefings if asked, stating 'fixing it never gives the same finish as doing it right the first time'. Barker and Naim, (2008) found UK house builders could readily identify and solve common problems - then typically repeated them, as the improvement information was not captured and reused. Bresnen and Marshall, (2000) suggested that contractors support CI, but found it hard to achieve in practice and found clients had unrealistic expectations from it. In regard to benchmarking against Key Performance Indicators (KPIs) Ireland does not use any comparable system to those in common use in the UK (Beatham *et al*, 2004). This means that benchmarking is very difficult to achieve, save some internal benchmarking, without comparable available industry data. Interestingly when benchmarking has been introduced to new territories, metrics for defects and rework is often one of the first KPIs to be introduced (Alarcón *et al*, (2001). Costa *et al*, (2006) discuss the variations in benchmarking metrics, finding most allow 'post-mortems' to inform future learning, but few allow for evasive action to be taken during live projects. Dave and Koskela, (2009) suggest that re-use of organisational knowledge greatly reduces time spent on problem solving and increases quality. The challenge here is to design a cost effective solution for the SME. The QM noted his experience that useful CI data was often lost or poorly captured in normal quality management systems, agreeing with the literature and field research. He also agreed that traditional quality systems engendered a 'post-mortem' approach and were often not very useful in avoiding defects, only at detecting them once created. His suggested solution concentrated on early stage interventions to assess and identify potential issues before they became defects.

CONCLUSIONS

This research has illustrated the use of Action Research as an approach to problem solving in SMEs. The results clearly indicate that homogenous categorisation of construction companies, for this purpose, using terms such as 'SME' is difficult, since they exhibit a very wide spectrum of intellectual, technical and financial abilities. This has implications for the development of improvement strategies at the process level, meaning that 'one size fits all' solutions are unlikely to be successful and are difficult to replicate in practice. AR provides a suitable vehicle for the development of situational solutions to socially constructed problems, permitting a deep understanding of the complex and interconnected variables involved. The results also indicate the particular complexity associated with the costs of defects, in terms of; (1) establishing the holistic cost of defects; (2) variable SMEs views on the costs associated with improvement strategies; and, (3) contextual realities of economic austerity.

The research also considered the argument made against AR, that it is a sacrifice of rigour, in favour of practical relevance. The research methodology applied a detailed theoretical framework to the work using twelve contentions of research validity as an overarching step-by-step checklist. The results of stage two (reported here), the emergent improvement plan elements, were also subjected to detailed critical reflection using four critical lenses of reflection. The results of reflection were to improve and tailor the emerging plan whilst aiding avoidance of researcher bias by forcing a consideration of other alternative meanings, views and solutions to the problems at hand. The knowledge gained is situational, but can contribute to understanding similar problems in similar situations.

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IDENTIFYING AND POSITIONING CONSTRUCTION SUPPLY CHAIN PLANNING PROBLEMS

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The construction industry struggles with an ineffective supply chain. A literature review, in combination with an empirical study aims at identifying and positioning perceived supply chain planning problems. The empirical part is a series of semi-structured interviews with construction site managers, purchase coordinators, and a project leader. Most site managers are responsible for mid-sized turnkey contracts, which enable comparison. Findings show that most of the supply chain planning problems relate to lack of coordination between actors, and that many of the problems discovered on-site originate from the supply process or the design process. Through proactive coordination of the actors in the supply chain planning process and the actors in the construction process, the problems on-site causing “fire-fighting”-activities could be reduced.

Keywords: coordination, planning problems, productivity, supply chain management, supply chain planning.

INTRODUCTION

A major challenge in construction projects is the planning process and its problems. Examples of main problems are lack of information (Laufer and Tucker 1987) and challenges in communication between actors (Dainty *et al.* 2006). However, little research has been focused on what problems exist when it comes to the supply chain planning process in construction. One exception is Bankvall *et al.* (2010) who has showed that many problems lay in coordinating works and plans among members in the supply chain process.

A common problem in the intersection between the project planning process and the supply chain planning process is poor delivery reliability when it comes to delivering material to site (Agapiou *et al.* 1998) and it has for a long time been discussed that the construction industry would benefit from implementing supply chain management (SCM) principles (Latham 1994). Vrijhoef and Koskela (2000) could show that additional costs of about 50 % are added to the purchase price due to improper management of supply chains and logistics. They also argue that productivity is negatively impacted due to the lack of SCM in construction. A first step when developing SCM is to identify typical problems in the supply chain planning process and to analyse where in the process they appear and from where they originate.

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A challenge when it comes to studying supply chain planning problems is where to draw the borderline between the “supply chain” and the “project”. In this study we will differentiate between the supply process and the construction process, according to the structure in Figure 5. The supply process encompasses all activities for refining raw materials to a final consumer end product. According to the definition of SCM made by CSCMP (2013), an equal important part of the supply process is the production of the end product. The construction process, however, concerns the activities for developing and erecting a building object, also including the production on-site. It is inevitable that these two processes will unify on the construction site and cannot be treated solitarily, the construction project encompasses both these two processes. The supply chain planning process does therefore concern the activities for planning the flow of material and construction on-site but not activities performed prior to construction (like design). Although, decisions made in this activity might have severe impact on the supply chain planning process. The purpose is to identify common problems related to the supply chain planning process and to position their origin in the supply and construction process respectively.

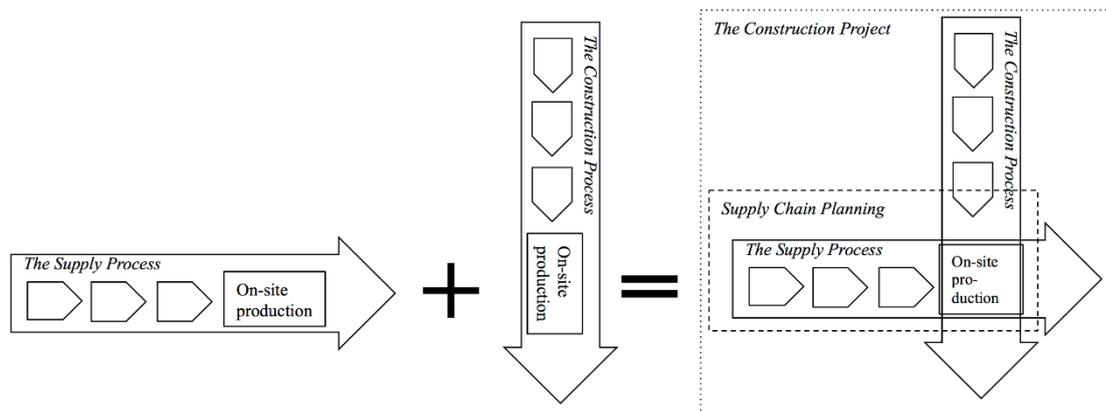


Figure 5 : A construction project as a construction and a supply process (Olsson (2000)).

Based on the purpose, the following research questions are addressed:

- RQ1: What are the most common problems related to the construction supply chain planning process identified (a) in the literature and (b) empirically?
- RQ2: Where in the supply/construction process do these problems originate?

METHOD

This study employs a combination of a literature review, a series of semi-structured interviews, and deductive reasoning. The literature review, addressing RQ1a, takes a starting point in the (Latham 1994) report and strives at identifying supply chain related problems. The interviews, addressing RQ1b, are conducted with respondents from five construction companies, all having Sweden as their main market. Finally, RQ2 is addressed via deductive reasoning (based on the outcome from the first two questions).

The interview study included identifying suitable respondents. Contact was made with Sweden's two largest construction companies and one mid-sized construction company who all accepted to participate. Eleven respondents were selected to participate in the study, including eight site managers, two purchase coordinators, and one project leader. All respondents have several years of experience in construction, are mainly concerned with residential construction projects, and are considered to be

actively involved in the construction projects, thereby being "close" to potential problems on a daily basis.

Interviews were in-depth and semi-structured, and a set of pre-defined topics was documented on beforehand. This document was e-mailed to the respondents about one week before the scheduled interview, to allow for respondents to prepare. The interviews were recorded and lasted between one and two hours. Transcriptions of the interviews were analysed in a quality research software² to identify if different respondents, and companies, experience the same type of problems or not.

Regarding the analysis process, the respondents are grouped based on gender, age, profession, years active, and company. As the respondents are asked to keep one project in mind they can also be grouped based on project type, project monetary size, project time, and type of building object. In this manner, comparisons between different project types can be made to see if certain project types are prone to certain problems.

Notes were taken during the interviews for classifying identified problems, with respect to the preceding literature review. This made it easier to code the interviews afterwards. However, before the interviews were coded, all transcriptions and notes were studied in order to identify new codes and to verify already identified codes.

SUPPLY CHAIN PLANNING PROBLEMS

Problems in the Literature

Planning problems in construction is a common topic discussed in the literature. Already in 1987, Laufer and Tucker (1987) identified a number of problems corresponding to planning and they concluded that most of the literature concerned technical aspects of creating schedules. Searching for literature concerning supply chain planning problems yields few results. Those who do talk about supply chain planning problems (Bankvall *et al.* 2010) often mention more "traditional" project planning problems (lack of communication, coordination, etc.). However, many of the traditional project planning problems are also a sub-set of supply chain planning problems (see Figure 5). For example, scheduling errors might be seen as a project planning problem, but as the on-site production also is a supply "activity", scheduling error thus also become a supply chain planning problem.

Those authors who focus on identifying problems both in the construction process and in the supply process have reported on many different problems. One problem is the interaction with subcontractors. Gidado (2004) reports that neglecting input from subcontractors in the planning process might lead to an increase in the amount of reworks plus a lack of a mutual agreement between the contractors on what the aim with the project is and how to plan. Gidado (2004) also discusses that plans are developed in short time, with limited resources, and without an understanding of planning difficulties and the project. Johansen and Wilson (2006) also identified that a lack of mutual perspectives on planning between participants might increase the amount of reworks. Menches *et al.* (2008) agree and report that both internal and external staff members are unfamiliar with the project.

One of the most common problems cited in the current literature regards information sharing. One example is a lack of information sharing when planning among project members (suppliers, subcontractors, etc.) (Bankvall *et al.* 2010, Fellows 2009). Kelsey

² www.dedoose.com

et al. (2001) report that solutions to identified problems in one project are not shared to other projects, which is vital to achieve continuous improvements. Another information aspect concerns technical information. Soekov and Lill (2011) argue that key personnel in a construction project do not have the same understanding of the project. This is apparent if one profession does the planning, but another profession is supposed to execute the plan. Ballard and Howell (2003) argue that interdependencies between activities are often forgotten or not recognised. This is supported by Arditi *et al.* (2002), who also argue that greater emphasis on production rate should be given when developing plans. They also argue that workflow and the handover process between two activities of different trades are neglected when plans are developed.

González *et al.* (2009) describe the dynamic nature as one important factor that often is neglected in planning. They argue that most plans are developed based on the idea that the project will not be exposed to any “dynamic” circumstances. This is also highlighted by Laufer and Tucker (1987) that describe project uncertainty and local site variations in projects as problematic when planning. Finally, Kelsey *et al.* (2001) report that necessary inventory holding areas are not properly planned in advance, and Gidado (2004) argues that other types of intricacies are forgotten. If these kinds of plans are developed they are seldom updated properly (Kelsey *et al.* 2001). Table 6 below summarises the identified problems in the literature. For a full list of references, please refer to (Thunberg 2013).

Table 6 : Identified problems in the literature.

Problems	References	Problems cont.	References cont.
Different meanings	(Johansen and Wilson 2006)	Local variations	(Laufer and Tucker 1987)
Exclusion of subcontractors when planning	(Gidado 2004)	Planning difficulties and project specifics forgotten	(Gidado 2004)
Unfamiliarity of the project	(Menches <i>et al.</i> 2008)	Lack of time and resources	(Gidado 2004)
Information shortage	(Bankvall <i>et al.</i> 2010)	Dynamic projects	(González <i>et al.</i> 2009)
Not understanding the construction process	(Soekov and Lill 2011)	Not considering production rate and repetitiveness	(Arditi <i>et al.</i> 2002)
Interdependency	(Ballard and Howell 2003)	Workflow planning	(Arditi <i>et al.</i> 2002)
Project uncertainty	(Laufer and Tucker 1987)	Flows and inventories	(Kelsey <i>et al.</i> 2001)

Perceived Problems from the Interviews

Table 7 below depicts those empirically identified problems that were most often cited by the respondents. If compared with Table 6 above it can be seen that some problems are similar and some not (e.g. delivery reliability and transporter issues). The most common problems cited by the informants regard some kind of lack of knowledge, information shortage, and attitudes, etc. The respondents argue that important information (about e.g. work planning, incoming deliveries, etc.) is often lost. This together with faulty information was reported as common issues among the respondents, and cases where extensive re-works had to be made due to faulty information were exemplified by the respondents. Other effects might be that different contractors schedule work on the same location at the same time, as they do not share this information.

Table 7 : Empirically identified problems.

Problems	Problems cont.	Problems cont.
Attitude towards team-works etc. ^{C1, C2, P1, S1, S3, S4, S5, S6, S7, S8}	Flows and inventories ^{C1, C2, S2, S3, S4, S7, S8}	Knowledge transfer ^{C1, C2, P1, S1, S2, S3, S4, S5, S6, S7, S8}
Lack of long term agreements ^{C1, C2, S2, S3, S6, S8}	Lack of time and resources ^{S1, C1, C2, S2, S3, S4, S5, S6, S7, S8}	Changing site layout ^{C1, C2, S1, S2, S3, S4, S7, S8}
Unfamiliarity of the project ^{C1, C2, P1, S1, S2, S3, S4, S5, S6, S7, S8}	Unpredictable delivery reliability ^{C1, C2, S2, S3, S4, S5, S6, S8}	Goods reception issues ^{C1, C2, S1, S2, S3, S4, S6}
Information shortage ^{S1, S2, S3, S4, S5, S6, S8}	Dynamic projects ^{C1, C2, S1, S2, S3, S4, S5, S6, S7, S8}	
Workflow planning ^{C1, C2, S1, S2, S3, S4, S5, S7, S8}	Transporter issues ^{C1, C2, S1, S2, S3}	

C1: Purchase coordinators (i=2), P1: Project leaders (i=1), S1. Site managers (i=8)

The interviewed project leader mentioned that there sometimes is an obsolete attitude towards teamwork mostly among the subcontractors. The site managers interviewed agreed, and some mentioned that some subcontractors do not want to attend coordination meetings, as they can “solve this by themselves”. The site managers also reported that they perceive problems with the internal staff members off-site, typically mainly involved in early phases of the projects. One example mentioned was that purchase coordinators procure subcontractors and materials from a supplier that the site manager knows do not work well. This means that knowledge from the site managers is not shared among the internal staff. If knowledge from site managers regarding the supply process is not transferred to other functions (like architects etc.) it is a risk that the purchase coordinators procure materials that have a negative impact on the supply process. One example is that special materials with long lead times are procured instead of standard products with short lead times. The informants also mentioned that communication lacks due to limitations in time and resources. The purchase coordinators and site managers lack the time to sit down and talk-through the supply process. As can be seen, many of the problems identified concern some sort of *communication*. Attitude, information sharing, and knowledge transfer are all important parts of communication.

Another problem often mentioned by the interviewed site managers regards the flow and management of materials. The most frequently mentioned issue concerns that the contractors do not know when and where materials will arrive and in what condition, often termed delivery reliability in logistics literature. The site managers mentioned that it is difficult to plan and schedule resources for managing incoming deliveries. The site manager also observed another type of problem resulting from late deliveries; the contact with the transporter. First they need to contact the supplier to know who is transporting the materials. Then they have to contact the transporter to get information of when and where the materials will arrive. The site managers believe that the transporters and not the suppliers cause most of the delays. They also feel that too much time is devoted on contacting the transporter.

Other issues mentioned by the purchase coordinators are that the material flow of the subcontractors is not reconciled with the main contractor. They mentioned that schedules and plans are not properly developed based on the material flows. This can result in excessive materials on-site at certain times and that multiple (non-consolidated) deliveries are scheduled and not coordinated to the same date and time.

The goods reception is problematic as it is not coordinated among the contractors. These problems all concern *material flow issues*.

Other problems when it comes to planning regard *complexity* factors. One problem often mentioned is the site layout. Workflow plans and inventories are often not updated with the changing layout of the site. The site managers argued that a work-site plan needs to be developed and be kept up to date. This plan also needs to be communicated to other contractors. This work plan also affects where inventory-holding areas can be located to not interfere with the craftsmen's activities. Another complex factor is the set of new contractors in the supply chain for each project. The site managers often mentioned long term agreement as a positive factor for planning workflow, material flows, and to overcome communication barriers (such as attitude).

PROBLEM GROUPING AND POSITIONING

From the discussion made in previous section four major problems areas appears; material flow issues, internal communication, external communication, and complexity (see Table 8). Internal communication regards communication with internal staff-members off-site at the main contractor, while external in this case regards communication with subcontractors, suppliers, and clients. Problems identified in the interviews like attitude towards meetings and planning together with a lack of and faulty information and lack of time and resources all concerns means to deal with communication. In comparison with the literature it is also evident that unfamiliarity of the project, exclusion of subcontractors in the planning process, workflow planning, different meanings, lack of long term agreements, not understanding the construction process, interdependency between activities, and not considering production rate and repetitiveness also concerns communication.

Material flow issues include goods reception issues, flows and inventories, transporter issues, delivery information, and delivery reliability. Other problems that could be grouped are site layout and dynamic projects from the interviews with local variations, project uncertainty, intricacy forgotten, and long term agreements from the literature. They all concern some sort of complexity. For communication, some problems exist both for the internal and the external part. For attitude, it can both mean sub-contractors attitude towards teamwork but also attitude among internal staff-members to co-work when developing plans.

Olsson (2000) argued that many problems originate from a lack of reconciling the supply process with the construction process. This is depicted in Figure 6 where the two processes meet on the construction site, the left-hand part depicting where the problem areas is located. From the interviews it is identified that internal communication problems (P2) arise in the pre-construction/design phase and its interaction with the construction site. The external communication problems (P3) on the other-hand are more associated with the supply process as the respondents concerned it as the communication with suppliers and subcontractors. To achieve a smooth production process, subcontractors and suppliers must be involved in an early phase to safeguard that the material flow process is designed appropriately.

Material flow issues (P1), however, concerns problems that is associated with the supply process. For example, the transporter issue is due to a flaw in the supply process and not in the construction process. Finally, complexity problems (P4) result from an inadequate interaction between the pre-construction processes and the

construction on-site. Even if the complexity is difficult to manage on beforehand, standard procedures can be developed in order to reduce its impact.

Table 8 : Grouping common problems from both the literature and the interviews.

Material Flow (P1)	Internal Com. (P2)	External Com. (P3)	Complexity (P4)
Goods reception issues	Knowledge transfer	Knowledge transfer	Project uncertainty
Flows and inventory	Attitude towards team-work, etc.	Attitude towards team-work, etc.	Local variations
Transporter issue	Information shortage	Information shortage	Dynamic projects
Delivery information	Unfamiliarity of the project	Unfamiliarity of the project	Planning difficulties and project specifics forgotten
Delivery reliability	Lack of time and resources	Meeting attendance	Changing site layout
	Not understanding the construction process	Lack of long term agreement	Lack of long term agreement
	Interdependency	Workflow planning	
	Not considering production rate and repetitiveness	Exclusion of subcontractors	
		Different meanings	

As discussed by Olsson (2000), it is important that both the construction and the material flow processes are considered when developing plans. Some of the problems discussed earlier can either be associated with the supply or the construction process. However, it is important to realise that these problems might exist because the two processes are not reconciled. Supply issues might arise due to a lack of transferring knowledge between design and construction teams. The design team might plan to use one sort of material that impacts the supply chain negatively (e.g. reduced delivery reliability or increased cost or lead time), which is acknowledged by some of the respondents. Decisions made in the design phase do have an effect on the supply process, but the design team does not know how the decisions on materials, solutions, etc. affect the material flow and thereby the project overall.

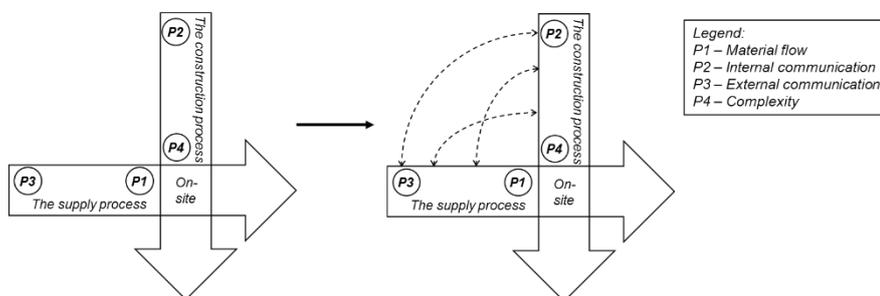


Figure 6 : Left: Mapping groups of problems to the construction and supply process. Right: Decisions made in the construction process affect the supply process.

To reconcile the construction and supply processes is vital, and key aspects of coordination concerns communication (both internal and external), collaboration, and knowledge transfer (Bankvall *et al.* 2010). It can then be argued that all four problem groups identified above actually to some extent concern coordination. Material flow issues stem from a lack of coordinating plans among contractors and suppliers.

Internal communication on the other-hand also regards a lack of coordinating the activities off-site in the preconstruction phase with activities on-site, including lack of sharing information and knowledge. External communication is a lack of coordinating work and information between contractors, sub-contractors and suppliers. Finally, complexity is mostly a result of not coordinating activities off-site. Plans developed off-site can often be revised if the construction team is advised early on in the process. They know much about complexity and can revise the plan based on their knowledge. A construction project is inherited with complexity due to many members and the separation of the supply and the construction processes. This implies that in order to cope with the complexity, coordination is important.

At the midst of the problems arising from poor coordination is the on-site activities. Yet, none of the site managers mentioned coordination in itself as a problem. At an operational level “coordination meetings” are held on a weekly basis with subcontractors. Internal processes at a tactical level is however not coordinated, one example being lack of coordination between the purchasing function and the production team. However, the purchase coordinators interviewed were all consistent in that this is the overall issue to tackle in order to overcome many of other problems occurring on-site. Faulty plans, lack of information, faulty materials, etc., often stem from a lack of coordinating plans among internal functions and external partners in an early stage in the construction process, in the design phase. As it is now, plans are developed by the main contractor and handed over to the subcontractors allowing them to develop their plans separately. To develop robust plans it would be preferable if both the supply process and the construction process are reconciled/coordinates (see the right-hand part of Figure 6), illustrated with the dashed arrows in Figure 6. To get the full potential of the coordination this should be done both internally at the main contractor, but also externally with supply chain members.

Many construction companies (and researchers) argue for implementing SCM principles, yet successful implementation of SCM in construction seem to be lacking. Mentzer *et al.* (2001) argue that to implement SCM, one must first become supply chain *oriented*. This means that the company must first align all its processes and functions to strive at the same goal, i.e. to coordinate internal processes. Some of the aspects that have to be in place to achieve this are trust, commitment, top management support, etc. Many respondents reported on a mismatch between the internal functions and the production team when it comes to supply chain planning. They also reported on a belief that more focus should be placed on the design phase and how decisions regarding the production affect the supply chain and vice versa.

Olsson (2000) discuss that the lack of ‘integrating’ the construction/design phase with the supply chain is one of the reasons for why problems arise. One first step could be to integrate the plans among project members in an early stage. However, the interviewed site managers are afraid their workload will increase, if they will be responsible for this coordination. This is probably a natural reaction from their point of view, but having Mentzer *et al.* (2001) in mind, a more appropriate step would be to put this coordination process in the design phase with the design phase team (with the supervision of the project manager) as accountable. The site managers should of course be consulted to capture important knowledge about the production and supply chain.

CONCLUSIONS

This study sets out to investigate what problems there is when it comes to supply chain planning in construction. Results from a literature review and interviews with construction personal help in forming a list of common problems and reasoning about where in the construction process they originate. It is concluded that the overall problem is a lack of coordination. The identified problems can all be grouped into material flow issues, internal and external communication, and complexity.

Addressing the coordination issues can have a positive impact on material flow issues, internal and external communication, and complexity. In order to coordinate the supply chain planning processes one must first cope with lack of coordinating internal processes.

Operational problems exist when it comes to the construction process and its planning/scheduling. The supply process in construction has just in recent time received attention from both construction management researchers and the operations management researchers. However, few authors connect the supply process with the construction process to see where problems (first discovered on the construction site) originate. Figure 6 shows that many “on-site problems” do actually originate from earlier on either in the construction process or in the supply process. This also suggests a greater attention to coordination. For example, if decisions made in the design process are not coordinated with the production team and the supply process it can have a negative impact on the overall performance. The design team might e.g. design a house with materials that just a few suppliers manage to produce. This will have consequences on costs and lead times.

An important insight is that many of the identified problems are not addressed on beforehand in the pre-construction phase; instead a “fire-fighter” mentality is common (fix the problems when they become a problem). Another insight is that at the beginning few respondents reckoned that they had problems. This is common as what they saw as a normal situation can be seen as problems by an external investigator. Finally, one way of overcoming the supply chain coordination issue is to design a planning process that does take knowledge and information from different contractors, suppliers, and internal staff into consideration. This might be done through an iterative mentality when developing plans in the design phase. Instead of “pushing” plans down to the subcontractors they should be developed more “co-jointly”. This puts pressure on developing long term contractors with subcontractors plus devoting enough time and resources in the design phase. The idea is to develop a more robust plan that already on beforehand is scrutinised for any error and issues that could be solved.

For the industry this study contributes in addressing problems with supply chain planning which might not be recognised by all hierarchical levels in a construction company. It also contributes in an identification of where the problems originate in the construction process plus connects this process with the supply process. For academia, many problems are listed before but not connected to the supply process. This suggests that the borderline between a construction supply chain and the construction process is thin and that the industry needs to take the supply chain and its coordination into consideration when developing plans. This implies that the industry still has a long way left to implement SCM principles. Further research lies in identifying if different members of the supply chain share the view of what is a problem or not, and how they can be overcome.

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CONSTRUCTION POLICY RESEARCH: BEWARE REASON MASQUERADING AS TRUTH

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One of the defining characteristics of the modern era has been the ascendancy and privileging of an instrumental version of reason at the expense of other, competing forms of rationality. Now deeply established and an integral component of Neoliberal discourse, it forms the dominant form of reasoning for many planners, policy-makers, academics and laypersons alike. Drawing on the works of Max Horkheimer and Max Weber, this paper considers the ways in which instrumental reason diminishes policy formulations and undermines democratic culture. It achieves this through a consideration of the exclusion of 'deep' green activists from policy formulation and an examination of the Capital approach to sustainability popularised by David Pearce. Recognising instrumental reason as a culturally specific value-laden ideal, this paper teases out the assumptions behind such thought and highlights the potential for alternatives. Such a realisation has important consequences, as the ability for built environment policy-makers to reimagine theory and practice becomes possible only when the veil of instrumental reason, cloaked and presented as a value-neutral ideal, is lifted. It is hoped that such a perspective will contribute to the growing theoretical and philosophical debate in Construction Management research.

Keywords: culture, democracy, instrumental reason, policy, sustainability.

INTRODUCTION

One of the defining characteristics of the modern era has been the ascendancy and privileging of an instrumental version of reason at the expense of other, competing forms of rationality. A reaction against the perceived deficiencies of pre-enlightenment thought dominated by religion and tradition, an instrumental form of rationality was seen by many, somewhat ironically perhaps, as a saviour and salvation for humankind. It was thought to be the light that would illuminate the darkness in the hearts and minds of the masses. But, as came to be recognised, an instrumental reason, wholly isolated from some additional form of religious, philosophical, or ethical rationale risks treating human life as a means to an end rather than an end in itself, thus diminishing its value in the process. Max Weber (1904) lamented the rise of instrumental reason in modernity and believed it to be responsible for the 'disenchantment' of society, with scientism and bureaucracy replacing long-held beliefs and considered to remove any sense of magic or mystery from social life. More recently, Zygmunt Bauman (1991) has linked the rise of instrumental reason to the horrors of the Holocaust, believing it to be a necessary, if not sufficient, condition for its occurrence. He states that, 'At no point of its long and tortuous execution did the Holocaust come in conflict with the principles of rationality. The 'Final Solution' did

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not clash at any stage with the rational pursuit of efficient, optimal goal-implementation. (Bauman: 1991: p. 17). Now deeply established, instrumental reason forms an integral part of the dominant form of reasoning for many planners, policy-makers and laypersons alike. This paper argues that the dominance of instrumental reason today, through lending itself to an increasingly hegemonic neoliberal discourse, undermines democratic culture and raises serious ethical concerns. It proceeds as follows: firstly, some background on instrumental reason and its link to policy is offered; next, a consideration of the marginalization of 'deep' green thinkers is presented; then, the 'Capital' approach to sustainability is examined; a discussion of Horkheimer's 'eclipse of reason' and the 'Citadel problem' are then further presented to problematise proceedings; some suggestions for the future are then offered and, finally, some concluding thoughts.

Instrumental reason and policy

Instrumental reason, what Max Weber referred to as the *Zweckrational*, '...focuses on the most effective or efficient means for obtaining some goal or desire' (Bishop: 2007: p. 90). It represents, '...a vision of the good life as a quest for mastery and control devoid of deeper or wider contextual meanings...' (Bishop: 2007: p. 93). This is often contrasted with Weber's alternative rationalities: the *Wertrational* (behaviour guided by values, e.g. religious or philosophical beliefs); affective action (behaviour guided by emotional states); and traditional action (behaviour guided by habits and traditions) (Bishop: 2007: p. 38). Of course, rather than being considered as discrete, mutually exclusive categories, in reality there is often bleeding and overlap between the categories depending upon circumstance and time. Drawing on Weber, Smiley *et al* (2013) suggest that a particular combination of cultural events and forces, including the standardization of time, the rise of Information Communication Technologies and a money economy, combined and contributed to an increasing predominance of an instrumental form of rationality. This now forms an integral part of the ascendant neoliberal discourse which has become our own, current, Weberian (1904) 'Iron cage'. It is important to note, however, that this 'iron cage' is intimately connected with anthropocentric Western ideals regarding the primacy of humans over nature, autonomy, individual rights and capital accumulation. As Bishop (2007) states, 'The disguised ideologies of liberal individualism and the instrumental picture of action are inherent...in policy formulation and assessment because policy-makers increasingly use the...rational-actors picture for their work (Bishop: 2007: p. 263). In its current form it would be almost unintelligible and certainly unacceptable to societies which have traditionally placed collective interests and a more holistic appreciation of human-environment interactions ahead of individual rights. The issue is that this particular type of rationality has now been spread and institutionalised by the dominant social actors of our time with organizations such as the International Monetary Fund and the World Bank entrenching and perpetuating its logic. As a result, a repeated focus and emphasis on efficiency, value for money and wealth accumulation has come to dominate construction policy discussions at the expense of alternative discourses.'

With the publication of the Egan Report in 1998, following on from the start of the New Labour government in 1997, for example, there has been a particular emphasis on evidence based policy-making (EBPM). EBPM has demanded 'efficiency' and 'objectivity' and is only interested in 'what works' (Parsons: 2002). Yet, an approach such as EBPM, with its use of targets, key performance indicators and disseminations of best practice, focuses on and privileges an instrumental version of rationality, what

Max Weber referred to as the *Zweckrational*, and arguably assumes, ‘...an abstract, uncontentious, universal knowledge’ (Michael and Brown: 2010: p. 11). The problem with any such attempts to turn to a positivistic stance is that it obscures the nuances and complexities of policy formulation as it is actually conducted. A more appropriate approach, perhaps, would be the Laswellian approach to policy-making and diffusion which suggests that policy is shaped by, ‘...power inequalities and recognised that knowledge is utterly embedded in power and value contexts and relationships’ (Parsons: 2002: p. 54). From this perspective, context matters and consensus cannot be assumed. For example, in the context of debates surrounding construction reform, who decides on what an ‘appropriate’ target is, what ‘best practice’ constitutes and how, why and when such a strategy should be adopted? There are also challenging questions such as, ‘...whether intensity of feeling should be considered as well as the number of persons preferring each alternative (Lindblom: 1959: p. 82). Is policy to be formulated through giving each actor an equal voice or should the cries of a passionate and vocal minority outweigh those of an apathetic majority? These are not easy questions. Furthermore, how do we decide the most ‘efficient’ way to arrive at a given goal? The privileging of efficiency itself rests on a fundamental philosophical assumption regarding its desirability. And, as Stone (2002) suggests, even if we accept efficiency as a desirable characteristic, ‘...technical efficiency does not tell you where to go, only that you should arrive there with the least possible effort (Stone: 2002: p. 61). For different individuals and groups will have differing visions of what an appropriate reform is and what constitutes an appropriate direction. Contrary to the EBPM approach then, such questions and perspectives help to reveal that the processes of policy formulation and diffusion should be considered as inter-subjective rather than objective. Policy is thus better understood as a continual negotiation between social actors with varying values, goals and ambitions. More accurately, policy is defined by the dominant values which have come to be institutionalised in a society and what is often actioned upon is solely the desires and values of those in institutional positions of authority. But alternative voices, pockets of resistance to the dominant discourse, do exist and it is illuminating to consider one next.

The exclusion of ‘deep’ greens

That an instrumental rationality obfuscates policy formulation and undermines democratic culture is seen more clearly by considering Sorrell’s (2001) critique of the reform agenda as inadequate in response to climate change and issues of environmental sustainability. He states, ‘While these reforms have the potential to address many of the barriers, the reform agenda makes practically no reference to sustainability or to energy efficiency’ (Sorrell: 2001: p. 1). He makes a powerful point in that many previous and current reports recommending change and reform in construction have offered little mention of environmental sustainability, certainly not for its own, intrinsic sake at least. Rather, the rhetoric of sustainability is used to maintain existing social norms and order. But Sorrell (2001) is by no means alone in questioning the reform agenda response to issues of environmental concern. Rees (1999, 2009), du Plessis and Cole (2011), du Plessis (2012), have all offered extended critiques of the construction industry’s attempts at reform and sustainability. Though the construction sector has moved towards adopting more environmentally responsible behaviour (see Morton: 2008), it has arguably not been enough. It has certainly not been sufficient to appease those ecologists who conceptualise a fundamental change in the built environment in response to perceived environmental threats and impending global catastrophe brought on by climate change. There are, for example, ‘deep’

greens: thinkers and activists, such as Gerzan (2005), who fundamentally reject the super ideology of industrialism and who urge for a reimagining of the relationship between humans and the environment. Their vision is one informed by a profound lack of anthropocentric reasoning and a deep and abiding respect for nature. It is decidedly eco-centric as opposed to anthropocentric. The problem, as Purnell and Freeman (2012) tease out, is that the prevailing discourse of the time, in this case a neoliberalism informed by instrumental reason, drowns out alternative voices such as this. Its,

‘...closed-normative core compartmentalizes and protects its underlying narrative from a true exchange of ideas. The closed-core thus shuts down the potential for any revision of managerial narratives before a conversation even begins. In some cases the closed-normative core might be a wilful rejection of new ideas. In other cases...the notion of closed narrative core represents an unconscious blind spot that eventually become a destructive force’ (Purnell and Freeman: 2012: p. 114).

It is destructive as, whether a result of ‘wilful rejection’ or an ‘unconscious blind spot’, policy thus continues down an increasingly homogenous path. Constituencies with voices which do not fit the already existing predominant narrative(s) are often unheard, marginalised and excluded, if they are heard at all. Opportunities and potential for the flexible revision and adaptation of policy is thus limited. This has important implications as, ‘...policies that fail to...represent interests and that confuse, deceive, or disempower citizens do not serve democracy’ (Schneider and Ingram: 1993: p. 345). Even if one disagrees with those green thinkers regarding the potential seriousness of environmental concerns, there is still arguably an ethical responsibility in a democratic society to allow their views to be heard and considered fully. This is because unless we assume that power and dominance confers rights, then ethically, the alternative is to recognise the intrinsic worth and equality of disparate voices. Yet this is a voice which is often ignored and marginalised. There are seemingly no seats at the policy table for ‘deep’ greens. But what of a more moderate approach? It is to this that we now turn.

The capital approach to sustainability

Atkinson (2008), in an approach indicative of instrumental and anthropocentric reasoning, advocates the use of a ‘Capital Approach’ to conceptualising the built environment and argues that this is particularly appropriate in order to tackle issues of sustainability. The Capital Approach (popularised by Pearce: 2003) suggests that the present wealth and assets of a nation (broadly conceived), and how they are managed, will have an impact on the stock of wealth for future generations (Atkinson: 2008). It is therefore important to consider issues of capital as matters concerning the built environment, which can endure across generations, are, ‘...influenced by the dominance of capitalism...’ (Ball: 1988: p. 43). However, not made explicit by Atkinson is that the capital approach appears to rest on a more fundamental assumption: namely, that the accumulation of wealth and assets, however broadly conceived, is a derisible end in itself and constitutes a particular vision of the ‘good life’. No mention is made as to how this specific, materialist vision came about, nor why it persists at the expense of other, non-materialistic or more communal visions of society, whose narratives do not chime with the already established ‘closed-normative core’ (Purnell and Freeman: 2012). This is typical of policy informed by instrumental reason which, ‘...neglects conflict and disagreement on ends...taking as given the values of dominant stakeholders’ (Sanderson: 1999: p. 329). Atkinson goes on to

suggest that, ‘...current changes in wealth must also have consequences for future well-being. It is plausible, then, that a decline in wealth will now lead to falls in future levels of well-being – such an economy would not be sustainable...’ (Atkinson: 2008: p. 242). Whilst, this is, of course, true to an extent, it does leave a series of questions to which Atkinson gives only the briefest of mentions. Firstly, how are we to conceive of wealth and assets? Who gets to decide? And what is to be included and excluded in policy formulation as wealth and assets, and for what reason? For example, are we to include elements of the natural world, such as forests, streams, lakes and mountains? Atkinson would say yes. Yet, those members of the ‘deep’ greens mentioned previously might have something to say about that. They would argue that such natural assets are of a different kind, ones that should be respected for having intrinsic value, and as such, should be treated as ends in themselves rather than means. The view of natural elements as wealth and assets to be considered resources which should be shared and passed on across generations rests on an anthropocentric vision, one which prioritizes human flourishing ahead of others. From this perspective, the incommensurability of ‘shallow’ environmental concerns, underpinned by both anthropocentric and instrumental reasoning, and ‘deep’ environmental concerns, informed by an eco-centric and holistic logic, becomes more apparent. This is contrary then to Atkinson’s statement that, ‘...there is likely to be far more complementarities between the two approaches than is commonly given credit’ (Atkinson: 2008: p. 243).

Atkinson also makes no mention of power, coercion and agenda-setting in the debate surrounding wealth and assets. Following on from Lukes (1974), one can conceive that actors who already possess the majority of wealth and assets at a given point of time (whether individuals or corporate entities) would have a vested interest in maintaining such wealth, and this would arguably extend across time to their kin in a future generation, thus maintaining and institutionalising inequalities across time. To ensure this, measures ranging from outright coercion to agenda-setting and ‘greenwashing’ could be employed and others have already pointed out the, ‘...ceremonial ways that organizations can signal deep greening without actually engaging substantively in it’ (Jermier and Forbes in Alvesson and Wilmott [eds] (2003): p. 171). From this perspective, significant possessors of wealth and assets may provide just enough lip-service to a cause to ensure that their own position and status is maintained, without any genuine commitment to the underlying aims (see, for example, Ness: 2010). Such actions serve as rhetorical devices which marginalise and exclude dissenting opinions, thus denying sincere conversation in the service of dominant interests. This has important consequences in an allegedly democratic society such as the UK, as, ‘...corporations and their executives can act...as a powerful force that undermines democratic accountability in modern Western society: the technocracy of management subverts the democracy of citizens’ (Alvesson and Wilmott: 2003: p. 12). Atkinson also neglects to mention the systematic marginalization of certain groups from wealth and assets, for example, the unequal holdings of white and ethnic members, or of men and women across society. Unless we are to sustain inequalities across generations, such questions would seem to be of great ethical importance.

The Capital approach, then, rests on an anthropocentric and instrumental rational view of the world. Though presented as a beacon of hope to the sustainability movement, it is based on a narrow normative conception of how things ‘ought’ to be, with the environment considered solely a means for human flourishing. The potential for policy formulated by an eco-centric logic, one in which humans and the rest of nature

are equals in a majestic and holistic tapestry, is not considered. Rhetorical shields suggesting that such an approach is ‘unrealistic’ or ‘impractical’ merely act as disingenuous agents, knowingly or not, for the status quo.

The eclipse of reason and the Citadel problem

Horkheimer (1957), following Weber, was distinctly critical of the predominance of instrumental reason in modern life and its tendency to obscure potential alternatives through its hegemonic position. For Horkheimer this was the moment when the metaphorical moon blocked out the sun: the eclipse of reason. In a now classic essay, he states, in opposition to received wisdom, that,

‘Mastery of nature has not brought man to self-realisation; on the contrary, the status quo continues to exert its objective compulsion. The factors in the contemporary situation - population growth, a technology that is becoming fully automated, the centralization of economic and therefore political power, the increased rationality of the individual as a result of his work in industry - are inflicting upon life a degree of organization and manipulation that leaves the individual only enough spontaneity to launch himself onto the path prescribed to him’ (Horkheimer: 1957: p. 4).

It is the latter part of this quotation which is of particular relevance to our discussion. Policy making has come to be dictated by individuals with limited potentials for possible actions and only enough freedom to, ‘...launch...onto the path prescribed...’ (ibid). Imaginations are constrained by the particular cultural zeitgeist in which they exist and thus reflect the dominant discourse of the day. In the current era, this is an anthropocentric vision of life supported by an instrumental rationality, the combination of which has led in recent decades to the emergence of an increasingly hegemonic neoliberal discourse. This is where the eclipse occurs, the move to a supposedly more rational approach, through its increasingly hegemonic discourse, comes to form a new prejudice, excluding potential alternatives. In doing so, it becomes ever more irrational itself as it lays claim to a level of certainty and ‘truth’ which cannot be proven or assumed. This contributes to the ‘technocratic totalitarianism’ in the construction sector, as suggested by Green (1998), with continuing discursive emphasis on ‘efficiency’, ‘value for money’ and ‘productivity’. It must be stated, though, that it is a mostly unreflexive form of totalitarianism, in which many dominant actors uncritically parrot discursive tropes regarding construction ‘improvements’.

What the discussion perhaps so far points to is, as Downey and Dumit (1997) suggest, a ‘Citadel Problem’. By this it is meant that the predominant discourse of our times, underpinned by Liberal foundational assumptions (including the primacy of the individual, the right to one’s own labour, and the right to private property), has positioned itself as the repository of supposedly legitimate knowledge in the modern world, at the expense of other alternative, competing lay knowledges. It resists perceived attempts to penetrate its boundaries, fortifying its position. Thus, what we are witnessing is an ongoing clash of cultural boundaries (Downey and Dumit: 2007). By unproblematically ascribing the concept of ‘facts’, a demarcation and delimiting of ‘acceptable’ knowledge occurs. The privileging of certain information as ‘factual’ is important as, ‘Whether or not something is called a fact makes a great deal of difference to us. Statements that begin, “*The fact of the matter is...*” lay claim to an important source of authority’ (Downey and Dumit: 1997: p. 6). This has important consequences, and,

'...one effect is to inscribe a boundary between those who achieve the authority to speak new truths and those who become card-carrying listeners. Claims to knowledge that fall inside a citadel can gain status, privilege... Claims that fall outside may have to struggle in a nether world of questionable legitimacy...' (Downey and Dumit: 1997: p. 6).

What is problematic and which raises ethical concern is that not all citadels are able to defend themselves equally. Institutional structures privilege certain forms more than others. In this instance, instrumental reason in its neoliberal guise has become predominant over alternatives and institutional barriers entrench this position and make resistance increasingly harder. The implication for policy lies in the consciousness and preferences of those in institutional positions of authority encroaching on an ever homogenous territory. The 'Policy-maker', in Marcuse's (1964) terms, has increasingly become a 'One-Dimensional Man', with the metaphorical veil of instrumental reason obscuring their vision. Not only are voices outside the citadel consciously ignored but often unconsciously, as policymakers genuinely see no 'real' alternative voices to consider. The concerns of 'deep' greens and other social groups, wishing for a fundamental reconfiguration of the relationship between humans, the built environment and the wider natural environment, are not considered then.

Where do we go, from here?

We have come to recognise, then, the potential for a singular, dominant conception of rationality to obscure our vision, and so, the need for a more reflexive, collaborative, democratic, and pluralistic approach is arguably appropriate as a remedy. Recognising the instrumental picture of action not as 'objective' but as one of many potential value-laden cultural ideals allows the possibility of us opening up the 'closed-normative core' (Purnell and Freeman: 2012). In terms of construction policy, this offers the potential to include a much broader spectrum of stakeholders in policy formulation. There are, however, barriers to reimagining practice, as the foundational atomistic assumptions regarding the primacy of the individual and private property rights are deeply engrained in our cultural psyches. A move towards the new model offered by Stilgoe *et al* (2006) in the table below would, perhaps, offer a more ethical, balanced approach though:

Table 1: Recreated from Stilgoe et al: 2006: p. 69

Old Model of Expertise	New Model of Expertise
Closed	Open
Homogenous	Diverse
Hubristic	Humble
Demanding public trust	Trusting the public
Expecting expert consensus and prescription	Expecting plural and conditional advice
Managerial control	Distributed control

So, when planning decisions are being made, for example, as wide a variety of stakeholders as possible would be included and their voices and concerns given equal time and consideration. Policymakers would be open and honest, humble enough to take seriously suggestions from the public, and there would be institutional

mechanisms in place that dispersed power and responsibility across the spectrum of stakeholders. This is important as, 'Citizen participation and deliberation on issues that have bearing on people's everyday lives are regarded as the normative core of democracy' (Bäckstrand: 2004: p. 33). Such a model challenges current preconceptions but would arguably offer a more ethical way forward, allowing a platform for the often voiceless underprivileged to be heard. This is important as, '...their needs command the same ethical status as those of the more powerful members of society (Etzioni: 1968: p. 494). If we take, as an example, a hypothetical plan for a new public park, a new model approach would canvass and take the ideas of local residents seriously; they would be integral to each and every stage of the decision-making process. There would be trust in the public. If this is difficult for some to accept, it is only because they have come to accept the privileging of one citadel of knowledge over another. Critical readers who take issue with this or believe it to be 'utopian' may wish to pause to reflect on the origins and structures influential in their own normative and value assumptions. Why, for example, should the opinion of one or two planners, with perhaps a few years' experience after their doctorates (if that), trump the collective will and wisdom of residents living in the area for years? As Bäckstrand states, '...people should be able to deliberate on issues that affect their lives...those who bear the consequences of decisions should be able to have a say' (Bäckstrand: 2004: p. 33). This would represent an active, genuine and sincere form of participatory democracy rather than the representative form so common today which is never far from a creep into a soft form of despotism, serving the dominant and often unreflexive interests of the day.

CONCLUSION

It has been suggested, then, that the predominance of an instrumental form of rationality undermines democratic culture and, in doing so, impoverishes policy formulation and potentials. The Capital approach to sustainability arguably perpetuates, and is informed by, a narrow conception of sustainability, one informed by an instrumental rationality. This is seen clearly when considering the juxtaposition between the Capital approach and the vision of sustainability popular with 'deep' greens. It is hoped that by raising awareness of the predominance of one particular type of rationality, that potential alternatives will be made visible and more pluralistic discussions possible. This is important as, '...taken-for-granted paradigms constrain the range of policies that policy makers are likely to consider' (Campbell: 2002: p. 23). This arguably represents a more ethical and democratic way forward. Most importantly, however, and to return to the title of this paper, we must beware instrumental reason masquerading as truth. That is not necessarily meant to suggest that it is false but, rather, that it is one truth of many, now representing the dominant Citadel of 'legitimate' knowledge in the current era. There is a need, however, in a supposedly democratic culture to take seriously the diverse range of voices ever present in a population and to ensure that each and every voice is heard, not solely the dominant elites. Now that we are aware, now that the veil has been lifted and we can begin to see more clearly, the choice is ours.

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THE MYTH OF BEST PRACTICE THROUGH THE LENS OF CONSTRUCTION SUPPLY CHAIN MANAGEMENT

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Much is made of the concept best practice. It is repeatedly drawn upon by policy makers, academics and industry practitioners as a quasi-solution to construction industry ills. As an expression, it is often difficult to contest. Indeed, best practice implies identifying policy, process and procedure that offer the most optimum and efficient outcome. In short, best practice is all about improving performance. However, for the majority of commercial organizations, best strategy is also about improving performance. Despite the apparently congruent ambitions, best practice is not equal to best strategy. This misapprehension only serves to propagate the myth of best practice. This is a polemic paper, exploring the utility of best practice through the lens of construction supply chain management. Drawing inspiration from economic theory, construction management literature and previous supply chain management studies, the myth of best practice in construction supply chain management is exposed. Regardless of Government sponsorship and considerable academic investment, adoption of best practice in UK construction supply chain management remains slow and routinely symbolic. Yet, supply chain members do not behave irrationally. If best practice was truly in their best strategic interests it is highly probable that supply chain members would adjust their rules of economic engagement accordingly. It may be strongly argued that in contrast to the prevailing hype and repeated suggestion of supply chain win-win scenarios, UK Government endorsed best practice does not adequately serve the commercial interests of the majority. The very limited achievements of demonstration projects serve as a case in point. Disappointingly, few lessons appear to have been learned. The myth of construction supply chain management and by extension best practice in UK construction continues unabated albeit under a shiny new banner, Construction 2025.

Keywords: best practice, supply chain management, myth.

INTRODUCTION

Although 'myth' is frequently used to simply depict a falsehood, the definition adopted in this paper draws upon a similar conceptualization of myth as that mobilized by Bradley *et al* (2000 p.1),

"...by 'myth' we refer to widely believed bodies of ideas about the way work is changing. These ideas are held by entrepreneurs, managers, politicians and policy

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makers; they have been explored and developed by many academics, especially in management and business studies and in economics."

Whilst critiques of 'myths at work' include the myth of lean production, the myth of globalization and the myth of technology and science as the solution to workplace problems, this paper focuses upon the myth of best practice. Indeed, best practice continues to be mobilized by Government, academia and professionals to inform, shape and provide legitimacy within the decision-making process and as a way to legitimize both the form and the content of change initiatives (BIS, 2013b). Notably, whilst these myths are undoubtedly very persuasive and extremely popular, they have a tendency to reside beyond the critical gaze. This paper is an attempt to explore the myth of best practice through the lens of construction supply chain management.

The UK Government has a history of meddling in the machinations of the construction industry (see Murray and Langford, 2003, Adamson and Pollington, 2006). Political intervention is not unwarranted; construction is a significant contributor to the national economic and social climate. Recent figures indicate industry turnover is in the region of £90 billion (down approximately 20% on 2008 figures), gross domestic product (GDP) is 6.7% and direct employment figures equate to approximately ten percent of the UK working population (2 million employees) (BIS, 2013a, BIS, 2008). In short, construction matters.

For the UK Government, interest in construction is arguably twofold. First, the performance of the construction industry has both direct and indirect consequences for current and future Government fiscal policy, regardless of political persuasion. It is widely conceded that a buoyant construction sector provides a sound economic foundation and instils the commercial confidence necessary for a positive trade and industry outlook. Conversely, a construction industry in recession erodes consumer confidence and subsequently weakens prospects for a sustained socio-economic recovery.

Second, not only is Government a political guardian of construction industry interests, it is also a major consumer of construction services and goods. As the largest construction client, the 'buyer' objective of 'best value' and securing the 'most economically advantageous tender' arguably regulates the procurement process. The promise of best practice' gives the buyer added assurance that their key objective of 'value for money' will be achieved. In theory, any reduction in project waste via efficient and effective practices will culminate in 'project' cost savings. These cost savings can be passed to the construction client via increasingly competitive tender prices. Despite considerable political and by extension client intervention, the construction industry remains largely impervious to structural and cultural change.

Numerous reports, championed by previous Governments have repeated challenged the construction industry to 'change its ways' and improve both industry performance and reputation (Latham, 1994, Egan, 1998, Wolstenholme, 2009, BIS, 2013a). Indeed, the past two decades has borne witness to a concerted effort to 'correct' what the UK Government and various client forums' regard as endemic industry inefficiencies and substandard performance. In response to repeated criticism and self-examination, the UK construction industry sought to 'creatively swipe' management theory and best practice from other industries, most notably the automotive (Egan, 1998), retail and manufacturing sectors (Briscoe and Dainty, 2005). Industry examples of best practice include, total quality management (TQM) (McCabe, 1988), lean production (Koskela,

1992), business process re-engineering ([Green and May, 2003](#)) and supply chain management ([Holti et al., 2000](#)).

It is through the lens of supply chain management that the myth of best practice can be disclosed. Over the past two decades, supply chain management in construction has been a popular theme of the reform movement. However, best practice in construction supply chain management arguably remains overworked and under analysed. It is readily conceded that despite considerable effort, adoption of best practice in construction supply chain management is at best limited ([BIS, 2013b](#), [Fernie and Tennant, 2013](#)). Whilst conformist interpretation focus attention on adoption ([Redmond, 2003](#)), repeated rejection of best practice in construction supply chain management raises question marks over applicability. Mainstream response is to ask questions of the construction industry; for example 'why is the construction industry so backward?' ([Woudhuysen and Abley, 2004](#)). This paper embraces an unorthodox stance, asking questions of both best practice and those who continue to endorse it.

This is thus a polemic paper, exploring, exposing and debunking the myth of best practice by deconstructing the way in which supply chain management in construction has evolved. The discussion in the paper is organized as follows. The opening section of the paper outlines the concept of best practice. The next two sections provide an explanation of supply chain management including a contextually sensitive interpretation of current practice in construction supply chain management. The discussion section unpicks three key 'inventions' of best practice. The paper concludes that best practice has ultimately failed to serve its intended purpose and it is timely for construction stakeholders and industry to acknowledge the limitations and move on.

BEST PRACTICE

The term 'best practice' is not confined to construction. Best practice is applicable to a wide range of industry and non-industry disciplines. Consistent with many contemporary management terms, best practice has multiple definitions. Some define best practice simply as "*the knowledge that underpins examples of excellence*" ([SECBE, 2006 p.3](#)). Others adopt a more mechanistic interpretation, defining best practice as specific methods, techniques or processes that consistently lead to a desired and/or successful outcome. Regardless of the semantics, identifying and deriving best practice ultimately requires the study of work and adopting those methods, techniques or processes that are deemed to be more successful than others.

The concept, development and diffusion of best practice programmes have been a pivotal and continuing theme in the commercial campaign for improving construction efficiencies and eliminating waste ([Murray and Langford, 2003](#), [Green, 2011](#)). Over the past two decades best practice initiatives in construction have included procurement, risk management, health and safety, lean construction, business process re-engineering, performance management, integrated project teams and supply chain management. The comprehensive list of 'borrowed' business processes is indicative of the range, scope and chronic popularity of best practice initiatives in the construction management field of study.

Best practice is not without its detractors ([Fernie et al., 2006](#), [Green, 2011](#)). Sometimes viewed as a management fashion label, best practice it may be argued is essentially a one dimensional management / operational tool. Consequently, methods, techniques and processes that are proclaimed successful elsewhere are routinely transferred to extraneous business arenas, regardless of diversity, complexity and

discrete market conditions. According to Green ([2011 p.319](#)), this endorsement of over-simplistic “*improvement recipes*” has been the cause of industry problems as opposed to their solution. Despite this ‘informed cynicism’ and notwithstanding the symbolic or substantive contribution to construction industry performance, the concept of best practice continues to inform and shape both Government policy and construction stakeholder aspirations.

SUPPLY CHAIN MANAGEMENT

A universal definition of supply chain management remains elusive ([Stock and Boyer, 2009](#)). Given the lack of consensus, the term supply chain management frequently means different things to different people ([Skitmore and Smyth, 2009](#)). Indeed, the pluralistic nature of supply chain management creates ideal conditions for ambiguity and ongoing ideological tension ([Kraatz and Block, 2008](#)). Notwithstanding the potential for competitive definitions, a careful review of supply chain management ‘thinking’ over the past three decades disclose three principle schools of supply chain management thought; namely a functional school, philosophical school and a conceptual school.

With its origins in manufacturing, the first supply chain management school of thought focuses on traditional elements of company organization, such as logistics, procurement and production. This may be classified as the ‘functional’ school of supply chain management. The function is “*to leverage the supply chain to achieve the lowest initial purchase prices while assuring supply,*” ([Spekman et al., 1998 p.631](#)). This “*involves the buyer undertaking proactive supplier development work, not only at the first tier of the supply chain, but also at all the stages in the supply chain from first-tier through to raw material supply,*” ([Cox et al., 2006 p.34](#)). In response to greater commercial complexity and growth in global trading, alternative schools of thought emerged.

The second school of thought adopts a philosophical outlook. The pragmatism evident in the functional school is supplanted by an all-encompassing, panoptic interpretation of supply chain management. The traditional organizational boundaries between management function(s) and commercial exchange has become increasingly indistinct. Contemporary supply chain management is not simply about logistics, procurement or production; it is about the way the organization conducts business and engages in commercial relationships in its broadest sense. According to Mentzer *et al* ([2001 p.18](#)) supply chain management is “*the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole*”. In other words, supply chain management becomes a ‘way of working’.

Recent calls from the supply chain management community have arguably established a third school of supply chain management thought; namely, a conceptual school ([Carter, 2011, Choi and Wacker, 2011](#)). The crux of the debate is the suggestion that supply chain management is presently devoid of robust, coherent and discrete theoretical foundations. Proponents therefore argue that for future substantive developments in knowledge and understanding, it will be necessary to undertake an introspective and critical appraisal of current supply chain management theory and practice. This includes, theory building and conceptual developments that may challenge both the ‘functional’ and ‘philosophical’ schools of thought.

CONSTRUCTION SUPPLY CHAIN MANAGEMENT

In construction, the theory and practice of supply chain management continues to attract considerable interest (O'Brien *et al.*, 2009, Pryke, 2009, BIS, 2013b). There are very persuasive arguments for the adoption of supply chain management. However, in construction there are also complex and diverse factors that arguably require contextually informed appraisal (Green *et al.*, 2005, Fernie and Thorpe, 2007).

In stark contrast to the commercially refined, largely unilateral and longer-term trading relations emblematic of the manufacturing sector, the organization of construction supply chain management is fragmented and short (Skitmore and Smyth, 2009). In essence, there are two distinct supply chain configurations in construction; a client-led supply chain and a contractor led supply chain (see figure 1.). Both of which coalesce around the execution of the construction project.

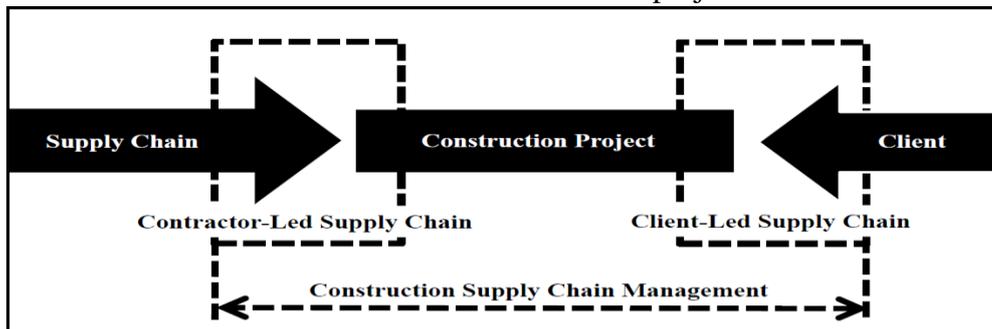


Figure 1: The Structure of Construction Supply Chain Management

The client-led supply chain reflects the traditional bi-lateral commercial relationship between the construction client and main construction contractor. Alternatively, a more progressive tri-lateral relationship between the construction client, specialist consultants and main construction contractor may be adopted. In the wake of the Rethinking Construction report (Egan, 1998), the tri-lateral arrangement of key supply chain stakeholders has grown in popularity (RICS, 2006, RICS, 2010). Regardless of membership or configuration, all the supply chain relationships are either project or repeat project orientated (Skitmore and Smyth, 2009). Given these project characteristics, the client-led supply chain is temporary and rarely extends upstream beyond tier one (the main construction contractor) or alternatively, downstream (the end-user).

The contractor-led supply chain largely reflects the bi-lateral commercial relationship between the main construction contractor and second tier construction service and product providers; namely, construction sub-contractors and/or suppliers. In reality, the contractor-led supply chain is a dyadic commercial relationship. In contrast to the client-led supply chain, the contractor-led supply chain has an organizational focus and rarely extends upstream beyond the second tier (sub-contractor / supplier). On the rare occasion when the supply chain relationship does extend beyond the second tier, it is typically a commercial relationship with a 'commodities' supplier; for example, doors, windows and/or plasterboard. Regardless of tier, commodities or provider, contractor-led supply chain membership is typically based on a number of performance criteria of which lowest price arguably remains first among equals (Eccles, 1981, Hartmann and Caerteling, 2010).

RESEARCH STRATEGY

The research strategy is not dedicated to testing a theory or building prescriptive models. On the contrary, the objective of the research is simply to adopt an alternative viewpoint, raise questions and stimulate debate. There are a number of parameters to this paper. Given the strong links between government policy, the reform agenda and supply chain management practice, the commentary retains a distinctly UK relevance. Informing the discussion is a wide ranging literature review. This draws inspiration from a number of discrete industry and non-industry sources including economic theory, government reports, construction management literature and previous supply chain management studies. Currently beyond the parameter of the discussion is two distinct construction industry sectors; namely, house building (domestic construction) and infrastructure (civil engineering).

DISCUSSION

Much is made of the concept 'best practice'. It is repeatedly drawn upon by policy makers, academics and industry practitioners as a quasi-solution for a range of industry ills. As an expression, it is often difficult to contest. Indeed, best practice implies identifying policy, process and procedure that offer the most optimum and efficient performance outcome. In short, best practice in construction supply chain management is all about improving performance.

The exploration, exposing and subsequent debunking of supply chain best practice is partitioned in to three distinct groups; namely, strategy, universal applicability and demonstration projects. Whilst the former two groups (strategy and universal applicability) may be labelled contested theory and owe more to persuasive discussion than science, the latter is based on a review of available empirical evidence. Individually they undermine best practice as a panacea for construction performance improvement and by extension industry transformation; collectively they reveal best practice as a workplace myth.

MYTH 1: BEST PRACTICE IS BEST STRATEGY

Whilst frequently considered as synonymous, best practice and best strategy can reflect very different business agendas. Best practice and best strategy on occasion may be congruent; however it is highly dependent upon a number of discrete variables. Crucially, interpretation of best practice is perspective dependent and this would include the individual and unique standpoint of each supply chain member. As Cox ([2006 p.31](#)) noted, *“the relationship between buyers and suppliers are essentially contested because of the non-commensurability of their objective interests...what may be desirable for one party in any exchange may not be equally desirable for another”*. This highly contested and commercially dynamic terrain repeatedly sanctions contradictory agendas based upon the self-interests of both the buyer and supplier.

For example, best practice from the client perspective (buyer) will in all likelihood equate to best strategy. This is simply because the commercial and wider business goals of best practice and best strategy are congruent. Embracing best practice is understood to improve both quality and time management, leading to a reduction in waste and most crucially lower the financial/capital cost. Client endorsement of best practice however frequently fails to consider the supplier viewpoint in exchange economics. Accordingly, best practice initiatives proposed by the client body (i.e. the buyer) are unlikely to be commensurate with a contractor perspective (supplier). On

the contrary, implementation of best practice may challenge key business objectives such as commercial leverage, relational power and trading margins.

Supply chain best strategy is unbound by the optimistic notions of best practice. It is readily conceded that concepts of best practice may inform strategic direction, however if best practice is perceived to compromise best strategy, then best practice will be largely overlooked or simply paid lip service. Supply chain members do not behave irrationally. If best practice was truly in their best strategic interests it is highly probable that supply chain members would adjust their rules of economic engagement accordingly. It may be strongly argued that in contrast to the prevailing hype and repeated suggestion of supply chain win-win scenarios, UK Government endorsed best practice does not adequately serve the commercial interests of the majority.

MYTH 2: UNIVERSAL APPLICABILITY

Universal applicability of best practice highlights two important drawbacks; namely context and competition. First, the diffusion and development of best practice and issues of context is neither new ([Green et al., 2005](#)) nor limited to supply chain management studies. Much has been written about the unique character and culture of the construction industry and the prerequisite for sympathetic interpretation of borrowed business practices witnessed elsewhere. The universal applicability of best practice evokes a rote generalizability that renders meaningless important local interpretations and tacit understandings.

For a project-based industry, universal applicability not only neglects industry and cultural context; the issue of knowledge transfer between construction projects is also largely overlooked. In Smyth's ([2010 p.268](#)) critical review of demonstration projects, it was stated that industry reports purporting to disseminate best practice "*tend to be descriptive of what was achieved with scant attention to how the achievements were brought about. This limits the extent and transferability of knowledge to other organizations*". Vagueness of time, place and circumstance undermines both the validity and extrapolation of the experiential learning taking place.

Whilst the universal applicability of business policy, process and procedure is routinely challenged, universal applicability of best practice and issues of corporate competitive advantage is frequently overlooked. Advocates of supply chain management suggest that organizations engaging with best practice are likely to increase their commercial competitiveness. This approach to competitive advantage is achieved by reducing project 'production' costs; these potential cost saving are passed on to the buyer (construction client). Although the construction client is at pains to stress that the construction contractor and by extension supply chain partner / member selection will be based on best value, this is arguably code for lowest capital cost. A low cost business strategy may impact positively on workload and turnover; however it does not necessarily address corporate margins.

In business, the over-riding goal "*is to position a company and its (services and) products where the market opportunity is highest.*" ([Nattermann, 2003 p.2](#)). Adoption of universally sponsored best practice arguably achieves the opposite. By herding supply chain members to adopt a standard business model, opportunities for organizations to differentiate themselves from supply chain competitors diminish. A diverse and complex network of economic exchange partners requires a dynamic and agile supply chain management strategy. It is doubtful that largely static, acontextual improvement recipes will afford supply chain members the opportunity to differentiate

services and goods within an unregulated, crowded and highly competitive marketplace. For the majority supply chain members, profit maximisation as opposed to profit-sharing continues to governs the strategic decision making process.

MYTH 3: DEMONSTRATION PROJECTS

Construction demonstration projects were a key feature of the reform agenda. By 2002 ([Egan](#)), it was reported that there were over 400 demonstration projects (38% housing and 62% construction) with a combined value of approximately £6bn. The statistics are impressive; however the use of demonstration projects to identify and disseminate best practice was arguably unsound. Labelling a construction site as a demonstration project immediately singles it out as different. All the supply chain stakeholders will be aware of this new-found status and as a result are likely to adjust their behavioural responses accordingly. Commonly known as the 'Hawthorne Effect', Fernie *et al* ([2006](#)) previously questioned to what extent this well-known phenomenon was considered in the final analysis of demonstration projects.

In addition to participants modifying their behaviour, demonstration project and learning by discovery has acknowledged limitations. Unless supported by “*explicit strategies for transferring learning*” ([Garvin, 1993 p.83](#)), there remains a inherent risk that poor scrutiny and casual analysis will actually promote supply chain inefficiencies and incompetence. Setting aside conceptual limitations and assumptions, arguably the most telling outcome from the construction demonstration projects was the lack of independent and rigorous empirical evidence ([Smyth, 2010](#), [Green, 2011](#)). Despite considerable investment and opportunity, the absence of substantiated, independently verified empirical evidence simply confirms the myth of supply chain best practice; it really does lie beyond the critical gaze.

RECOMMENDATIONS AND CONCLUSION

The question marks associated with demonstration projects are not insurmountable. Whilst resultant evidence of supply chain best practice may have been found wanting, the potential to learn and transfer knowledge remain. However, it may require an alternative set of ground rules. For example, why try to imitate management theory and practice from elsewhere? What about two hundred years of construction innovation? What about the significant majority (SME's)? Rather than reflect 'on' adopted best practice as in previous demonstration projects maybe encouragement should be given to reflect 'in' current construction practice.

Presently the rhetoric of supply chain best practice frequently belies the reality. At the heart of supply chain best practice debate is the ever-present non-commensurate business objectives of economic exchange. Whilst advocates of supply chain best practice are keen to declare the potential for win-win scenarios, win-lose scenarios remain far more common place. This is not a criticism of current construction supply chain management practice. Win-lose scenarios are simply a manifestation of the orthodox model driving economic exchange relationship in construction. Until this commercial tension is resolved in an approach that is commensurate to both the client (buyer) and the contractor (supplier), the myth of best practice in UK construction supply chain management is likely to endure. To suggest otherwise, is probably an example of unremitting buyer / supplier gamesmanship.

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GOVERNMENT INFLUENCE ON THE CONSTRUCTION INDUSTRY DURING THE ECONOMIC RECESSION 2007 - 2013

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Due to the high degree of international and economic integration across the globe, the 2007 global financial crisis quickly spread, causing recessions and widespread credit restrictions in advanced nations. During recessions, economic fluctuations cause dramatic changes to the market structure of industries, in particular, that of the construction sector. These structural changes can be further influenced by government strategies and policies; which if used incorrectly, can serve to fuel and exacerbate downturns. In contrasting form, during an economic recession, government strategies and policies can also be used to aid in exiting such economic turbulence. From an extensive review of literature it became apparent that very little research offered a comprehensive and systematic overview of Irish and UK construction related government policies and strategies adopted during recessions; hence the emergence of this topic. As part of an ongoing research PhD, the purpose of this paper is to collate and group Irish and UK Government strategies and policies adopted for the construction sector during the recession period 2007-2013; resulting in the establishment of a construction industry development framework and a taxonomic framework. The results reveal serious problems with the national strategic plan for the Irish construction industry, given that there is no overseeing body or target dates for implementation of the proposed actions. Furthermore, both countries failed to prioritize the proposed key actions within their strategic plans. The findings of this paper can be applied in the context of the construction sector to address shortcomings in the respective subsectors, while also aiding policy makers and company executives in mapping out future strategic milestones.

Keywords: economic development, government policies, recession, taxonomy.

INTRODUCTION

The 2007 global financial crisis which began in the United States was caused by an interest rate increase in July that triggered bankruptcies in the subprime market along with the start of tumbling house prices as demand dried up (Knopp 2010). The collapse of Lehman Brothers in September 2008 signalled the acute stage of the crisis, with the severe economic recession quickly spreading across the global financial system; causing recessions and credit crunches in advanced nations such as Ireland and the United Kingdom (UK). Subsequently, the challenging economic environment which unfolded sent unconceivable shockwaves across the construction sector as

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confidence weakened across the property sector. In response, governments used monetary and fiscal policy measures in order to stimulate growth and to maintain economic stability.

From a thorough review of previous studies it became apparent that very little research offered a comprehensive and systematic overview of Irish and UK construction related government policies and strategies adopted during the recent recession. To address this gap in knowledge, the purpose of this paper is therefore to collate and group Irish and UK Government strategies and policies adopted for the construction sector during the recession period 2007-2013. It aims to establish a construction industry development framework and a taxonomic framework, which will aid policy makers and company executives in mapping out future strategic milestones, while also providing a basis on which to benchmark the industry.

GOVERNMENT RESPONSE DURING RECESSION

Through its administrative power of intervention, government can play a major role in the construction industry, thereby influencing the market structure of the sector (Kang 2006). During recession, governments will generally change monetary policy by lowering the interest rate while it raises interest rates when there is inflationary pressure. With regard to fiscal policy in recessions, actions are generally taken by governments in order to stimulate the performance of the economy. During the recent recession, interest rates declined and inflation fell rapidly, leaving governments in both Ireland and the UK with little room to use monetary policy to stabilise the economy.

The scope of this study will be broadly based on fiscal policies, which according to the Federal Reserve (2012), refer to the tax and spending policies of government. Throughout the economic literature ongoing debates concerning two distinct theoretical approaches on fiscal policy come to the fore, namely; neoclassical and keynesian. Keynesian models purport that fiscal policy should be countercyclical, while neoclassical models imply fiscal policy should remain neutral (Cuadra *et al.* 2010). In the aftermath of the 2007 global economic recession, Krugman (2009) polemically argued that keynesian economics, in the form of expansionary fiscal policy (e.g increasing public expenditure), are required to foster economic growth. Furthermore, Claessens *et al.* (2009) in their study of 21 OECD countries during the period 1960-2007, found that expansionary policies are associated with less severe recessions. Conversely, Blinder (2006), after evaluating empirical evidence on the matter, argues against the use of discretionary fiscal policy.

In the construction industry, a lot of the research concerning government strategies and policies are profiled under the domain 'construction industry development'. Some of the more prominent works on the role construction plays in national economics and the influence of government on the industry include; Turin (1973), Ofori (1993a), Hillebrandt (1984), and Fox and Skitmore (2007). However, there are only a limited number of studies which examine construction industry development and government influence during times of recession (e.g Ofori 1988; Hillebrandt *et al.* 1995; Chiang *et al.* 2004; Ng *et al.* 2009), with little on theoretical developments. Ofori (1988), for instance, critically reviewed the construction industry in Singapore between 1960 and 1986. In 1985 Singapore suffered a national economic recession where GDP fell by 1.9%, mainly attributable to an oversupply of property. Despite attempts by government to stimulate demand in the private sector, and increasing expenditure by 5% on public sector works (Ofori 1993a), construction output fell by almost 12%. In

the UK, Hillebrandt *et al.* (1995) investigated the behaviour and strategies of 18 large UK construction contractors during the early 1990s recession, while also examining the construction environment. They concluded that the recession was caused by a tightening of monetary policy, where government increased interest rates from 7.5% to 15% to combat an overheated economy. Conversely, it caused the property market to collapse. Chiang *et al.* (2004) reported on a collaborative research project involving 11 Asian countries relating to the years 1995-2001. The study entailed a detailed review of each construction industry, specifically highlighting the industry behaviour and government policies adopted in response to the 1997 Asian crisis. In Australia, for example, they found that the implementation of fiscal policies, such as the goods and service tax in 2000, led to a contraction in construction activity of over 24%, however the sector steadily emerged out of this in 2001 (CII and Sharma 2004). Utilizing an extensive literature review and a series of interviews, Ng *et al.* (2009) investigated the construction industry development of advanced economies (Australia, Japan, Singapore, South Korea, UK) that encountered financial recessions. They summarised the strategies and policies adopted by the studied nations using a long-term framework which included five key attributes: government policies and strategies supporting construction business; industry led better practice and culture; financial resources and skill training; research and development for construction; and exploring alternative markets. In relation to government initiatives, they concluded that if a recession lasts for a long period of time, then it would be difficult for government to increase expenditure on public projects.

TAXONOMY OF GOVERNMENT STRATEGIES AND POLICIES

Given that most of the studies above analyse construction related government policies and strategies under a broad spectrum, the framework proposed by Ng *et al.* (2009), was further developed, resulting in a new construction industry development framework (Figure 1). Using the framework shown in Figure 1 as a guiding template, Irish and UK construction related government strategies and policies adopted during the recession period 2007 – 2013, were collated and grouped under a taxonomic framework (Table 1). While a full review of all government strategies and policies adopted during the recession are outside the scope of the study, those most applicable to the construction industry are outlined as follows;

- Strategic planning and reform - In response to industry pressure, the Irish Government published a national strategy for the construction sector in 2013, which set out a vision for the industry to 2015 and beyond (Forfas 2013). In contrast, the UK construction industry has gone through several years of reform after the Latham and Egan reports (Latham 1994; Egan 1998). Furthermore, a Housing Strategy was published in 2011 followed by the launch of Construction 2025 in 2013, documenting the vision and long-term strategic direction for the industry (UK Government 2013).
- Laws and regulations - To combat issues regarding poor quality standards the Irish Government announced publication of the Building Control (Amendment) Regulations 2013. Registered employment agreements were ceased in 2013; thus allowing employers to hire new employees on lower pay. The Construction Contracts Act 2013 was also enacted to combat the severe problem of delayed payments encountered by main contractors and subcontractors during the recession. In the UK, the Planning Act 2008 was introduced in order to fast-track the planning process for major infrastructure projects, while under the Localism Act 2011, a new major infrastructure

planning unit was established (Department for Communities and Local Government 2011).



Figure 1 Construction industry development framework

- Spending on Public works - In Ireland, expenditure on public capital projects in the years leading up to the recession averaged at €9.1bn per year (Government of Ireland 2008) while during the recession spending averaged at only €3.4bn per year (Department of Public Expenditure and Reform 2011). During the recession in the UK, public and private infrastructure investment increased from £41 to £45 billion per year (HM Treasury 2013). However, there was a 15% drop in the value of public construction output from a peak of £32.2bn in 2010 to £27.3bn in 2013 (Office for National Statistics 2014).
- Incentive Schemes - In 2011, the Irish Government established a new National Internship scheme called 'JobBridge', which provides work experience placements for jobseekers. The Government also implemented energy efficiency incentive schemes while conversely providing work for smaller construction firms through the Better Energy Homes scheme, and the Home Renovation Incentive scheme. The UK Government launched the Renewable Heat Incentive scheme for the non-domestic sector, while the Green Deal scheme was designed to entice home owners and businesses to adopt more green energy technologies. As part of the housing strategy 2011, a number of incentive schemes were implemented, such as; the New Build Indemnity Scheme, Firstbuy, and New Homes Bonus scheme.
- Innovative Sources of Financing - The Irish Government developed very few innovative ways of raising finance for construction projects during the recession. It wasn't until April 2013, some six years into the recession that Real Estate Investment Trusts (REITs) were launched. Conversely, the UK Government responded better to the economic crisis by providing finance for infrastructure projects through direct measures, such as the UK Guarantees Scheme, while also creating a new Green Investment Bank to tackle any shortfall in the debt markets (HM Treasury 2010-2013).

- Education, Training and Research - In Ireland, the Department of Jobs, Enterprise and Innovation increased expenditure by 17% during the period (Department of Public Expenditure and Reform 2011). As part of its jobs initiative programme, the Irish Government announced 'Springboard' which offers higher education places for the unemployed. In order to stimulate research and development, Enterprise Ireland launched innovation vouchers and innovation partnership grant programmes. The UK Government established the Tunnelling and Underground Construction Academy (TUCA), with the objective of training workers for major infrastructure projects, while the Employer Ownership Pilot (EOP) scheme was launched with the aim of allowing employers to design and develop their own training (HM Treasury 2013).
- Tender and Procurement Practices - In response to significant cost overruns on major public projects, the Irish Government introduced the Capital Works Management Framework (CWMF) in 2007. The UK Government set up 'Infrastructure UK' in 2010 in order to investigate methods of reducing costs on major infrastructure projects and to coordinate and simplify planning and prioritisation of investment in infrastructure (HM Treasury 2014). Similarly, the UK's Government Construction Strategy was launched with the main objective of delivering a 15-20% reduction in construction costs. The governments requirement of fully collaborative 3D BIM by 2016 is also stimulating change across the supply chain in the UK construction sector.
- Tax Reforms - In order to help the declining property market in Ireland, a new incentive relief from Capital Gains Tax was announced. The government also made changes to Value Added Tax (VAT) rates with a reduction in 2010 and an increase in 2012 (Revenue 2014). The UK Government also implemented tax reforms and as part of the fiscal stimulus package in 2009; VAT was reduced, along with the spreading of tax payments for SME's. Furthermore, in 2010 and 2013 the UK Government reduced Corporation Tax for large and small businesses (UK Government 2009 - 2013).
- International Assistance - During the recession Enterprise Ireland announced a €100m Enterprise Stabilisation Fund in order to help exporting small and medium enterprises (SME's) who were in financial difficulty (Enterprise Ireland 2009). They also launched a tailored training initiative called 'Leadership 4 Growth: Construction'. The UK Government through its Construction Strategy 2025, proposed the 'GREAT' brand, which identifies global trade opportunities for firms (HM Government 2013). The High Value Opportunities (HVO) programme was also launched, and aims to help UK firms bid and win work for large overseas projects (UK Trade and Investment 2014).

DISCUSSION

The taxonomy shown in Table 1 outlines the various construction related strategies and policies which were adopted by the Irish and UK Governments during the economic recession 2007-2013. Although a full discussion of all the themes portrayed in Figure 1 is outside the scope of the paper, the extent of the discussion will be focused on four themes, namely; strategic direction and reform; laws and regulations; international assistance; and spending on public works.

During the crisis the Irish construction sector lacked any form of strategic direction from government, taking some six years after the recession started, to announce a

national strategy for the sector. Meanwhile in the UK, strategic direction was accomplished a lot earlier, through the Housing Strategy in 2011 and the Construction Strategy in 2013. There were some significant problems identified with the Irish strategic plan, such as, the non-existence of an overseeing body to deliver the plan, and a lack of target dates for monitoring each of the proposed 36 key actions. In comparison, the UK's strategy adopts a more practical and realistic approach, in that, the plan is overseen and delivered by a new Construction Leadership Council, while the key actions encompass target dates on which to monitor their progress. Nevertheless, both strategic plans lack prioritization of the stated key actions. In his research on construction industry development, Ofori (1993b) reported similar observations with regard to construction sector strategic plans.

During the recession the Irish Government introduced the Building Control (Amendment) Regulations 2013 in order to deal with poor quality standards and to help combat the black (cash) economy. Yet again, the government delayed in adopting such an important regulation, but on a positive note, the new regulations bode well for the industry. All contractors and subcontractors involved must be registered and tax compliant, thereby reducing shadow economy operators, and the loss of revenue to the state. According to a survey conducted by the Construction Industry Federation (CIF) (2012), the number of black economy operations have increased by 90% since the downturn began. Also gone are the days of building off planning permission drawings, with all build stages now requiring proper supervision and compliance, thus bringing Ireland in line with UK standards. In the UK, the government responded swiftly by introducing the Planning Act 2008 in order to boost construction activity by fast-tracking major infrastructure projects. However, in five years only a mere 14 developments have been decided on, with government acknowledging that there is still room for improvement (Department for Communities and Local Government 2013). Moreover, with regard to both countries, there is cause for concern with the lack of appreciation by government of the importance of timely decisions during recession. Similar sentiments were acknowledged by Hillebrandt *et al.* (1995) relating to the 1990s recession in the UK.

In relation to international assistance, Enterprise Ireland has been proactive in assisting Irish construction firms export their services abroad. According to a Forfas (2013) report, a number of Irish construction companies involved in professional services have become well established in international markets during the recession period, with some companies reporting a 15% increase in export intensity between 2010 and 2011. Nevertheless, despite launching a tailored training initiative called 'Leadership 4 Growth: Construction', which was designed to develop the capabilities of Irish CEOs in attaining international growth (Enterprise Ireland 2014), several large Irish construction contractors failed miserably on their international expansion. For example, Sisk and Roadbridge ceased construction works in Poland in 2012 following major disagreements with the Polish roads authority, reporting losses in the region of €50 - €60m (Independent 2012). Evidently there is a serious need for more appropriate government action in helping Irish contractors to succeed internationally. A lack of government assistance was also evident in Hong Kong, with Chiang *et al.* (2001) concluding that the government has never helped local contractors in securing

Table 1: Taxonomy of construction related government strategies and policies adopted during the economic recession 2007-2013.

Strategies & Policies	Ireland	United Kingdom
Strategic Planning & Reform	Forfas report	Housing Strategy
	Establishment of new department	Construction 2025
Laws and Regulations	Building control regulations 2013	Localism Act 2011
	Cease of employment agreements	Planning Act 2008
	Construction Contracts Act 2013	
Spending on Public Works	63% reduction in spending	15% reduction in spending £14bn CrossRail project
Incentive Schemes	National internship scheme	Renewable heat incentive
	Better energy homes scheme	Green deal scheme
	Home renovation scheme	New build indemnity scheme Firstbuy New homes bonus
Innovative Sources of Finance	Real estate investment trusts	UK guarantee scheme
		Green investment bank
		Enterprise zones
		Insurance growth action plan
		Pension infrastructure platform
Education, Training & Research	17% increase in dept. spending	Set up TUCA
	Springboard	EOP scheme
	Innovation vouchers & partnerships	Patent box initiative
Tender & Procurement Practices	Capital works management framework	Infrastructure UK
		Construction strategy
		BIM mobilisation group
Tax Reforms	Capital gains tax relief	Reductions in VAT rates
	Introduction of property taxes	Spreading tax payments
	Changes in VAT rates	Reduction in Corporation tax
International Assistance	Enterprise stabilisation fund	'GREAT' brand
	Leadership 4 growth: Construction	HVO programme

contracts abroad through fiscal means. In contrast, the UK already have a well established base of international contractors with experience of overseas contracting spanning back many decades. However, only recently has the UK Government put significant emphasis on international growth for its construction firms; mainly through its Construction Strategy 2025. Through the High Value Opportunities (HVO) programme which was established in April 2011, UK firms have already won £8 billion worth of contracts at all levels of the supply chain (UK Trade and Investment, 2014), thus demonstrating the success of key government assistance. Similarly in Turkey during the late 1980s, a contraction in the construction industry resulted in a response from Government in the form of a signed agreement with the Russian Federation (Oz 2001).

During economic recessions the rhetorical question facing governments is; whether to spend your way out of recession or to implement acute austerity measures? Increased spending in the form of expansionary fiscal policy entails a Keynesian approach, while implementing acute austerity measures and shifting towards a balanced budget, encompasses a more neoclassical type approach. Between 2010 and 2013, military style austerity was the choice in Ireland, with spending on public works decreasing by 63%, while in the UK, less rigid budget cuts resulted in a spending decrease of 15%. This corresponds with economic theory, whereby contractionary budgets lead to economic and employment contraction. During the recession period 2007 - 2013, construction output in Ireland contracted by a staggering 79%; from €38.6bn to €8.25bn. In contrast, construction output in the UK contracted by just 5%; from £127bn to £121.1bn over the same period. Evidently, the severe reduction in spending on public works in Ireland has had a detrimental effect on the industry as a whole, however the effect on the UK construction industry was less prominent. As reported earlier, there is also an inherent risk in using the construction industry as a vehicle for economic growth. During the mid 1980s recession in Singapore the government increased expenditure by 5% on public sector works which conversely caused construction output to fall by almost 12% (Ofori 1993a). Economists will always generally disagree on whether government should use spending on public works to regulate the economy, or not. Furthermore, a consequence of low level spending during the six year recession period, particularly in the case of Ireland, is that there will be clear shortages and needs for public construction work, e.g social housing, viable transportation networks, and renewable energy schemes.

CONCLUSIONS

It is recognised that the government and its bodies play a major role in the behaviour and structure of the construction industry; particularly in times of recession. This paper has reviewed various construction related strategies and policies employed by the Irish and UK Governments during the recession period 2007-2013 under a construction industry development framework. Furthermore, this results in the development of a taxonomy of government strategies and policies, contrasting both Ireland and the UK. The results reveal serious problems with the national strategic plan for the Irish construction industry, given that there is no overseeing body or target dates for implementation of the proposed actions. Furthermore, both countries failed to prioritize the proposed key actions within their strategic plans. There is cause for concern for both countries regarding the lack of appreciation by government of the importance of timely decisions during recession. Also of particular concern are the ramifications of low level spending during the recession period, particularly relating to Ireland, given that there will be clear shortages and needs for public construction work.

The proposed taxonomy developed will aid policy makers and company executives in mapping out future strategic milestones, while also providing a valuable source of reference, especially during times of economic turbulence. It also provides a platform for academic researchers where the study could be used to investigate the effect of exogenous factors on the strategies adopted by construction firms during the recession.

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GENDER EQUITY IN CONSTRUCTION PROFESSIONS: A NEW INSTITUTIONALIST PERSPECTIVE

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The construction industry remains the most male dominated sector in Australia. Despite three decades of formal gender equity initiatives by government and business, there is little understanding of why there has been little change to the hierarchical and numerical underrepresentation of women. Using a New Institutionalism perspective, more specifically Lowndes and Wilson's (2003) concepts of robustness and revisability, the nature and intent of formal gender equity initiatives, policies and practices are analysed through a single case study of a multinational construction firm. Through in-depth interviews with senior management and a documentary analysis of formal equity and diversity policies it is concluded that the robustness and revisability of policies, initiatives and practices are critical to achieving lasting change in gender equity in the construction industry, as is a focus on men as well as women and gendered practices in policy design.

Keywords: gender, policy, equity, diversity, new institutionalism.

INTRODUCTION

The lack of gender diversity in the construction sector is a persistent problem recognised in Australia and elsewhere, which exacerbates skills shortages, reduces productivity and constrains innovation (Toohey *et al.* 2009). Despite many reforms to increase the representation of women in construction, it remains the most male dominated sector in the country (EOWWA 2012). Women's participation has fallen from 17% of the Australian construction workforce in 2006 (ABS 2006) to just 11.6% in 2012 (EOWWA 2012). Women in construction not only fare poorly among technicians, trades, labourers and machinery operators (3%), but also in professional and management roles (14%) (ABS 2012). These figures are typical of many Western countries (Sang and Powell 2012). Gender segregation is horizontal and vertical, with men numerically and hierarchically overrepresented (Sang and Powell, 2012). Men dominate senior 'technical', 'fee-earning' careers, while women congregate in junior, support roles and non-fee-earning professions such as human resources and marketing. Early enthusiasm from women about construction professions and their own careers in the sector decreases with increased exposure to the workplace (Dainty *et al.* 2000). In Australia, women are leaving the construction professions almost 39% faster than their male colleagues (APESMA 2010).

Laws and regulations underpin the legal case for gender equity and diversity in Australia, including state and federal sex discrimination and harassment laws (Sang and Powell 2012). The federal government requires companies with more than 100

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employees to report on both the nature and composition of gender in their workforce (WGEA 2012). In 2013 the Australian Stock Exchange (ASX) also introduced disclosure of diversity policies and reporting of gender targets for senior management positions for all publically listed corporations. Despite these initiatives, barriers to gender equity remain in many construction firms, including a lack of networking opportunities and challenges balancing work/family (Sang and Powell 2012). Further problems include bias and discrimination in construction company policies and procedures, informal recruitment and progression practices, and work which takes place during unsociable hours and in remote locations (Dainty *et al* 2000). The continued dominance of a culture which emphasises long hours and ‘presenteeism’ is problematic for many women (Watts 2007).

Given the intransigence of the gender equity issue in construction, a fresh approach to the problem is needed and the aim of this paper is to draw upon ‘new institutionalist’ (NI) theory to analyse the intent and nature of ‘formal’ policies and practices to attract, retain and support the progression of women professionals in the construction industry. This is an important contribution to knowledge since we need to understand formal policies before we can understand whether and how informal gendered rules and practices intersect with, and compete with, subvert or even substitute for formal policies (Chappell and Waylen 2013).

RECONCEPTUALISING GENDER EQUITY USING NI

Gender diversity research in construction remains theoretically weak. While research has recognised the existence of the problem and identified the industry’s masculine culture as a factor in recruiting, retaining and promoting women in the sector, it has not yet clearly conceptualised the impact of this culture, or paid attention to the operation of informal rules in frustrating the effectiveness of the initiatives which are widely used by construction firms to bring about greater gender equity (Sang and Powell 2012). There is a need to advance the theoretical debate in this area to better understand the failure of formal policies to shift the gender imbalance.

To this end, the application of a NI theory offers a valuable new approach for examining gender diversity in the construction sector. NI has developed around four main perspectives: rational choice; historical; organizational (or sociological) and more recently; discursive (or constructivist) institutionalism (Hall and Taylor 1996). The basic premise shared across these perspectives is that organisational rules and procedures “*matter*” (March and Olsen 1984: 747) in defining and organising decision-making and action in and out of organisations (Lowndes 1996). Rules and procedures are devised by human beings to enable, constrain and shape the behaviour of agents – people, organisations and government (DiMaggio and Powell 1983). They are a product of human agency and are constructed through processes of negotiation, conflict and contestation (DiMaggio and Powell 1991). Rules and procedures or ‘institutions’ outline acceptable behaviours and sanctions imposed if these behaviours are not complied with (Lowndes 1996; March and Olsen 1984). Rules and procedures may be both formal (e.g. legislation, policies) or informal (e.g. norms and practices). Formal rules are consciously designed and clearly specified’ (Lowndes and Wilson 2003: 279) and disseminated and enforced through official channels (Helmke & Levitsky 2004).

The design of institutional rules is the result of multiple designers with different perspectives about their origin, nature and intent (Lowndes and Roberts 2013). Furthermore, policy designers face constraints and challenges in the creation and

implementation of new rules and procedures as organisations have the capacity to “*absorb or deflect new initiatives*” (Newman 2001: 28). Once designed, weak implementation or a lack of active maintenance and revision of policies will ensure that policies are ineffectual (Meyer and Rowan 1991). Founded on the understanding of the constraints and challenges associated with institutional design, Lowndes and Wilson (2003) suggest a twin criteria framework for good policy design consisting of ‘robustness’ and ‘revisability’.

Robustness refers to the maintenance of policy strength and resistance to change over time. It is operationalised through: 1) clarity of values underpinning and being tied to policy design; and 2) the nature and effectiveness of policy enforcement, usually through sanctioning. Together a good fit between values and enforcement, help policies to ‘stick’ and shape organisational behaviour (Lowndes and Roberts 2013).

Revisability is the capacity for policy amendment or alteration, which is needed when a policy fails to achieve its objective. It is operationalised through: 1) flexibility and adaptation of policy design through policy learning over time; and 2) variability in policy design and the extent to which there is tolerance of different design variants in different locations (Lowndes and Wilson 2003). This is relevant to construction where policies often originate in head office and are implemented on-site.

METHOD

This paper presents preliminary analysis of the first phase of a larger research study examining gender diversity in the Australian construction industry. It uses a single case study approach to examine formal rules and their robustness and revisability. The single case study approach is frequently used both in organisational and policy analysis studies (Kanter 1977; Lowndes and Wilson 2003). While single case study research may not be generalizable, Flyvbjerg (2006: 223) argues that knowledge gained through case studies provides a highly valid and “*nuanced view of reality*”. Case studies are also important for testing theories (Patton and Appelbaum 2003), which is what we seek to do in relation to NI.

This study focuses on a privately owned multinational tier-one construction contractor, which operates in the commercial, residential, engineering and infrastructure markets. The company’s structure is typical and representative of large construction companies around the world, being led and managed by a CEO and executive management team, which is composed of regional managing directors, legal counsel and strategy, safety, human resource and operations directors.

Data was collected through a documentary analysis of the company’s HRM documents in relation to the attraction, recruitment, retention and progression of women and men. These documents included policies, strategies, and internal communications relating to gender equity, existing staff engagement surveys, employee performance and career progression planning strategies and pay equity analysis. In addition, semi-structured interviews were conducted with ten purposefully sampled policy designers, HR managers and business leaders, including the CEO. The purpose of these interviews was to build a picture of the nature and intent of the gender diversity policies in use, and develop an understanding of how these policies were sourced, (re)designed, disseminated, measured and enforced within the organisation. Interviews were recorded with permission from participants and transcribed verbatim and anonymised to protect interviewee identities.

DESIGNING NEW GENDER DIVERSITY RULES

Interviews revealed that context for the design and development of gender diversity in the organisation within the last 4-5 years was triggered by management's concern about a talent and skills shortage in the sector due to the recent construction and mining boom period in Australia:

"It came up primarily because we were looking at constraints in terms of our staff and where do we get new good staff, how do we grow staff and we looked at a whole range of issues and... one bleedingly obvious one was, ... half the population are female and we don't have anywhere near that in terms of our staff... we can tap into that – that can help." **RESP #1, CEO**

"We've had some economic conditions that were interesting, first we had the GFC, so you know you could pick and choose what resources you wanted but not long after that....our business was heavily impacted by a number of factors including the mining boom..., so it almost like kicked you up the butt that you had to think shit load more about your people." **RESP #3, Business Leader**

Policy development in this area also coincided with a heightened market awareness brought about by legislative changes to gender reporting and paid parental leave in Australia.

"There's been a lot of discussions and focus around women on Boards and the like, I think the more that's in the marketplace and just general industry, I think that helps to, you know, raise the awareness ... where it definitely wasn't a prevalent topic, you know, some years ago." **RESP #6, Business Leader**

Change appeared to be particularly noticeable to interviewees three years ago, with the appointment of a new CEO from within the Group, the introduction of an executive management team inclusive of a small number of women and a change in HR leadership:

"I think [the CEO] definitely has taken it on board and it's something that cascades from the top as a result." **RESP #9, HR Manager**

"[The HR Exec Director] and the other women on the executive management team ... they are the main agitators." **RESP #2, Business Leader**

"Who really makes the difference - it will be the CEO and then the regional managing directors because they are the drivers - I suppose I have a very old fashioned, simplistic view ...what interests my boss absolutely fascinates me. So my sense is unless things are being driven by those business leaders then it's not going to be in play." **RESP #7, Business Leader**

Yet it was noted by **RESP #10, Policy Author and Business Leader**, that there was "variations of readiness" for policy development in this area within the executive management team. She stated, *"I think they're all ready, but I think some are here and doing it and others are trying to still get their head around what it is that they're doing, yeah, and why."* In terms of policy robustness, it could be argued that business imperatives and leadership, rather than company values, have underpinned gender diversity policy development in this organisation.

Interestingly, with one exception, all interviewees associated gender diversity with increasing the number of women both through recruitment and retention in the company:

“I think there’s a pretty strong push in the industry and strong recognition that we’ve got to get more women in.” RESP #4, Business Leader

“Once we started that conversation then we – we did a fair bit of navel gazing as to well, for a start, how are we treating our existing, you know, female population and are they getting the same opportunities, are they being paid the same, are they – and that revealed some fairly interesting things.” RESP #1, CEO

Whilst interviewees identified that that the majority of their employees were men, they were overwhelmingly silent regarding the connection between gender diversity and men. They did not attach gender or gender diversity to men, but identified it as a problem for women (Lewis and Humbert 2010). This is interesting, as research has repeatedly acknowledged construction’s masculine culture is holding back gender diversity (Barnard *et al.* 2010), yet the interviewees made no reference or link between masculine culture, high levels of male presence and masculinity in relation to gender diversity.

In the last three years, to improve gender diversity the company has applied a variety of formal policies and initiatives. These mechanisms were often sourced and developed internally by management or via external consultants. These included policies and initiatives such as parental and care leave, affirmative action towards women in graduate recruitment, pay equity reviews and corrections, gender bias training for recruiters, women support groups, mothers groups, establishment of a diversity policy and a gender diversity committee. Policies such as the code of conduct and parental and care leave respond directly to the company’s legislative responsibility. Most of these policies and initiatives are tied to women, in contrast to other HR policies and initiatives such as flexibility and learning and development which are distinctively underpinned by the company’s values. Identified in policy documents, the company values resemble: safekeeping, exceed, teamwork and honesty. The company values are set within a “*can do*” (RESP #6, Business Leader) culture which sits alongside its “*DNA*” or unique company identity which promotes loyalty of tenure, ‘larrikinism’, openness and humility. The company DNA has been built on a rich history which sometimes appears to muddle the company’s values. It is also important to note, that while descriptors of values, DNA and culture may appear gender neutral on face value, a gendered dimension often underpins them.

The company has also pursued less direct initiatives and policies, such as diversity and gender bias training within management development training modules. It has commenced investigation around career pathways and transparent recruitment and progression practices within the company. Some initiatives have originated from focus group research in 2013 which explored employees’ perceptions of gender equality in their business. This research identified a clear disparity between men and women’s perceptions of the barriers and causes of gender inequality. The nature and inflexibility of the industry, the lack of women graduating from construction related courses and personal preferences or choices made by women were identified by men as key barriers to gender equality. Conversely, the dominant male culture, assumptions and stereotypes made about women and the lack of flexibility in the industry were identified by women:

“When we did ... some dedicated workshops in each region with a group of males and females... We got ... some fairly eye opening feedback about how differently things can be perceived ... That was fed back to the executives and

that – there’s some things that really stand out for them. Some comments about girls playing with dolls and boys with Lego. Just some archaic type thinking that you’re still unearthing from that whole piece. So then recommendations came through from that about the need to focus on career development and one up career conversations for females. ” RESP #9, HR Manager

The interviews reflected this in part, particularly in relation to the lack of women graduating from engineering and construction, and in the personal career choices women made with one interviewee advocating;

“We are still struggling with gender diversity because there are just not enough women in the market or coming through at a graduate level.” RESP #2, Business Leader

A key outcome of the internal research was a focus on flexible work practices within the organisation. Reinforced by results from the biannual company survey, which highlighted employee burnout and retention issues, a senior leadership group made flexibility their central project. Underpinned by company values and business principles, the group set out to establish a pilot on a new construction project where they aimed to meet program and six day production with company employees working a five day week. The pilot is considered critically important for the company and industry as a whole, yet in its introductory phase it has met with challenges associated to expectations placed on different site roles, particularly around responsibility and availability on site.

“It’s game changing for the industry if we can crack it in a way that I think is meaningful ... They’re struggling but we’ll get there.” RESP #10, Policy Author and Business Leader

Interviews with management indicate that policies and initiatives are disseminated with the company using a top down approach, rather than locally designed initiatives.

“Same story and messages...get cascaded down from the national exec to the state exec to the project managers on the site and the project manager on the site then cascades that stuff down through his – his project team.” RESP #1, CEO

Within the company, enforcement strategies were not in place and their existence dependent upon future assessment of policy success or failure, which relied on informal conversations often between senior management and employees and employee surveys:

“We haven’t ...I mean so far I think it’s – all the conversations, the anecdotal evidence and some of the stats is suggesting that it –that there has – has been some momentum. So I haven’t had to have a carrot or a stick and, you know, I – I think I’d have to address that one, you know, if – if we saw it trending that particular way.” RESP#1, CEO

ROBUSTNESS AND REVISABILITY

The work of Lowndes and Wilson (2003) suggests that the more robust and revisable the formal rules are, the more likely they are to become entrenched. Applying this framework to this tier one multinational contractor’s gender diversity policies and initiatives, a mixed picture emerges. Table 1 summarises our perspective of how the company’s policies align with the features of robustness and revisability framework.

It appears that the company has placed greater emphasis on revisability in policy design, whilst underplaying policy robustness. Policy robustness is operationalised through a clear tie to values and effective enforcement of policy. In relation to the policy documents reviewed, values are clearly underpinned by and are identified in some of the policies and initiative documentation, such as those associated with the flexibility and learning and development but are absent from policies associated with gender diversity, parental leave, remuneration and talent and succession planning. Enforcement of policies is not spelt out in the policy documents, with exception of the code of conduct which responded to legislation. From the interviews conducted, the pay equity policy whilst still debated has been enforced repeatedly by the CEO. The flexibility policy has been applied using a whole of project approach which changes the actual work practices on site, involving all employees. With regards to the remaining gender diversity policies, enforcement strategies were not detailed by interviewees and knowledge of what policies and initiatives are being followed and the nature of how they are being followed within the different company locations is poor. Self-enforcement of policies within the company appears limited.

Table 1: Robustness and revisability of company policies

Policy and Initiatives	Robustness		Revisability	
	Values	Enforcement	Flexibility	Variability
Flexibility (2)	●	●	●	●
Diversity (incl. gender) (7)			●	●
- Women's Group			●	●
- Mum's Group				
People	●*		●	
- Graduate recruitment			●	
Learning and Development (22)	●			●
- Diversity training			●	
- Gender bias training			●	
Code of Conduct	●**	●		
Parental Leave			●	
Performance (5)	●**		●	
Remuneration (4)		●	●	●
- Gender pay gap correction			●	
Talent and Succession (4)				●

(#) number of policies *in relation to flexibility only**makes reference but does not state values

Revisability is operationalised through the flexibility and capacity for policies to be adapted in response to learning from execution and through variable designs which respond to different locations and context. The company has undertaken extensive and ongoing learning via employee surveys and focus groups. Responses to these initiatives were taken and used to establish new policies such as flexible work practices on site, gender bias training for managers, exploration of company expectations associated with career pathways, investigation and adjustments to transparency around recruitment practices and pay equity analysis and correction. On the job learning from different groups across the business whilst highlighted as successful within the flexibility pilot, have been hidden by a lack of transparency between different regional groups. The company looked to use a moderate level of variability in policy design with a range of initiatives such as flexibility and pay equity

focused on reducing barriers to gender equity and which could be applied to different contexts within the business. The women's group which was initially designed as a support group for women within the business has evolved to include male managers, yet the focus still remains on women's experiences. From this preliminary study, it is difficult to gain a complete picture of the extent of policy variability across different contexts within the organisation. However, this will be more fully explored in the next stage of the research.

CONCLUSION

Although gender diversity in construction has been on the agenda of academics, government and industry for the last two decades, for our case study company and its management it has only recently emerged as a tangible issue deserving of action. New-institutionalism is not only useful for helping to explain why things stay the same, but it can also provide new insights for understanding how to achieve change. This is essential for developing new practical strategies to address the on-going gender imbalances in the construction industry. NI argues that good policies need to be robust and revisable in order to 'stick'. Policies that are unpinned by company values and are effectively enforced are robust. Policies which have been developed, adapted from lessons learnt and which are flexible in their application are revisable. At the same time, the policies which have been established focus overwhelmingly on women and revisability and are not particularly robust according to Lowndes and Wilson's (2003) definition. This is significant because the combination of revisability and robustness are both critical to embedding new rules and achieving change, in this case to gender practices.

This case study, although limited in terms of generalizability, illustrates how an NI framework can explain the lack of progress towards gender equity in the construction sector. Subsequent stages of this research will include comparison studies investigating the approach of other tier one multinational construction companies to formal gender diversity policies. We also acknowledge that individual formal policies and initiatives do not stand alone, but are embedded and intertwined in an environment with other formal and informal rules which both compliment or confound them (Lowndes and Roberts 2013). Good policy design therefore is not just about policy creation, but is an 'ongoing commitment to enforce rules, models of practices and rehearsed stories' (Lowndes and Roberts 2013: 171). NI argues that policy effectiveness therefore relies on human agency if it is to shift embedded or nested power relationships, particularly when applied to diverse contexts such as construction sites (Lowndes and Roberts 2013). Future stages of the research will therefore investigate the informal rules or practices and the narratives or story telling which exist and how these interact with the formal rules within our case study construction companies so as to understand the intransigent problem of gender inequality in construction.

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A CRITICAL REVIEW OF THE LITERATURE ON DISABILITY MANAGEMENT IN THE CONSTRUCTION INDUSTRY

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This paper reports on a review of the literature on disability management in the construction industry. The review explores the concept of disability management and existing guidance in the field in Canada before exploring the pillars of effective disability management programs. The review extends to investigating the literature on the topic as it pertains to the construction industry, focusing on the extent to which disability management practices are implemented in the industry and barriers to their successful implementation. The review is being conducted in preparation for an initiative undertaken by the Construction Engineering and Management at the University of Manitoba and funded by the Workers' Compensation Board of Manitoba. This initiative aims to evaluate the maturity of disability management practices in the Manitoban construction industry. The review shows how disability management as a concept developed in the mid-1980s. Its founding pillars include organizational policies and procedures; recruitment practices; employment retention practices; rehabilitation practices; modified or alternate work opportunities; awareness, training and promotion practices; involvement and collaboration; and monitoring and evaluation. While the concept appears to be constantly evolving, its application in construction remains limited. Only six research papers pertaining to disability management in construction were found, highlighting the need for more work on the topic. The review of these papers shows how the industry's disability management practices remain inadequate. Disability management continues to be seen as a burden to construction employers for the most part, making it difficult to challenge traditional perceptions. Using maturity modelling to evaluate the effectiveness of these practices with the ultimate aim of improving them appears to be an important research opportunity that needs further investigation.

Keywords: disability management, maturity modelling, return-to-work.

INTRODUCTION

In spite of decades of research and practice, there is incongruity between what employees with disabilities need in terms of physical arrangements (Palmon *et al.*, 2004) or organisational policies (Stone and Colella, 1996) and what is offered to them. Research shows how employers shy away from hiring people with disabilities because of negative expectations about performance (Kulkarni and Valk, 2010). There is a general assumption among employers that coworkers may not value the contributions of people with disabilities or may react negatively to them (Lengnick-Hall *et al.*, 2008). This is despite research showing how people with disabilities perform as well as other people (Kulkarni and Valk 2010). They are as committed and motivated, have

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fewer accidents in the workplace and do not have higher absenteeism or turnover rates (Colella, 1994; Lengnick-Hall, Stone and Colella, 1996). Liff (1999) argues how non-discriminatory recruitment approaches can actually enhance long-term profitability. This is significant for an industry like the construction industry where injury rates are staggeringly high, resulting in lower productivity and higher costs. In Manitoba, Canada specifically, construction related injuries accounted for approximately 14% of all injuries (Worker's Compensation Board of Manitoba (WCB) 2012), reinforcing the need for regulations and programs that ensure the fast return of workers with disabilities to the workplace and protect them from discrimination.

The paper provides a critical review of the current state of research in disability management in general and in the construction industry in particular, as well as existing guidance in place to support disabled construction workers. The review additionally identifies the pillars of effective disability management programs in the workplace. This is in preparation for a research conducted by the Construction Engineering and Management (CEM) Group at the University of Manitoba to evaluate disability management in the Manitoban construction industry and its relation to safety performance. This research seeks to develop a model to evaluate the maturity of the construction industry's disability management practices, to be used as a tool by construction organizations for benchmarking purposes. This is to shed more light on the significant gaps in the literature and address them by highlighting future research opportunities.

OVERVIEW OF DISABILITY MANAGEMENT

Disability management (DM) was developed by employers to control disability costs beginning in the mid-1980's (Galvin, Tate, and Schwartz, 1986). The concept built on older vocational rehabilitation programs for injured workers and gradually evolved to incorporate the return to work (RTW) model. As regulations became more stringent, aspects such as safety, ergonomics, ecological assessment and specialized case management strategies were integrated to it (Hursh, 1997; Rosenthal *et al*, 2005). Over time, the service-based approach evolved to a workplace based approach and took into account aspects such as organizational development, safety, risk management, and case management (Rosenthal, *et al*, 2007). These aspects became the foundations of disability management policies and programs. Disability management can be defined as a workplace prevention and remediation strategy that seeks to prevent disability from occurring. Lacking that, it aims to intervene following the onset of a disability using coordinated, cost-conscious and quality rehabilitation services to ensure continued employment of those experiencing functional work limitations (Akabas, Gates, and Galvin, 1992; Rosenthal, *et al*, 2007). In essence, it incorporates three key domains: prevention, early intervention and proactive RTW interventions to reduce the impact of injury and disability and to accommodate those experiencing functional work limitations.

According to Rieth, *et al*. (1995), DM involves three levels of disability prevention: primary prevention, intended to prevent on the job and off the job disabilities; secondary prevention, intended to minimize their impact and cost; and tertiary prevention, intended to encourage rehabilitation and RTW. In practice, most firms primarily concentrate on tertiary prevention, that is, intervene upon the occurrence of injury. Intervention at this level essentially limits the number of strategies that can be implemented without substantial cost implications, hence the reluctance my firms to formally adopt DM policies. According to Tshobotlwane (2005), employers

frequently overstate the cost of adjustments needed to accommodate disabled people in the workplace as an excuse to discreetly discriminate against them. The overriding focus on tertiary interventions greatly limits the effectiveness and impact of DM. DM is a model that should protect from work hazards and promote improvements in personal health behaviours (Angeloni, 2013). Unfortunately, this aspect is hardly considered when implementing DM in workplaces because of the focus on tertiary prevention to the detriment of primary and secondary prevention. Although prevention is the best way to protect employees and control costs, workplaces need a way to manage resources and assist employees should injuries and illnesses occur. A comprehensive DM program should enable early preventative actions and intervention, helping to alleviate many of the concerns experienced by injured or ill employees. It should improve communication and clarify the roles and responsibilities of the participants involved. It should also assist employees with many of the issues encountered on their way back to work. According to La Torre *et al.* (2009), key success factors for DM include “*injury prevention and safety programs, health promotion and wellness programs, early intervention and RTW plans, benefit programs design, internal and external communication system, education, worksite accommodations, transition work options, and identification of key worksite personnel*”. According to Lingard and Saunders (2004), construction firms pursue DM as a strategic organisational response to the globalization of the company's activities and the growing multiculturalism of workforces and a competitive necessity.

The success of DM programs has consistently been measured in terms of cost containment, administrative efficiency, and reduced complexity of benefit systems for the employer (Angeloni, 2013). DM advantages include improved employee health and safety and, thus, improved morale and satisfaction (Calkins *et al.*, 2000; Harder *et al.*, 2006). Therefore construction companies that implement DM programs should benefit not only from savings in direct costs but also in indirect costs. Indirect cost savings include lower disability insurance premiums due to a reduction in overall disability claims (Hargrave *et al.*, 2008; Kuhnen *et al.*, 2009). The premise of DM is that comprehensive policies that take into account the physical and organizational work environment as well as the personal health risks of individuals are more effective than those that consider each separately (Angeloni, 2013).

GUIDANCE ON DISABILITY MANAGEMENT

Research shows prevalent discrimination in the labour market against people with disabilities (Reynolds *et al.*, 1997; Duckworth *et al.*, 1998). In response to this, several countries have enacted legislation such as the Americans with Disabilities Act and the UK Disability Discrimination Act to protect their rights. Although Canada does not have separate legislation to protect their rights (Shrey and Hursh, 1999; Prince, 2010), over the last few decades, two pieces of legislation have been introduced at the federal level: the Canadian Charter of Human Rights and the Duty to Accommodate. These require employers to provide reasonable accommodation to workers to enable them to do their jobs. However, these regulations also have “*undue hardship*” clauses that can allow employers to circumvent this obligation. Additionally, Canada has invested heavily at the federal and provincial levels in the development of training programmes for DM, with the goal of creating safer work environments that accommodate employees with disabilities (OECD, 2010). An example includes the Targeted Wage Subsidies Programme, designed to encourage employers to hire employees with disabilities by temporarily subsidizing up to 100% of their wages to address their workplace accommodation needs (OECD, 2010). Despite these legislations, disabled

persons still face widespread employment discrimination. Although Canada does have human rights laws forbidding discrimination based on disability, this has not transpired into a federal disability act, resulting in very little progress for Canada (Burns and Gordon, 2010), particularly regarding employment equity. Only three out of ten provinces have their own disability legislation: Ontario's Accessibility for Ontarians with Disabilities Act (Government of Ontario, 2001 (revised 2005), Nova Scotia's Community ACCESS-Ability Program (Government of Nova Scotia 2005) and Manitoba's Accessibility Act (2013). The Council of Canadians with Disabilities (2005) stressed the need for a federal disability act and for integrated services for people with disabilities to ensure inclusiveness and decrease systemic barriers. Their report highlighted the inadequacy of existing policies in doing so. The disparities between federal and provincial legislation and programs seem to compound the problem, thus the need in Canada for programs that work in parallel rather than against each other (Burns and Gordon, 2010).

A major proponent in monitoring and regulating DM practices in the Canadian workplace includes the Workers Compensation Acts enacted in every province and their regulating bodies. The concept of workers compensation originated in Germany, Great Britain and the United States between the late 1800s and early 1900s. In Canada, workers compensation is managed by Workers Compensation Boards operating under provincial regulation (OECD, 2010). Federal employees who are not under provincial jurisdiction are covered by the Federal Government Employees Compensation Act. The aim of these acts is to provide compensation to injured workers regardless of fault, ensure their timely and safe return to work and prevent workplace injuries and diseases. Premiums are paid by employers to an "*Accident Fund*" and rated according to industry classes and occupations, and individual employer's experiences. The more work injuries or illnesses occur at the workplace, the higher the premium. Under the Workers Compensation Act and Occupational Health and Safety Regulations, employers are responsible for short and long-term disability benefits to employees who experience work-related injuries and illnesses. Premiums accumulated are directed towards providing medical and rehabilitation aid, supplementing lost wages to injured workers and paying for board administration fees.

At the industrial level, construction companies have an obligation to their employees with respect to disability management (DM), whether there are formal procedures in place or not. In Manitoba, RTW programs implemented to manage disability involve reporting and documenting work injuries, offering alternate work, or modifying existing work (WCB 2010). Modifications include altering aspects related to workers' duties, responsibilities, work location, work hours or any combination of these. Although agencies like the WCB encourage and promote the implementation of DM in workplaces, many construction firms do not have formal DM and return-to-work programmes and practices (Ormerod and Newton, 2004). This is because of the limited opportunities for alternate or modified work in construction, and the fact that construction work is varied and changes from project to project. The difficulties associated with constant work restructuring in addition to the cost implications of doing so act deter firm from adopting formal DM programs.

FOUNDING PILLARS OF DISABILITY MANAGEMENT

This literature review involved identifying the founding pillars of disability management through reviewing a number of existing relevant initiatives and handbooks in the UK, Canada and United States. These include the Effective

Workplace Disability Management Program, Canada (2013), the National Institute of Disability Management and Research's Disability Management in the Workplace Guide (2003) and the Employer's Forum on Disability (EFD) Action Plan (UK). DM best practices can be categorized into the following eight founding pillars.

Organizational policies and procedures

The foundation of a disability management program is based on the development of an organisational policy and organizational procedures, their dissemination and implementation, and the development and implementation of evaluation mechanisms. These policies and procedures usually include: a mission statement for the program, the program objectives, details on program administration and accountability and definitions of the roles and responsibilities of key stakeholders (National Institute of Disability Management and Research's Disability Management in the Workplace Guide, 2003). They also include information on program eligibility, roles and responsibilities of other departments and partners (e.g., occupational health and safety, benefits providers), and grievance-resolution procedures (OHSAH, 2010). The comprehensiveness of the program is dependent on the size of the company. Saunder and Lingard (2014) found that small construction firms did not have formal processes in place to manage disability management and therefore needed greater assistance than medium-to-large companies. This problem is compounded by the fact that existing legislation does not require organizations to adopt formal DM policies.

Recruitment practices

This encompasses practices that ensure the inclusion of disadvantaged people in the recruitment and job selection process. Examples include interviewing applicants with a disability who meet minimum job requirements, considering them on their abilities (IRS, 1996, Dibben, *et al*, 2000) and inquiring about what can be done to better accommodate them (IRS, 1996, Dibben, *et al*, 2000).

Employment retention practices

These practices aims to ensure that employees who become disabled or injured remain employed (IRS, 1996, Dibben, *et al*, 2000) and are not wrongfully terminated.

Rehabilitation practices

This set of practices aims to ensure optimal functioning of employees who experience a disability by improving their interaction with the physical environment through the provision of physical accommodation measures (The Conference Board of Canada, 2013). Examples of such measures include technical aids and devices; accessible transportation; handrails and ramps; accessible elevators, workstations and washrooms. The nature of construction projects, with the majority of the work centered on site projects greatly impedes the provision of specific accommodation for injured and disabled workers.

Modified or alternate work opportunities

This includes the completion of a job needs assessment to determine how the DM program can best meet the needs of employees with disabilities (Brooker *et al*, 2012). In some cases, it may not be possible or financially viable for employees to return to their original jobs, and transitional job options may not be immediately obvious. In this situation, a comprehensive analysis of employees' skills is done to modify their original jobs or identify alternate jobs within the organization for which the employee would be more suited (The Conference Board of Canada (2013). Modified work can

reduce disability-related costs, facilitate workers' recovery and return to work and reduce the likelihood of similar injuries. Such practices also ensure that the company is fulfilling its legal obligations (National Institute of Disability Management and Research's Disability Management in the Workplace Guide, 2003). While the provision of alternate or modified work can be challenging in construction, Welch *et al.* (1999) identify a number of modifications that can be made to the jobs of injured construction workers to help return back to them.

Training and promotion practices

Effective communication and promotion of a DM program ensures widespread understanding and support for it within the organization (OHSAH, 2010). Open communication builds trust among employees and helps address negative attitudes about the program. However, this can be challenging in conventional building projects that are characterized by miscommunications and adversarial relationships, thus the need to train supervisors and raise awareness on DM in the workplace. This should help address the stigma associated with it and facilitate the successful return of injured workers (Brooker *et al.*, 2012). The provision of training programs to RTW coordinators and supervisors should ensure the effective implementation of related practices and promote the employment of people with disabilities (National Institute of Disability Management and Research's Disability Management in the Workplace Guide, 2003).

Involvement and collaboration

Collaboration is essential to the successful management of disability in the workplace. A DM committee helps take into consideration the perspectives of employees with disabilities and other stakeholders. The committee can inform union leaders of upcoming changes to the program for example and involve them in the decision-making process for the ultimate benefit of the employer and employees (Brooker *et al.*, 2012). It can also ensure stakeholders' access to information and discuss with them workers' needs and functional capabilities. It can also facilitate face-to-face meetings between employer and employees to address RTW issues and enable supervisors to address employees' concerns early on (OHSAH, 2010).

Monitoring and evaluation

To succeed, a workplace program must be evaluated regularly. This allows the employer to identify necessary program modifications and improvements and analyze injury and illness statistics (OHSAH, 2010). It also helps justify program costs and assess its benefits. The evaluation ensures that the program meets not only its overall objectives, but employees' needs as well. The RTW plan for each employee should also be evaluated accordingly. This is to ensure that employees are not aggravating their physical or mental health conditions by returning to work too quickly and that their individual needs have been met effectively (The Conference Board of Canada, 2013).

DISABILITY MANAGEMENT IN CONSTRUCTION

Research on DM in construction is still in its early stages, with very few journal papers published on the topic. A study by Clarke *et al.* (2009) analyzed the British and Dutch approaches to DM in the construction industry and found the Dutch model to be more skewed to the social model, while the British one was considerably more regulated. The authors found the construction industry in both countries to be highly disabling and exclusive. The nature of the industry is such that many construction

workers do not have a long-term relationship with their employers; compounding the unwillingness of employers to accommodate them should they get injured (Welch *et al.*, 1999, Lingard and Saunders, 2004). The study recommended sector specific approaches in disability policy that further narrows down on specific dynamics within different sectors. Small construction firms are also less able to accommodate injured workers than larger ones because they are less likely to have the resources to do so (Kenny, 1999, Lingard and Saunders, 2004). Therefore, workers in small firms are more likely to suffer if injured than workers in larger ones (Cheadle *et al.*, 1994). Many employers perceive that people with disabilities don't have a place in the construction industry (Newton and Ormerod, 2005; Tshobotlwane, 2005), with new entrants facing more challenges than returning ones. This is because employers are less likely to recruit people with disabilities than to take back ones disabled because of an injury on the job (Newton and Ormerod, 2005).

The review also shows that there is little to no formal practices in place to support construction workers with disabilities and that employers are ready to comply with existing legislation only when adjustments to do so are minor and inexpensive (Tshobotlwane's 2005, Newton and Omerod 2005). Construction employers are also less likely to have such policies and practices than employers in other industries (Newton and Ormerod 2005). Tshoboltwane's (2005) survey of employers and workers with disabilities in the South African construction industry found the majority of employers ignorant of the Employment Equity Act Provisions. Employers who had complied with the act found the cost to do so negligible. This directly contradicts the findings of Lingard and Saunders (2004) who through their study deducted that most construction companies regarded DM to have increased their operating costs with negligible benefits in terms of worker output. Additionally, firms were reluctant to adopt and implement formal rehabilitation and RTW programs because of the difficulty with providing suitable alternate work for disabled persons. Lingard and Saunders (2004) found that construction injuries usually led to long-term disability: a disturbing fact given the lack of formal polices in place to prevent this. Unlike the results by Newton and Omerod (2005), employers surveyed by Lingard and Saunders (2004) thought disability management practices increased operating costs but provided little to no return in terms of reducing lost workdays.

Jobs for workers with disabilities automatically excluded by employers included "*ladder climbing, walking on rough ground, tunneling, working at height, working in confined spaces, working on the railways*" (Newton and Omerod 2005). In their research, Smallwood and Haupt (2008) found that physical impairment made workers with disabilities more suited to administrative work.

A later study by Omerod and Newton (2013) used interviews and mini focus groups to investigate barriers to the employment of young people with disabilities in the UK construction industry. The study revealed the need for inclusive approaches that would treat workers with disabilities equally rather than favourably. The industry including both employers and professional institutions also needed to raise awareness on the range and scope of opportunities available for young workers with disabilities to dispel the myths that construction work is only for able-bodied, fit men. Smallwood and Haupt (2008) recommended that governments provide incentives to encourage the employment of people with disabilities.

CONCLUSION

Overall evidence suggests that an effective disability management program is needed to ensure a healthy and inclusive workforce, yet many in Canada have not yet adopted the type of multi-faceted approach required for this, especially in construction. The problem is complex and requires the collaboration of all industry stakeholders to reduce the burden of workplace disability and challenge traditional perceptions. This research aimed to review the literature surrounding the concept of disability management in general, and in relation to the construction industry specifically. This is in anticipation of a study conducted by the CEM Group at the University of Manitoba with funding from the Workers Compensation Board of Manitoba to evaluate the maturity of disability management practices in the Manitoban construction industry in relation to safety performance. The literature review covered the concept of DM, briefly identified the pillars for a successful DM program and explored guidance in Canada aimed at promoting equality in the workplace. The findings of the review reveal the inadequacy of formal DM programs employed by construction firms and an overall hesitance towards integrating disabled persons in the industry. The fact that only six research papers pertaining to DM in construction were found, none of which focusing on Canada, highlights the need for further research on the topic. This is essential to enable the move towards a more inclusive environment for all people irrespective of their disabilities.

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HOUSE BUILDING

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EXPLORING INDUSTRIALISED HOUSE-BUILDERS' PERCEPTIONS OF LOCAL REQUIREMENT SETTING - AN INSTITUTIONAL LOGICS PERSPECTIVE

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Industrialised house-builders (IHBs) are housing contractors who use standardised processes and building systems as a means to time and cost efficiently address the current housing shortage in Sweden. Recent governmental investigations argue that the mandate for local planning authorities (LPAs) to intentionally set stricter requirements than those prescribed in the national building code can stifle the potential for increased industrialisation. The aim of this paper is to explore IHBs' perceptions of local requirement setting (LRS). It seeks to use the concept of institutional logic to advance the understanding of how LRS affects IHBs. Data was collected through in-depth interviews with representatives of five IHBs encompassing a mix of building systems spanning the Swedish multi-family housing market. From the data we identify three distinct categories of LRS: intentional, interpretive and public procurement-related. The respondents' perceived issues with LRS are found to relate more closely to the process of setting requirements than to the requirements themselves. The political debate about LRS has entirely neglected interpretive LRS, LRS in public procurement as well as the entire process perspective. Institutional logics is shown to offer new and interesting perspectives on the agency/structure dominated cognitive and intra-organisational processes that shape the emergence of local requirements in interpretative LRS and LRS in public procurement respectively. Since LRS is affected both by individual planning officers (agency) and the LPA organisation (structure) further studies will explore their perceptions of LRS.

Keywords: housing, industrialised house-building, institutional logic, local planning.

INTRODUCTION

Sweden is suffering from an increasing shortage of housing. Statistics (Prop. 2013/14:126) show that during the last decade the increased housing demand on the housing market due to population growth has outweighed the increased supply from newly constructed housing. Increased industrialisation, due to being regarded as a way to meet clients' demands for lower production costs, shorter time frames and higher product quality in construction, is promoted as a potential remedy to the housing shortage both by governmental investigations (SOU 2012:86, Statskontoret 2009) and by national research agendas (Stehn *et al.* 2013). Swedish construction clients have significant barriers towards adopting technical innovations and do not actively drive the development towards an increased industrialisation (Hedgren and Stehn 2014). The practices of local (municipal) authorities related to local planning and public procurement have also been identified as barriers to increased industrialisation, both

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by suppliers and clients (Stehn *et al.* 2013) and by the government (SOU 2012:86). Little research attention has been given to external project conditions stemming from governmental agencies, particularly in a Swedish context. For example, a UK survey of the leading house-builders identified the slow process of obtaining planning permission as a significant barrier to the use of offsite MMC (the UK movement towards increased industrialisation), that the many potential benefits of offsite MMC were not realised due to the delayed planning process, and suggested that the UK planning system needed to become more flexible (Pan *et al.* 2007).

In Sweden the movement towards increased industrialisation is spearheaded by industrialised house-builders (IHBs). IHBs are housing contractors who use standardisation and repetition of processes, building parts and methods to create products which, as opposed to traditional construction projects, are concurrently based on the specifications of client and the limitation of the pre-defined building system (Engström and Stehn 2014). Each IHB's chosen engineering and production strategies dictate the level of pre-definition of their building system and the reduction of its design flexibility (Johnsson 2013). Design flexibility entails two interrelated dimensions: compliance with varying client/customer demand and adaptability of the building system. Demands that influence the adaptability and that are not configurable to the building system are difficult for IHBs to accommodate because they interfere with the engineering and production methods. Demands that are configurable can more easily be met through product development or even adjusted for a specific project. To counteract their reduced design flexibility IHBs are forced to make an early entrance into the design phase (Brege *et al.* 2014) and by extension also into the local planning process. Even so, IHBs are still dependent on external requirements on projects being transparent, predictable and adaptable in order to realise the benefits from the use of their building systems.

The right for local planning authorities (LPAs) to set requirements for local construction projects is central to Swedish construction law. Societal changes have led to an increased need for municipalities to profile themselves, thus inclining LPAs to exercise this right more extensively. SOU 2012:86 concluded that the municipal practice of local requirement setting (LRS), the action to set requirements which intentionally specify a higher standard than that which is prescribed in the national building code, has led to a situation with largely varying requirements between and sometimes within the 290 different Swedish municipalities. The practice of LRS is considered to disregard IHBs' needs for transparency and predictability and thereby stifling the potential for increased industrialisation (SOU 2012:86). The position taken in this paper is to question this standpoint. The public and political debates surrounding LRS has primarily focused on these intentional local requirements and the government proposition to forbid them. But, what if changing the legislation is not the solution to all problems related to LRS? What if LRS is an issue of the process of setting requirements rather than an issue of the requirements themselves?

The aim of this paper is to explore IHBs' perceptions of LRS. The study uses the theoretical concept institutional logic to advance the understanding of LPA's practices related to LRS and how these practices affect Swedish IHBs. Institutional logic offers a holistic perspective on the interplay between individuals and organisations and highlights enabling as well as constraining effects on social actors on both of these levels. Data was collected through exploratory interviews with five contractors, who encompass a mix of building systems and together give reasonable coverage of the multi-family housing market. By contrasting the data with institutional logic it

becomes evident that the problems perceived by the respondents extend beyond the requirements themselves. Rather, these problems relate to the process that shapes their emergence of local requirements.

RESEARCH DESIGN, DATA COLLECTION AND ANALYSIS

Empirical data in this on-going work was collected during August 2013 - January 2014. The data collection was performed through the use of explorative interviews with representatives from five different IHBs in order to provide insight into their perceptions of LRS. We consider an IHB's perceptions to be the collective of the perceptions of the individual that make up the organisation so by exploring the perceptions of its individuals we may draw conclusions about the perceptions of the entire organisation. The chosen IHBs encompass a mix of building systems which spans a large portion of the Swedish multi-family housing market and the respondents all have experience with the issues between IHBs and LRS (Table 1).

Table 1: Overview of the selected IHBs 1 - 5 and respondents R1 - R9

IHB	Degree of off-site production technology (Pan et al. 2012)	Respondent: IHB-experience in years (position)
1	Modular building	R1: 8 (CEO) R2: 7 (Marketing manager)
2	Modular building	R3: 20 (Marketing manager)
3	Modular building	R4: 10 (Marketing manager)
4	Component and subassembly	R5: 4 (Architect/Urban planner) R6: 4 (Concept manager) R7: 4 (Marketing manager)
5	Non-volumetric preassembly	R8: 7 (Marketing manager) R9: 7 (Development manager)

The respondents were asked questions about (1) what their overall perceptions of LRS was, (2) which consequences LRS has for them, (3) how they counteract these consequences of LRS, (4) how they perceive the actions of LPAs in relation to LRS and (5) why they believe that the LPAs act in such a way. These questions were derived from the collective pre-understanding present within our research group. We endeavoured to perform all interviews in situ as indirect interview techniques deprive the researcher of seeing the respondents' informal, nonverbal communication. Even so, a number of follow-up questions for clarification purposes were asked via telephone and e-mail. The interviews, which lasted for 60-90 minutes each, were recorded and subsequently transcribed.

Together with a review of recent governmental investigations of the legislative framework for housing construction and lead times in the planning and building process the data from question areas (1) and (2) were used to develop a contextual description. They were also used to formulate a categorisation (Figure 1) of different categories of LRS. Due to the size of the data from question areas (3), (4) and (5) a pre-analysis was performed prior to its analysis in relation to the aim. This preanalysis served the purpose of restructuring and condensing the data material in preparation for the main analysis. In order to preserve the depth and richness of the data we elected to perform this process manually. The main stage of the analysis entailed contrasting the

restructured interview data with two of the core concepts of Thornton's *et al.* (2012) model for institutional logic: dynamic constructivism and symbolic interactionism.

INSTITUTIONAL LOGICS: AGENCY AND STRUCTURE

The dichotomy of agency, the autonomy of social actors (individuals or organisations), and structure, the institutions which limit the choices of social actors, resides at the core of institutional theory. Institutions are understood as *“supraorganisational patterns of activity by which individuals and organisations produce and reproduce their material subsistence and organise time and space. They are also symbolic systems, ways of ordering reality; thereby rendering experience of time and space meaningful”* (Friedland and Alford 1991: 243). Early neo-institutional scholars typically emphasised the importance of institutional structure, and deemphasised the importance of agency, for shaping organisational practises. Institutional rules (Meyer and Rowan 1977) describe appropriate ways to manage organisations within certain organisational fields and provide legitimacy to organisations which conform to these rules. An organisational field can be thought of as a group of organisations that constitutes a recognised area of institutional life, e.g. suppliers, consumers, competitors and regulatory agencies (DiMaggio and Powell 1983). DiMaggio and Powell (1983) theorise that all organisations within one organisational field are subject to isomorphism, i.e. gradually become more similar over time. Early neoinstitutional theory's one-sided focus on structure, for which it has often been criticised, eventually prompted Friedland and Alford (1991) to develop the concept of institutional logic, in an attempt to reintroduce agency into the institutional debate.

The paradox of embedded agency

Institutional logics are defined as *“the socially constructed, historical patterns of material practices, assumptions, values, beliefs, and rules by which individuals produce and reproduce their material subsistence, organize time and space, and provide meaning to their social reality”* (Thornton and Ocasio 1999: 804). The concept deals with three interrelated levels of analysis: individuals competing and negotiating, organisations in conflict and coordination, and institutions in contradiction and interdependency (Friedland and Alford 1991). Institutional logics scholars currently recognise seven institutional logics: family, community, religion, state, market, profession and corporation.

Friedland and Alford's (1991) efforts to reconcile agency and structure resulted in the model known as embedded agency. Embedded agency simultaneously enables and constrains agency. Opportunities for agency are provided through contradictions between institutional logics and constrains are provided through establishment of core principles for organisational activities and channelling of interests (Thornton *et al.* 2012). Some scholars, e.g. Holm (1995) and Seo and Creed (2002), have viewed embedded agency as a paradox: how can individual social actors change institutions if their actions, intentions, and rationality are all conditioned by the very institution they wish to change? Due to lack of explicit theory regarding embedded agency, this paradox remained unresolved for many years. Thornton *et al.* (2012) has recently developed a model for the cognitive and intra-organisational processes which make up embedded agency by adopting theories from social and behavioural psychology.

Social identities, goals and schemas in interaction

Thornton *et al.*'s (2012) model, adapts the concept of dynamic constructivism (Hong *et al.* 2000, Hong and Mallorie 2004) in an attempt to resolve the paradox of embedded agency. According to this view institutional logics are best understood as learned knowledge structures that, as a result of differences in social interaction and socialisation, are unevenly distributed across a population. Individual social actors' actions rely on the availability, accessibility and activation of the different institutional logics that individual social actors can learn (Thornton *et al.* 2012). Opportunities for agency through contradictions exist when at least two logics are available to an individual social actor, but all available logics are not equally accessible. Accessibility is determined by previous experiences which associate the situational context to particular institutional logics (temporary accessibility) and by structural elements such as organisational routines and practices which directs the actor's attention towards certain logics (chronic accessibility). In routine situations individual social actors are likely to activate chronically accessible logics. In novel situations temporary accessibility determines which logic is activated. If no highly accessible logic is deemed to be applicable to the situation agency is achieved as other available but less accessible logics may be activated instead.

Thornton *et al.* (2012) further posit that a number of social identities, goals and schemas are culturally embedded within all institutional logics. The identities and goals embedded in one logic can be either contradictory or interdependent to the identities and goals embedded in another. Schemas guide expected behaviours and are used by individual social actors for resolving ambiguities and drawing inferences. Under novel conditions the schemas embedded in the most accessible logics are incongruent with the situational context. In these cases the actor may attempt to resolve the incongruences by activate combinations of social identities, goals and schemas from multiple logics simultaneously.

Drawing on Mead's (1934) concept of symbolic interactionism Thornton *et al.* (2012) posit that a group of social actors use distinct symbolic languages of the institutional logics they activate to ritualistically interact with one another and generate a shared focus of attention. In these interactions schemas provide frames, different interpretations of the social reality. As individual social actors are embedded within different logics they may activate social identities, goals and schema which contradict with those activated by others. Such contradictions serve as barriers to cooperation and generate conflict and power struggles in social interactions (Thornton *et al.* 2012). Every social interaction is also a negotiation (Strauss 1978) and internal power structures influence the outcome of these negotiations, thus partly determining which of the competing goals and frames will dominate the group's shared focus of attention.

LRS IN A SWEDISH CONTEXT

According to the Swedish planning and building act construction projects need to be connected to a legally binding detailed development plan (in Swedish referred to as detaljplan). If no such plan exists, one must be created. Once a client's building permit application has been reviewed and accepted, construction may begin. Most often, however, there is no finished detailed development plan that fits the project so the client usually becomes involved in the detailed development planning. Parallel to the detailed development planning, separate development agreements (exploaterings/markanvisningsavtal) are often negotiated between client and LPA. The last decade has also seen a marked increase in the number of local design

programmes (gestaltningssystem) amended to detailed development plans and development agreements or used for judging building permit applications. In all these forums LPAs act as governmental agencies and as such any local requirements they set are passed on to the contractor via the client. Due to IHBs' reduced design flexibility they have more difficulties accommodating local requirements than traditional contractors do.

According to R3, when an IHB complies with a local requirement the implication is that there will have to be design revisions. R1 feels that the practice of LRS disfavours IHBs in relation to traditional contractors and reinforces a status quo.

LRS is commonly defined as the action of to set requirements which intentionally specify a higher standard than that which is prescribed in the national building code (SOU 2012:86). This intentional LRS, primarily related to energy requirements, is often discussed in politics. Yet, all respondents agree there are other instances of LRS besides from intentional LRS. Based on their answers we have identified three main categories (Figure 1).

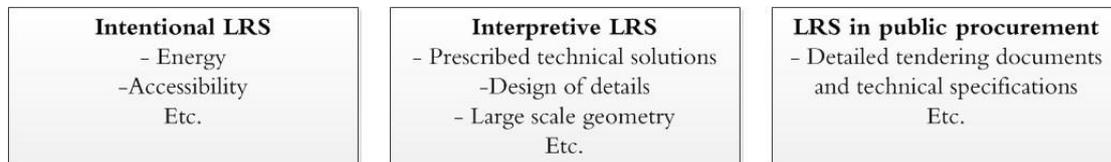


Figure 1: The three different categories of LRS

Intentional LRS is generally motivated by a wish to contribute to sustainable development or as a means to profile the municipality in order to attract citizens and economic resources. Intentional local requirements can be either quantitative, as in the case of energy requirements (observed by respondents R1 - R8), or qualitative, as in the case of accessibility requirements expressed as increased or extra increased accessibility (observed by R1, R2, R3, R4, R6, R7 and R8).

“Municipality A says one thing, municipality B says another and municipality C a third. If we are to build an ordinary multi-family apartment building we face different levels of energy requirements” – R4

According to R1, R2, R4, R8 and R9 intentional requirements are configurable via product development, for example increasing wall thicknesses to facilitate energy requirements. Rather, the problem IHBs perceive with intentional LRS is that they struggle to achieve sufficient repetition when the design solution constantly changes due to variance in requirements, which results in higher production costs. Some design revisions are so major that the project economy will be unable to sustain them.

Interpretive LRS entails the setting of all requirements that are interpretations of national and international goals which are mandated to the municipalities to enforce. Boverket (2011) identified over 100 national political goals, in addition to national strategies, plans, programmes and international strategies and initiatives, out of which at least 40 could be considered to be overarching. Given the abstract nature of these goals planning officers are forced to make interpretations in order to concretise them to a sufficient degree. Interpretive requirements are often qualitative, e.g. prescription of particular technical solutions (observed by R1, R2, R6 and R9) or regarding design of details (observed by R1, R2, R3, R4, R6, R8 and R9). Pre-defined building systems rarely include these prescribed components or solutions, but may include other components or solutions capable of performing the same functions. There are also quantitative interpretive requirements such as highly detailed restrictions on large

scale geometry (observed by respondents R1 - R4). Modular building systems, for example, are limited to certain geometrical dimensions and may not fit neatly into a detailed development plan with highly detailed geometrical restrictions.

R4 and R8 say that the variability of interpretive requirements promotes uncertainty for IHBs, as there is no way of telling which interpretations of which goals will be made for each project. Some interpretive requirements, such as prescription of nonstandardised openings, interfere with the engineering and production methods and as such are not configurable to the building system. These requirements cause serious issues for IHBs and may force them to relinquish projects altogether.

LRS in public procurement is different to other categories of LRS, because the municipality does not act in the capacity of a governmental agency in these situations. Yet, R1 pointed out that planning officers are more often than not involved in preparing the tendering documents and technical specifications. LRS in public procurement is synonymous with high levels of prescribed detail in these documents. R1, R2, R3, R4, R7 and R8 explain that this makes it difficult for IHBs to efficiently compete for the contracts, because compliance with the local requirements means a non-optimal use of the building system which results in a less competitive tender.

AN INSTITUTIONAL LOGICS PERSPECTIVE ON LRS

R1, R3, R4 and R8 think that LPAs have a positive attitude towards IHBs. Yet, R4 and R8 remark, their organisational practices do not necessarily reflect that. The best explanation for this is that representatives of IHBs likely activate different logics than planning officers do. Representatives of IHBs most likely activate market logic to a great extent whereas planning officers could be expected to regularly activate a more diverse set of logics, primarily dominated by state, family and/or community logics. Structural elements such as organisational routines and practices make these logics accessible to the planning officers and thus results in the activation of different social identities, goals and schemas than the activation of market logic would have.

“Even if they understand and respect our situation, their own ambitions and goals for their operation are overshadowing. They will always strive towards their goals and visions, and our situation is forced back.” – R8

R5 and R6 suspect that LRS in public procurements is a result of inexperienced planning officers. This inexperience implies that market logic is not available to the planning officers due to a lack of familiarity. R1, R2, R4 and R8, however, feel that the today's planning officers are very competent and professional. Instead, R1, R2 and R3 claim that the local requirements are caused by traditional organisational routines and practices. Here public procurement should be understood as a routine situational context. Over time particular logics have become highly accessible, severely limiting the chances of alternative logics being activated.

R1, R4 and R8 feel that, due to vague formulations, interpretive LRS often generate the most problems, as it entails that LPAs and IHB can make different interpretations of the requirements.

“Our opinion was that we had interpreted the descriptions in the detailed development plan in such a way that the spirit of the requirement was met, but the municipality made a totally different interpretation. Furthermore, to some extent they accepted deviations from their own interpretation because they liked certain parts of our solution ... but not all of it; just arbitrary.” – R8

In this situation the planning officers and the respondent had relied on different institutional logics when interpreting the requirements. What R8 sees as arbitrary is likely the result of agency. Hedgren and Stehn (2014) describe IHBs' as radical innovation and as such any project involving an IHB should present itself to most planning officers as a novel situational context, thus promoting agency. The difference in embeddedness and uneven distribution of institutional logics among the planning officers enables a wider variety of responses. In this case the planning officers responded by activating unexpected and somewhat incongruent social identities, goals and schemas. The respondents were reluctant to make general statements about interpretive LRS. We attribute that to the varying degrees of situational novelty each planning officer perceives in combination with the unpredictable nature of agency making it difficult to discern recurring patterns.

R1, R2, R4, R5, R6 and R8 noted that some planning officers have more influence than others. In one case R1 and R2 observed that the mid-process replacement of a key planning officer resulted in the LPA radically changing its behaviour. If one individual social actor is replaced by another, particularly when difference in embeddedness is great, this influences the groups shared focus of attention; even more so if that has a strong standing in the internal status hierarchy.

While Thornton's *et al.* (2012) model does not explicitly state it, it stands to reason that when the shared focus of attention between two organisations aligns, i.e. when social identities, goals and schemas resonate, there is a better foundation for cooperation. R1, R2 and R3 observed that municipalities are easier to cooperate with when they have been unable to find a tender with sufficiently low price in the first round of public procurement and since have had to readjust their expectations for the project. It is also supported by observations made by R3, R4 and R8 that it is easier to find good compromises to LRS issues if your arguments for the use of standardisation and repetition resonate with the LPAs' own ambitions for the project. All respondents agree that dialog is most fruitful when both parties focus on finding solutions, and thus finding shared values is viewed as an important factor for successful interaction with LPAs.

"You have to be able to break the code within the detailed development plan and decipher the ambitions that the municipality had for the area when making the design programme. You must be able to do that and still create housing with attractive apartments and reasonable costs for living." – R3

CONCLUSIONS

This paper contributes to practice in two ways. Firstly, we identify three distinct categories of LRS: intentional, interpretive and public procurement-related. Secondly our analysis reveals that not only are local requirements products of underlying cognitive and intra-organisational processes, the outcomes are influenced by the individual planning officers and LPAs themselves. Furthermore, we conduct a theoretical argumentation about how these processes function. Dynamic constructivism illuminates influences of both agency, in the case of interpretive LRS, and structure, in the case of LRS in public procurement. Symbolic interactionism further clarifies that internal power structures allow individual planning officers to greatly influence the LPA's shared focus of attention. The public and political debate about LRS has exclusively dealt with intentional local requirements and thus neglected not only interpretive LRS and LRS in public procurement but also that requirements do not simply emerge from thin air. In light of this, we argue that the

governmental proposition to forbid intentional local requirements is likely to have only a marginal positive effect on the potential for increased industrialisation.

The implications are that there is a continuing need to reform the organisational routines and practices of LPAs related to public procurement in order to better enable IHBs to participate in the tendering. Also the situational novelty IHBs represents to planning officers needs to be reduced, thus narrowing the variety of elicited responses.

This study is based on perceptions of representatives of IHBs. Moving forward this phenomenon will also be explored from the perspective of planning officers. The exploration of planning officers' perceptions of LRS should address the implication that congruent focuses of attention between LPAs and IHBs improve the basis for cooperation. We believe that our respondents' embeddedness within certain institutional logics did influence their responses, yet our analysis did not account for this. Similarly, we believe that when our respondents speak about LPAs or the municipality in general terms they may in fact be speaking of particular individuals. Any influence that the embeddedness of individual social actors has warrants further analysis.

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A SYNERGISTIC SUPPLY CHAIN ENHANCING OFFSITE MANUFACTURING UPTAKE IN AUSTRALIAN HOUSE BUILDING

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Offsite manufacturing could become a key innovation for the future of Australian house building due to its capacity in meeting the growing housing demand, green construction and fewer requirements for labour force. It is a modern construction method where house building involves offsite factories and onsite construction. Three major challenges for managing the two working sites are broken junction, jumbled on-site process and vague demands from unclear customers. The two sites have several forms of non-value added activities. On the other hand, the house customisation adds more complexities to the design specification that leads to slow response to achieve house customer demand in short time. This is a proposition paper which aims to explore the opportunity of offsite manufacturing in Australia. This research conducts the offsite manufacturing exploration by reviewing the related literature. The research discovers that incorporating lean and agile concepts could overcome the existing barriers of offsite manufacturing uptake in Australia. Therefore, four house building strategies: built to stock, assemble to order, design to order, and self-building house are introduced for different house building alternatives in Australia.

Keywords: Australian housing, offsite manufacturing, synergistic supply chain.

INTRODUCTION

In Australia, the residential building sector contributes significantly to the national economy with the overall production value reported as AUD 47 billion in 2010-2011. The sector involves many independent building organisations to construct separate houses and other residential buildings including semi-detached houses, townhouses, flats, units and apartments. Nevertheless, the values of work commenced in residential building are likely to be less responsive to the growth of other construction activities (ABS 2013). This situation may be resulted from housing supply and demand influences. The housing supply has been found not keeping in pace with the housing demand (NHSC 2013). A promising solution to successful increasing in housing supply is the offsite manufacturing (OSM) (Blismas and Wakefield 2009). It is a non-traditional construction method which involves two working sites: offsite factory and onsite construction. To generate effective delivery of OSM, the paper suggests the synergistic supply chain of lean and agile manufacturing concepts. These concepts with promising gains have been suggested to be transferred to house building production (Blismas and Wakefield 2009; Manley *et al.* 2009). Recognising the

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shortage of the Australian house building supply, the research is undertaken to understand the situation of OSM in Australia. Moreover, the study aims to integrate the knowledge on of lean and agile applications in the Australian house building context.

LITERATURE REVIEW

The Australian housing supply has been found in a shortage to serve the housing demand. This situation could be influenced by housing supply and demand factors. The Previous studies have discussed the Australian housing supply shortage from the housing demand side rather than the supply challenges (Liu and London 2011). This paper, therefore, includes discussion on the Australian housing shortage from the supply perspective. The paper presents a possible relationship between the house delivery and the construction method used. OSM is a suggested modern method that has capacity to increase the supply of housing in Australia (Manley *et al.* 2009).

While there is plethora of studies on OSM in Australia, some studies such as Blismas and Wakefield (2009) covered the drivers and barriers of OSM in the Australian built environment. The main drivers for OSM were the shortage of skilled labours, environmental sustainability advantages, reducing the occupational health and safety (OHS) risks, and improving value, productivity and quality. The main barriers were including low level of industrial knowledge on OSM, longer lead times and freezing the design in early stages. Blismas and Wakefield (2009) and Manley *et al.* (2009) revealed that opportunities of OSM uptake are centred on detached housing, high-density multi residential complexes, and public facilities. However, these previous studies did not suggest any strategy or framework that can be practically utilised to overcome the OSM barriers. This research, therefore, will explore further to what could potentially be the solutions for more effective OSM supply.

RESEARCH METHODOLOGY

This paper is presented as a proposition paper in which the the research aim is to explore the opportunity to the uptake of OSM in the Australian house building. The uptake of OSM in Australia can be subject to certain barriers that prevent house builders to pursue OSM. This notion will be included in this research investigation. To achieve the research aim, the methodology is designed into three phases to systematically collect and analyse the related materials.

Phase 1: A review of related OSM literature was conducted. At this stage, the opened online databases were explored. The databases include Emerald, Elsevier, Taylor and Francis, American Society of Civil Engineers (ASCE), CIB World, book publications, and Google Scholar. In addition, some published reports from Australian government and housing industry alliances were searched. This includes Housing Industry Association (HIA), National Housing Supply Council (NHSC), Australian Housing and Urban Research institute (AHURI), and Australian Bureau of Statistics (ABS). Data collection from the databases focused on the initiatives employed to explain the housing supply shortage, OSM uptake, and lean and agile in Australian built environment.

Phase 2: Explore the factors contribute to OSM uptake in Australia.

Phase 3: Develop an appropriate OSM supply chain model that could enhance the OSM uptake in Australia. The model development relied on the data analysis from the previous phases.

RESEARCH FINDINGS AND DISCUSSION

The opened online search discovered 169 accessible publications from 1992 to 2014 that met the data selection criteria specified at the first phase of the research methodology. These publications included 146 articles and 23 reports that reflected the OSM, house building shortage, and supply chain concepts including lean and agile practiced in Australia. Most of these publications focused on identifying the drivers and barriers of OSM. The evidence urging the use of lean and agile concepts and their combination was to overcome OSM barriers in Australia (Blismas and Wakefield 2009; Manley *et al.* 2009). The research findings are discussed as follows:

Factors influencing Australian housing supply

Australian housing sector has experienced housing supply shortage. The situation is evident through several studies on housing affordability (NHSC 2013) and housing completion time (Gharaie *et al.* 2010). Several factors have been mentioned as being contributed to the housing supply and demand. The Demographia Survey in 2014 highlighted the deterioration of housing affordability across 39 housing markets in Australia. The decline is likely caused by housing supply factors. The housing supply in Australia includes several stages such as strategic planning and development, land release, building approval, construction commencement and completion, and strata title registration and available for occupation (NHSC 2013). This paper focuses on the house construction process which starts from house building commencement and finished with house completion. As the latest statistics of ABS (2014a) indicated that the number of houses completed is lower than the number of houses commenced. The factors affecting the house supply are discussed as following.

Completion time for new houses

The house completion time is the time period between the first and last physical building activities to make house ready for occupation (Dalton *et al.* 2011). The house completion time is a major factor indicating the quality of housing delivery to house buyers. There is an increase in the average Australian house completion time, while the production rate has found to be relatively stable. The statistics of ABS (2014) reported the average completion times of new houses in Australian states, territories, and national level. Using 2003 to 2008 as a base line, the states of New South Wales, Victoria, South Australia, Tasmania, and the Northern Territory experienced increasing house completion time in 2008 to 2013. The house completion time remained the same in the states of Queensland and Western Australia, and Australian Capital Territory. The completion time progressively expanded in all regions in 2003 to 2008. The states of Western Australia and Victoria were recorded with the highest house completion time at approximately 3.3 quarters in 2013.

House buyers' design preferences

The house type and design are main factors of house buyer's preferences (NHSC 2013). The house preferences may vary from person to person based on some factors including household age and income, family size, and cultural background. The house preferences include the size, internal and external design, and location of the house. The average floor area of the Australian dwellings has been increased. The average floor area of new detached houses increased from 162.4 m² to 248.0 m² from 1984 to 2009 (ABS 2012). It is evident from an examination of volume builders catalogues such as of Metricon, one of the largest 20 home builders in Australia (HIA 2013), that double-story houses and more complex street facing façades has increased.

Level of skilled labour

The house building is labour intensive industry with its main product of new dwellings or renovated dwellings. The supply of labour is an important element of the housing supply. According to DEEWR (2012), there are shortages in some construction trades such as roof tiler, glazier, plumbers and cabinetmaker from 2008 to 2012. The house builders are working in a competitive environment that requires a skilled labour. The challenges include new working relationships such as partnering and virtual enterprise. The challenges are also include changing the construction technologies and adopting modern methods of construction. It can be concluded that the skilled labour is an essential component of the house building industry to achieve all the mentioned challenges. The skills shortages contribute to the undersupply of housing (NHSC 2013). As the construction work will be delayed due to the skilled shortage that requires some contracts with additional stakeholders.

House price

House prices is a critical element determining the new housing construction. In Australia, house prices have increased in all locations at similar rate of growth. The ABS (2014b) estimates that the Houses Price Index (HPI) for the weighted average of the eight capital cities increased by 3.4 % during December quarter 2013. It leads to an increase in the average HPI of the eight capital cities by 9.3% during the financial year 2012-2013. The housing supply is a function of house price. The house price includes land price, construction costs, and lagged house stock. The growth of house prices is driven by the increase in the prices of establishing houses. The study of Liu and London (2011) stated that the construction costs are responsible for a higher proportion of the increase in house prices in some regions. They concluded that the construction costs are a significant component of the poor performance of the Australian new housing supply.

Offsite manufacturing in Australia

In order to respond to the housing shortage, builders are looking for more efficient materials and new methods of construction. One example of new material is using Cross-Laminated Timber (CLT) in preference to traditional clay bricks. A new method is such as employing Offsite Manufacturing (OSM) with Structural Insulated Panels (SIPs) (NHSC 2013). OSM refers to the fabrication of house components in an offsite factory as well as their subsequent activities on a construction site (Goulding *et al.* 2012). It provides several benefits including improving onsite safety by providing cleaner and tidier construction site as well as enhancing quality of the house components under factory production. Moreover, OSM reduces environmental effects by reducing waste generation, shortening lead time and increasing the efficiency and productivity (Pan and Goodier 2012). The products produced using OSM fall into four categories (a) component manufacture and sub-assembly which always made in a factory and never considered for onsite construction (e.g. door, trusses, windows); (b) non-volumetric pre-assembly (panels) that are pre-assembled units which do not enclose usable space (e.g. wooden panels and Structural Insulated Panels (SIPs)); (c) volumetric pre-assembly (pods) which are pre-assembled units which enclose usable space and are typically fully factory finished internally, but do not form the buildings structure (e.g. bathroom and kitchen pods); and (d) modular systems which are pre-assembled volumetric units which also form the actual structure and fabric.

Previous studies positively addressed OSM in the Australian built environment. Hampson and Brandon (2004) suggested OSM as a key vision for improving the

construction industry. Two research projects carried out by Blismas and Wakefield (2009) and Manley *et al.* (2009) confirmed that OSM has capability to produce high-volume and high-quality houses based on the efficiencies of the manufacturing principles. In spite of the benefits of the OSM, the factory production has several forms of non-value added activities including waiting time, transportation, defective products, and unnecessary motion (Womack and Jones 2003). Moreover, three major challenges arise from the management of two working sites concurrently. These challenges are the potential for lack of coordination between the offsite and onsite activities, the jumbled onsite processes due to difference between the production flow at offsite factories and construction flow onsite, and the vague demands from undecided customers (Chang and Lee 2004). These challenges might lead to slower response to achieve customer order. Some attempts have addressed the challenges of OSM by adopting successful concepts from the manufacturing industry, particularly lean and agile concepts (Höök and Stehn 2008; Vidalakis *et al.* 2013).

Application of lean and agile in OSM

Lean concept comprises of management practices that focus on eliminating all forms of wastes from the value stream (Sertyesilisik 2014). The concept has been widely adopted beyond its origin in the automobile manufacturing. Kenley (2014) emphasised on improving the productivity of construction industry through production systems intervention. Lean production concept is the best known intervention. It has been used by the house manufacturers in Japan by transferring the knowledge from automobile manufacturing to house manufacturing (Gann 1996). The practice of lean concept in house building requires using factory based production. However, the construction has unique characteristics (i.e. features of output, nature of processes, customer involvement, and supply chain). Therefore, lean construction has extended by Koskela (1992) to address the specific characteristics. The main challenge of lean construction is related to the interfaces between the OSM and the construction site. The production flow at the offsite factory is continuous and different from the construction site which is turbulent. This is due to uncertainties at the construction site such as changes in customer demand or site conditions. This leads to unpredictable delays to achieve the customer order. Agile construction was proposed by Daneshgari (2010) to proactively respond to any onsite uncertainties. Lean construction focuses on creating an efficient physical process of manufacturing. Agile, on the other hand, emphasises on high level of service through flexibility and customisation (Naim and Barlow 2003). These factors are important for OSM as OSM implies standardisation of products and processes, and emphasises on flexibility for house customers.

Some concerns were found from the existing literature in applying lean or agile as a standalone concept when uncertainties in construction are present (Christopher and Towill). Many studies suggested a combination of lean and agile concepts in OSM (Blismas and Wakefield 2009). However, these studies were conducted in different context to Australian house building environment. It was discovered further that no specific lean and agile integration strategy for OSM in Australia was formulated. Combining lean and agile within the whole supply chain can be accomplished by using the decoupling point and known as leagile (Purvis *et al.* 2014). In general, the decoupling point separates the supply chain into lean in the factory site and agile in the construction site.

SYNERGISTIC SUPPLY CHAIN FOR OSM HOUSE BUILDING

Christopher and Towill (2000) emphasise that supply chains must be in touch with market demand changes. The supply chain comprises all stakeholders involved to achieve customer order. The OSM house building supply chain suggested in this paper can be visualised as shown in Figure 1. The supply chain includes the house materials suppliers, offsite factory, designers, construction site, and customers. The Last Planner™ System (LPS) is used to establish a better coordination among supply chain stakeholders to achieve the house customer demand. LPS is used to transfer planning responsibility between construction organisation management and the field persons. The LPS facilitates the workflow so that labour and material resources can be more productive.

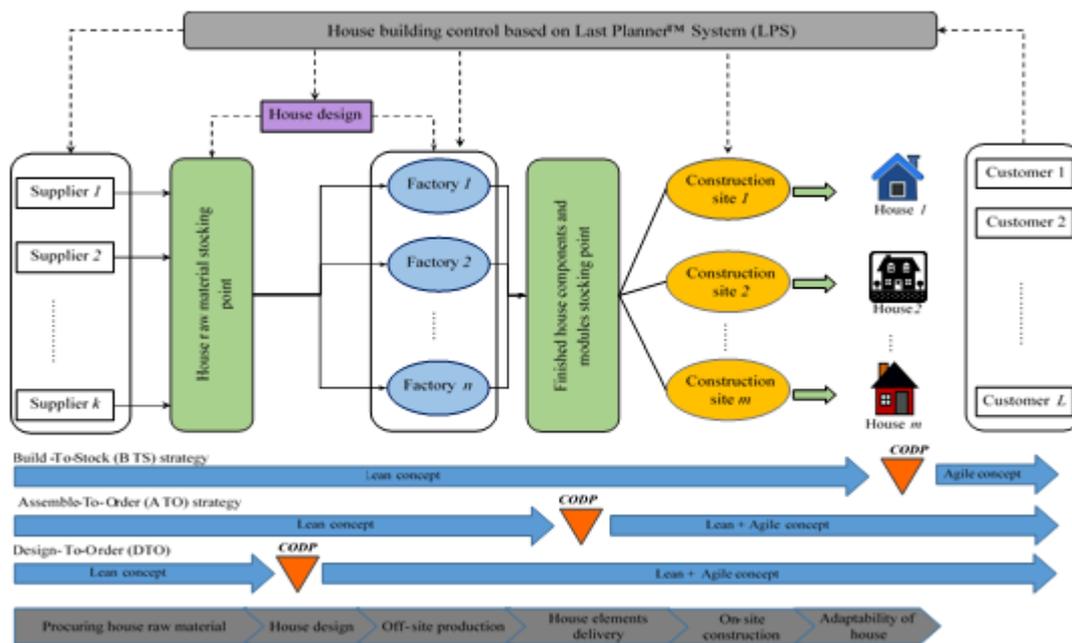


Figure 1: Synergistic OSM house building supply chain and included leagile strategies.

The LPS encompassing four levels of planning processes with different consecutive spans: master scheduling, phase scheduling, Look-ahead Planning (LAP), and Weekly Work Planning (WWP) (Forbes and Ahmed 2011). The master schedule defines the work to be carried out over the entire duration of a project. It identifies major milestone dates and incorporates critical path method logic to determine overall project duration. Phase scheduling generates a detailed schedule covering each project phase such as foundations, structural frame, and finishing. The phase employs reverse phase scheduling and identifies handoffs between the different specialty organisations to find the best way to meet milestones stated in the master schedule. LAP indicates the first step of production planning with a time frame ranging from two to six weeks. At this phase, activities are broken down into the level of processes, constraints are identified, responsibilities are assigned, and assignments are made ready (Hamzeh *et al.* 2012). WWP represents the most detailed plan in the LPS showing interdependence between the works of various specialist organisations. WWP guides the production process. At the end of each plan period, assignments are reviewed to measure the reliability of planning and the production system. Analysing reasons for

plan failures and acting on these reasons is used as the basis of learning and continuous improvement.

OSM supply chain strategies

For competition, Christopher and Towill (2000) emphasise that supply chains must be in touch with market demand changes which can be divided into three critical dimensions; variety, variability, and volume. The supply chains may be lean prior to decoupling point and agile beyond decoupling point. The previous research of Childerhouse *et al.* (2000) and Naim *et al.* (1999) proposed a leagile model to be applied in the UK house building. The model was based on using material DP. In this paper, the leagile supply chain for Australian house building employs the customer order decoupling point (CODP) which suggested by Olhager (2003). The CODP in this study represents information and material DP. The material DP represents the stocking point of finished house modules or components. The information DP denotes the point where the customer order enters the housing supply chain. In this paper, four alternative positions for CODP, developing four house building strategies, are suggested to be employed in Australian house building supply chain. These strategies are discussed below.

Build-To-Stock (BTS) strategy

In BTS, the CODP located after the onsite construction activities and finished house building. This strategy is also known as speculative house. The houses are designed and built based on the builders' catalogue (Dalton *et al.* 2011). Customers have a choice to select from the available houses based on the location, cost, size, and design. The market winner in this strategy is the lower finished house selling price. Therefore, the activities before selling should be lean to fit the costs. While, agile is suitable after the CODP to diminish the delivery time. As a result, it maximize the customer satisfaction and the speed of return on investment.

Assemble-To-Order (ATO) strategy

The CODP is positioned at the offsite factory. The customers' houses are built according to the builder's catalogues. A variety of houses designs are included in the catalogues. Customers have a degree of flexibility to select a mix of 'specs' to match their demands. The customers can add extra features to their own kitchen, bathrooms, external living area, as well as upgrade standard items such as windows and doors (Dalton *et al.* 2011). The house builder then do the construction activities onsite and assemble the selected modules to complete the houses. The market winners in this strategy are the price and designs of house modules, and the completion time. It is suggested in this strategy to employ lean within the offsite factories. Agile will be employed in stages of shipments and onsite construction to ensure more responsiveness in delivering the houses.

Design-To-Order (DTO) strategy

In this strategy, the customer demand enters the supply chain at the design stage. Therefore, customers have a relatively high degree of customisation. They can specify the design of their own house modules. They have the flexibility to change on the predesigned modules to fit their needs. The market winner in this strategy is high customisation. Therefore, the house building stages need a combination of lean and agile. Lean is suitable for supplying the material and running the offsite factories, whilst the other activities need to be more agile.

Self-Build Homes (SBH) strategy

In this strategy, homeowner is significantly involved with the actual building process. The Australian housing is produced by small to large organisations. In 2012, the largest 100 builders commenced about 36% of all residential dwellings (HIA 2013). This proportion indicated that 64% of all residential have been constructed by small builders or in the form of self-building houses. The customers need to hire an architect for house designing, and builders and trades people for some onsite construction activities. Therefore, the key role of house building organisations is to supply the house components to the suppliers. House building organisations should make the house designs as simple as possible and provide variety of designs to meet different types of house needs. Lean is suitable to run the house modules factory, while agile is the best option for quick responses to demands of house components suppliers.

LINKING OSM STRATEGIES AND HOUSING FACTORS

This paper contended that the four housing supply factors mentioned earlier influence the shortage situation of the Australian housing. Moreover, these factors impacts the selection of the OSM strategies. The research findings confirmed the concept adopted from Fisher (1997) on matching the supply chain strategy to supply factors. The four OSM strategies suggested are not applicable to all housing supply factors. Table 2 demonstrates the association between the strategies and housing supply factors. Selecting the appropriate strategy depends on the house customer demand and the capacity of the house builder.

Table 2: Association of OSM strategies and housing supply factors

	BTS	ATO	DTO	SBH
Completion time for new houses	Short	Medium	High	Short-Medium
House buyers' design preferences	Low	Moderate	Very high	High
Level of skilled labour	Medium	Medium-high	Medium-high	Less labour
House price	Moderate rang	Moderate-high	High	Low-moderate

The house customer demand for a ready-to-move-in house makes BTS the suitable strategy. However, if the house customer own the land, the strategies are limited to ATO, DTO, or SBH. In the case of ATO and DTO, the customer and builder need to discuss the degree of house customisation in relation with completion time and price. Moderate degree of customisation in ATO results in medium completion time and moderate to high house price. On the other hand, the DTO allows the customer with more degreed of customisation with high completion time and price. The SBH strategy is appropriate for the customers whom are attempting to build their own homes. The strategy allows for savings in construction costs and completion time as well as more design preferences.

CONCLUSION

The Australian house building sector has experienced continuous housing demand. The house customer preferences, completion time and house price add more complexities to the design specification. OSM has been introduced as a solution to improve the housing supply in Australia. The OSM concept is originated from the

manufacturing sector. To enhance OSM implementation, lean and agile manufacturing concepts as a synergistic supply chain can be integrated within the OSM supply chain. This synergistic supply chain offers four house building strategies: BTS, ATO, DTO and SBH. The four strategies attempt to answer different situations of house customer demand and capacity of builders. The synergistic supply chain can be considered as an attempt to increase the supply of housing in Australia. This research contributed to rethinking on housing issues beyond the domain of construction for housing policy makers, construction executives, managers, designers and developers. For comprehensive realisation of OSM benefits to Australia, more studies can be developed to verify the results of the proposed strategies. The verified results could lead to future development of OSM particularly in Australia. Adopting OSM housing policies may further require collaboration with planning and legislation research.

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PLACING DEFECTS AT THE HEART OF HIGH QUALITY NEW HOMES: THE LEARNING PERSPECTIVE

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The UK new-build housing sector is facing dual pressures to expand supply, whilst delivering against tougher planning and Building Regulation requirements; predominantly in the areas of sustainability. The sector is currently responding by significantly scaling up production and incorporating new technical solutions into new homes. This trajectory of up-scaling and technical innovation has been of research interest; but this research has primarily focus on the ‘upstream’ implications for house builders’ business models and standardised design templates. There has been little attention, though, to the potential ‘downstream’ implications of the ramping up of supply and the introduction of new technologies for build quality and defects. This paper contributes to our understanding of the ‘downstream’ implications through a synthesis of the current UK defect literature with respect to new-build housing. It is found that the prevailing emphasis in the literature is limited to the responsibility, pathology and statistical analysis of defects (and failures). The literature does not extend to how house builders individually and collectively, in practice, collect and learn from defects information. The paper concludes by describing an ongoing collaborative research programme with the National House Building Council (NHBC) to: (a) understand house builders’ localised defects analysis procedures, and their current knowledge feedback loops to inform risk management strategies; and, (b) building on this understanding, design and test action research interventions to develop new data capture, learning processes and systems to reduce targeted defects.

Keywords: action research, defects, house builders, new homes, risk management.

INTRODUCTION

In the United Kingdom (UK) there is a considerable shortfall in the number of dwellings required (Wilcox and Perry, 2013). It is claimed that an additional 240,000 homes a year will be required to meet demand and needs (Holmans, 2013), a housing output increase of over 70% when compared to 2012 levels (DCLG, 2014a). In order to satisfy the increased demand the UK government has introduced a number of new-build focussed policies and incentives to increase the housing supply (HM Government, 2011). For example, the Get Britain Building investment fund is

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designed to enable house builders to progress housing development sites that have stalled, have not started or are classified as being on hold (DCLG, 2014b).

In addition to increasing housing supply, under the Climate Change Act (2008) the UK has set a 2050 target to achieve carbon emissions reductions of 80% compared to 1990 levels. One contributing factor to achieving these reductions is the target for all new houses to be 'zero carbon standard' (Zero Carbon Hub, 2014) from 2016 (UK Government, 2012). The zero carbon home agenda has resulted in the introduction of tougher planning and Building Regulations, including changes to part L 'Conservation of Fuel and Power' (DCLG, 2013).

The house building sector has responded to the dual pressures by significantly ramping up supply, with a 23% increase in new housing starts for 2013 compared to 2012 volumes (DCLG, 2014a). In addition to increasing supply, the house building sector is incorporating new technical solutions into new-build houses to meet the tougher regulatory requirements (NHBC Foundation, 2012). Whilst responding to these pressures, the sector is reporting materials, skills and workforce shortages following the 2008 economic downturn. The reported shortages are causing concerns within the industry over future housing quality (e.g. UKCES, 2012; HBS, 2013); however, there is scant rigorous empirical evidence to verify the reported concerns.

The paper offers an insight into the challenges facing the new-build housing sector: increasing the production of new houses, whilst developing new technical solutions to meet tougher low-carbon regulation requirements. A review of new-build housing sector literature finds authors concentrating on the 'upstream' implications for house builders of the new ramping up of production whilst delivering against a new set of regulations. The extant literature, though, gives scant consideration to potential 'downstream' implications, namely build quality and defects. The literature review distils a number of gaps within the literature, culminating in a proposed research agenda to address these gaps.

NEW HOUSE-BUILDING INDUSTRY PRESSURES

New technical solutions

In the UK new-build housing industry, the up-scaling of production, with the incorporation of new technical solutions to meet new regulatory requirements has been of research interest. The significant emphasis of research focuses on the new technical solutions (material artefact) itself: how it performs, the demands of the system when integrated and the micro-economics of the system (e.g. Bevan and Lu, 2012). The potentiality of the new technologies is of particular interest. Hinnells (2008), for example, identifies a number of potential new technologies (including fabric measures and micro-generation) to achieve reductions in energy demand. Sodagar *et al.* (2011), for instance, conclude that straw bale construction is a viable option to reduce carbon emissions.

Upstream implications for business model and standardised design template

A number of commentators have highlighted the upstream implications of new technical solutions for house builders' business models and standardised design templates (e.g. Lees and Sexton, 2014; Pan, 2010). Standardised design templates are defined as "*the design and production plans and practices which, through constant repetition from development to development, permit house builders to meet the various market and regulatory requirements as economically as possible*" (Lees and Sexton, 2014: 277). Lees and Sexton (2014) indicate that the rationale for the choices

of new technical solutions by house builders is to minimize the disruption to their standard design templates. Sodagar *et al.* (2011) highlight the lack of material availability and pressures on suppliers as part of the minimisation of disruption logic pursued by housing builders.

Downstream implication for build quality and defects

The importance of potential 'downstream' implications of the ramping up of supply and the introduction of new technologies for build quality and defects is less prominent in the literature, but strands are to be found and are growing in volume and influence. There is increasing evidence that the inclusion of new technologies can and does adversely impact new-home quality; both in the material sense of the home itself and in the well-being of occupants. Yao and Yu (2012), for example, raise concerns of the risk of overheating in zero carbon homes with high thermal performance and airtightness characteristics. While Osmani and O'Rielly (2009) report builders' concerns about micro-renewables bolted on to properties, following several instances where damage has occurred after installation. Gill *et al.* (2010) drill further down on the types of defects in the low-energy homes they surveyed. These defects include numerous leaks to rainwater harvesting systems and the failure of a biomass district heating system.

There has been even less focus on the potential effects of ramping up housing supply will have on the new build housing sector in general. The house building industry is said to be particularly prone to the cyclical cycle of boom and bust (Eurostat, 2010). It is often argued that in periods of housing market boom, build quality is reduced as delivery dates tighten and materials/workforce capacity becomes stretched (e.g. Sommerville *et al.*, 2004). The quality question is especially salient and raises a potential pressure for site management. In addition to quality being neglected, other pressures exist at the site management level and beyond, evidenced by the house building sector currently reporting materials, skills and workforce shortages (e.g. HBS, 2013; UKES, 2012).

When the issues of skills, materials and workforce shortages caused by the rapid increase in production are coupled with the additional requirement to introduce new technical solutions into new homes to conform to tougher regulations, a number of potential downstream implications for suppliers, site management, trades, and general build quality may arise. The Home Builders Federation (HBF) survey results (HBF, 2014) show that in 2014, 92% of home owners reported defects within their new-build house, the first time there has been an increase since 2011. The results provide early indications that the current new-build housing pressures may be eroding build quality.

UK NEW-BUILD HOUSING DEFECTS

*Research into new-build housing defects in the UK is comparatively limited. There are two potential problems of this lack of explicit research into UK new-build housing defects. First, a large number of publications tend to focus on work within the wider construction sector (e.g. Porteous, 1992; Latham, 1994; Josephson and Hammarlund, 1999; Love and Li, 2000) or non-new-build housing (e.g. Page and Murray, 1996; Olubodun, 2000). Second, new-build housing defect research is largely non-UK based and tends to focus in, Australia (e.g. Georgiou *et al.*, 1999; Ilozor *et al.*, 2004; Mills *et al.*, 2009) and Spain (e.g. Macarulla *et al.*, 2013).*

The UK new housing defects are researched under a number of categories, including: defects (e.g. Atkinson, 2002), snags (e.g. Sommerville and McCosh, 2006), faults (e.g. BRE, 1990) and non-compliance (e.g. Baiche *et al.*, 2006). These terms appear to be used interchangeably to describe similar research into the area of imperfections in buildings.

A 'defect' is defined as a shortfall in performance occurring within the life of the product, element or dwelling (BRE, 1988). More specifically, Watt (1999) defines a 'building defect' as a failure or inadequacy in the function, performance, legal or user requirements of a building, and can become apparent within the structure, fabric, services or other facilities of the building.

A 'snag' is argued by Sommerville and McCosh (2006) to be the same as 'errors' and 'defects' within a new house, whereas Atkinson (2002) argues 'errors' as a cause of 'defects'.

A 'fault' is described as an unacceptable departure from good practice set out in Building Regulations and other authoritative publications (BRE, 1990), while Baiche *et al.* (2006) infer a 'non-compliance' to be a failure to adhere to Building Regulations, or approved standards.

Due to the differing categories, Sommerville (2007) argues the need for a standard lexicon, suggesting a lack of consistency in terminology as a factor that constrains research into defects. Despite the non-standard terminology within the literature, the authors often produce similar causes of the occurrence of defects. These causes include, for example, poor site management, supervision and inadequate quality inspections (e.g. Auchterlounie, 2009; Atkinson, 2002); and, lack of trade/operative skills and knowledge (e.g. Baiche *et al.*, 2006; Sommerville and McCosh, 2006). Based on common findings, authors tend to advocate similar recommendations to reduce defect prevalence. The consistency in findings and recommendations within the UK new-build housing defect literature suggests that standardising terminology is not a key factor in enhancing future research and reducing defects. As the UK defect scholarship utilises differing terminology and categorisation for defects, this begs the question as to whether individual house builders have differing interpretations for what constitutes a defect.

Despite the differing terminology within the literature, research into new housing defects can be generally grouped into three aspects: (a) the stage in which the housing project is studied; (b) the level of analysis; and, (c) the findings, and how the findings are used. Each aspect is discussed below.

(a) The stage in which the housing project is studied

The defect literature tends to focus on a particular stage of a house building project, without a whole project perspective being considered. The stages typically studied include the construction stage (e.g. Atkinson, 2002), and the post completion stage (in particular, the first two years post completion) (e.g. Sommerville and McCosh, 2006). In addition to focussing on a particular stage, prevailing literature draws upon small sample sizes. For example, Atkinson (2002) observes a single housing site while Baiche *et al.* (2006) investigate eleven local housing developments. These studies provide valuable detail in depth but are limited in the representativeness of the results.

Research that does investigate large sample sizes (covering a wide range of house builders and geographical areas) focuses on defects occurring within the first two years of a property's life (e.g. Sommerville and McCosh, 2006). The investigation of

defects that occur within the first two years tends to produce results that indicate that the majority of problems are related to aesthetics e.g. the general finish of the property (e.g. Auchterlounie, 2009; Sommerville, 2007; Craig, 2007).

The occurrence of defects within new-build houses is however not limited solely to the first two years post completion. Outside of the first two year period, new-build houses are subject to a further eight year warranty period (Sommerville and McCosh, 2006), where the warranty provider will keep a record of claims as part of their risk assessment procedures (Auchterlounie, 2009).

According to the National House Building Council (NHBC, 2013), defects occurring during years 3-10 of the NHBC warranty include foundations, substructure and ground floors, superstructure, roofs, services, fixtures and finishes, and ancillary buildings and external works (see Figure 1 below). The results indicate a different defect trend from the 'aesthetic' issues reported in the first two years. It also confirms new-build properties are not defect free the moment they move outside of the defects liability period (two years). (Note: The National House Building Council (NHBC, 2014) is the UK's largest new-build warranty provider, providing cover on circa 80% of all new homes built within the UK.)

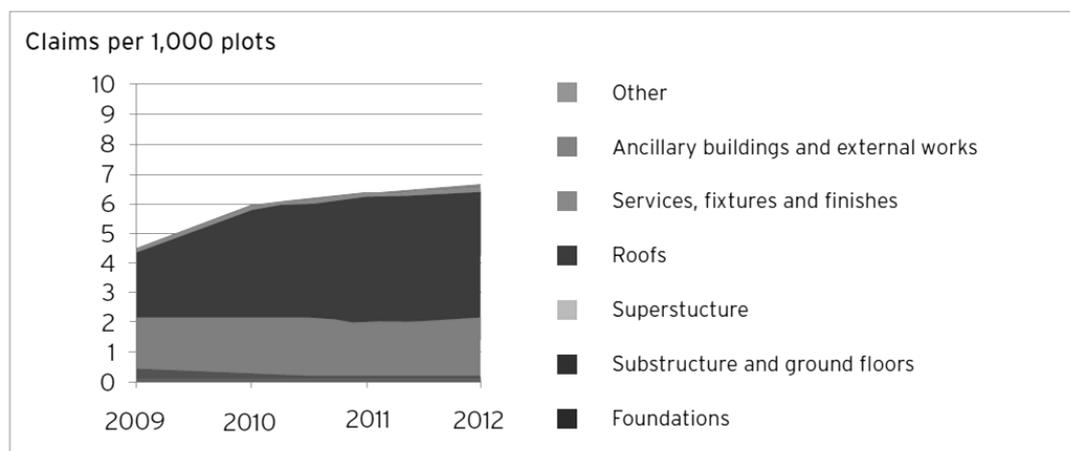


Figure 1 - Defects occurring during years 3-10 of the NHBC warranty (NHBC, 2013)

(b) *The level of analysis*

Generally, the UK new home defect literature focuses on industry level analysis as opposed to individual house builders. The industry level analyses can provide useful aggregated insights (e.g. Atkinson, 2002; Barker, 2004; Callcut, 2007; Auchterlounie, 2009), but can be prone to assuming that all house builders have the same characteristics and associated performance. There are notable exceptions that do acknowledge the heterogeneous nature of the new-build housing sector. Sommerville *et al.* (2004), for example, highlight the multitude of methods that individual house builders use when recording and undertaking the snagging process. Similarly, Sommerville and McCosh (2006) argue that there is a clear difference in quality from one house builder to the next. Of the publications that differentiate between organisations and their respective processes (excluding Davey *et al.*, 2006), the majority prescribe a "standard" solution for all house builders (e.g. Egan, 1998; Roy *et al.*, 2003; Sommerville *et al.*, 2004). The appropriateness of a 'standard solution', given the varied nature of house builder types and practices is an empirical question which has not been adequately investigated.

(c) The findings and how they are used

The research findings within the UK new-build housing defect literature are generally centred around: numerical occurrences of defects (e.g. Sommerville and McCosh, 2006), responsibility for defects taking place (e.g. Atkinson, 2002), the type of defects occurring (e.g. Baiche, *et al.*, 2006), and the links between defects and home owner satisfaction (e.g. Auchterlounie, 2009). The existing research findings suggest that generally authors are able to establish the number, types, cause, and home owner satisfaction relationship of defects. However, a common feature running through the majority of the UK new-build housing defect literature is how findings and recommendations are seldom actively reported back to the house builder to assist with their feedback and learning processes (e.g. Sommerville and McCosh, 2006; Auchterlounie, 2009).

DISCUSSION

What has become clear from the review of literature surrounding the challenges facing the UK new-build housing sector (i.e. increase of supply, and regulatory change) is a primary focus on the potential upstream implications this has for the house builder. The literature regarding the new-build sector's challenges has not focused on the potential downstream implications of the ramping up of supply and the introduction of new technologies for build quality and defects.

The synthesis of UK new-build housing defect scholarship highlights a multitude of differing terms and categories to define defects. These differing terms raise the question as to how house builders interpret and classify defects. The extant literature, whilst using differing terminology for defects, adopts a similar approach, undertaking research into defects occurring at either the construction stage, or within the first two years post completion. The new-build defect literature lacks a broad approach (Sommerville, 2007), that utilises UK wide data of defects being discovered in both the defects liability period (first two years), and later on within the property's life (the additional eight year warranty period). Such data would provide a new research opportunity to understand the types of defects occurring within the first ten years of a large number of UK new-build houses, as well as allowing researchers to differentiate between separate house builders.

One reason for differentiating between separate house builders is that the defects literature generally either present house builders as being uniform, focussing on industry level analysis, or authors assume that a one fits all 'standard' solution to a given problem is appropriate for all house builders. One drawback of UK new build housing defect research reporting on an industry level is a lack of a feedback loop. In other words, the research findings and proposals are rarely actively reported back to the house builder. *Egan (1998) suggested that house builders should in general methodically assess completed projects, in order to feed the knowledge gained back into future development processes as a form of continuous learning, with Callcutt (2007) arguing the need for a consistent assessment of quality.* One way of introducing the missing feedback loop to the UK new-build housing defect research could be to adopt a 'post occupancy evaluation' (POE) approach. Within the field of building performance POEs are utilised (e.g. BRE, 2003). The POE is concerned with providing feedback relating to factors for achieving success in the design, construction, and use of buildings, with an aim of learning from this active feedback in order to make improvements in future projects (e.g. Cohen *et al.*, 2001).

Introducing a feedback loop to new-build housing defects (as opposed to simply analysing post completion defects), may provide house builders the opportunity to learn from active feedback, to enable them to make informed small changes to their respective processes, and subsequently improve future 'repeat projects', the "*learning perspective*". Whilst the '*learning perspective*' has been suggested as a means of continuous improvement within the house building sector in general (e.g. Egan, 1998; NAO, 2007) the extant new-build housing defect literature is silent on how house builders actually learn and make improvements based upon past experience, if at all.

To summarise, a number of gaps within the literature have been highlighted: a) the lack of research into downstream aspects of the UK housing industry dual pressures, namely build quality and defects; b) the need to understand house builder's categorisation and interpretation of defects; c) the requirement for a broad research approach utilising data from both the first two years, and the following eight year warranty period to give an understanding of defects occurring later within a property's life, larger regional coverage, and the ability to differentiate between separate builders; d) the call for studying individual organisations and their differing processes in order to understand their respective processes regarding post completion defects, and learn from the better performing organisations; and finally, e) building upon this gained knowledge, develop the 'learning perspective' by utilising a POE approach to new-build housing defects, to introduce small changes (in line with their current processes) achieved by providing feedback to the house builders, with an aim of the organisations learning from this active feedback in order to make improvements in future 'repeat' projects, and reducing defects.

FUTURE WORK

As part of an ongoing collaborative research programme with the National House Building Council (NHBC) the authors propose to investigate the gaps identified in the previous section. First, develop an understanding of house builders' localised defect interpretations, data capture, and analysis procedures. In addition to comprehending how these procedures inform the builders' subsequent risk and quality management procedures. Finally, building upon this understanding and by drawing upon NHBC warranty data and builder repair records; test action research interventions to develop new defect assessment tools and post occupation evaluation (POE) learning systems that can fit in to the individual organisation's existing business models and processes in order to reduce future occurrences of prevalent defects.

CONCLUSION

This paper set out to establish the challenges facing the new-build housing sector, finding research to be favouring studies in to 'upstream' implications for house builders; whereas the scholarship gave scant consideration to potential 'downstream' implications, namely build quality and defects. A synthesis of the current UK new-build housing defect literature established a number of research gaps, *especially how house builders actually learn and make improvements in order to reduce defect prevalence via knowledge gained past experience*. The end result of the paper is a collaborative research project with the NHBC to address the gaps in literature. Research to understand how organisations both individually and collectively in practice; record, analyse and learn from their defect experiences, concluding in the development of defect assessment tools and learning systems to reduce prevalent defects.

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SHALL WE DANCE? ENCOUNTERS FOR ENERGY RENOVATION OF SINGLE FAMILY HOUSES

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In the strive for climate change mitigation and transition the building stock is a major issue to acknowledge as its energy consumption and production of carbon dioxide is significant, around 30% of the total in Sweden. Government policies, subsidies and more have therefore been applied to deal with this issue. However the bulk of efforts have focused on dwellings, office buildings, public buildings and other major installations, whereas the single family house areas have received less attention and presently even enjoy a public regulation regime which leaves up to ten years of room for manoeuvre before private house owners are obliged to react. This leaves the arena for more voluntary types of renovation. Studies shows that house owners doing such renovations are prone to contact and use their local SME craftsman. The encounters between house owners and craftsmen come to impede the degree and quality of the energy renovation referring to costs, unstable and/or ineffective technologies, lack of understanding of subsidies and financial options and even general insecurity. This paper reports a local study of three craftsmen contractors and their interaction with house owners as potential customers which is part of a project with a group of participating SMEs. Through interviewing, participant observations and shadowing, the sales processes and negotiations were followed on site inside the customers house. Theoretically the study draws on Goffman's concepts of presentation of self in everyday life, performance, staging and "front". The results show a complex interactive pattern, like a dance, where limited local knowledge play a role as does subtle assumptions about cost and economic capacity. Thus rather than placing the responsibility for conservative renovation actions on either the craftsmen or the house owners, it is claimed here that the two parties are acting in a routinized play they cannot easily escape.

Keywords: energy renovations, detached houses, Goffman, SME.

INTRODUCTION

Buildings represent 30% of the total energy consumption within Sweden (Boverket 2010). Energy renovations are therefore important to carry through seeing it is one of the most significant contributions to decrease energy usage within buildings (Risholt *et al.* 2013). There are some energy renovations carried out today, but a much greater amount is required to be able to reach EU's directives (EU 2010). House owners prefer to contact small and medium sized enterprises (SME) when renovating or planning to renovate their houses (Doona and Jarlbro, 2009).

This paper aims at studying the interaction between craftsman and customer, asking what kind of processes might lead to the scoping of the renovation task.

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This study is part of a project developing building SMEs business models in response to the need for energy renovations. Customer and customer relationships are important parts of a SME business model and understanding of customers need is vital (Osterwalder and Pigneur 2010). To develop a comprehensive understanding of sales processes, negotiations and customers' perspectives, enterprise and customer interactions were followed.

The paper introduces Anton, Bosse and Stefan which are the craftsmen followed as well as Sebastian, Christer and Bosse which are the customers as well as AntonSebastian, Bosse - Christer and Stefan - Oscar which are the pairs of interaction. We come to focus on multiple scripts of identity and therefore use the pseudonyms names to avoid too readily assigning functional roles to them.

The papers' central contribution is the emphasis and understanding of interactive encounters, the dance between the craftsman and the customer, underlining the joint enterprise they enter into as alternative to putting the "*blame*" one sided when the result is a convenient and restricted renovation without much energy consumption reduction. Goffman is here used to enable a more interaction and symbolic oriented analysis of the craftsman-house owner relations that otherwise often are described in a one-sided manner, blaming either side. Moreover Goffman also enables departing from thinking that cost and economy are dominating the relation.

The paper is structured as follows. It opens with a theoretical framework using the dramaturgical approach and pointing to the role of script. Then follow the method section. The empirical part describes two staged encounters and the material is then analysed together with the third case.

THEORETICAL FRAMEWORK

The theoretical framework conceptualises the renovation occasion as a staged performance. 'Staging' is here understood as a construction of a physical arena and occasion for an act (Goffman, 1959; Clausen and Ushinaka, 2007). This emerges through interaction and would involve "*one to one*" occasions as well as "*one to many*" (Goffman 1959). Staging of renovation arenas is conceptualised as a performative becoming of a collaborative sociomaterial agency (Clausen and Ushinaka, 2007). Importantly, as noted by Pinch (2010), staging involves the construction of performers (on stage) and audience, spectators to the events on stage. The performative dramaturgical repertoire encompasses using language, narratives, gestures, bodily movements (Van Praet 2009) as well as clothing. It involves processes of initial definitional work, encounters (Goffman 1959, 1961) and might lead to mutual social obligation if not disrupted (Darr and Pinch 2013). It also involves agent tactics of performing front stage as well as back stage, and finally, but importantly, sociomateriality is part and parcel of these staging processes.

A sales encounter, where a service or a product is attempted sold is a case in point of a staged interaction (Darr and Pinch 2013). They view sales encounters as important because studying them uncovers the social fabric of market exchange, and reveal that service and product value and sales price are socially constructed. Darr and Pinch (2013) study several types of sales encounters, one being material commodities traded through face to face encounters on the sales floor in shops. Another being market pitchers at flee-markets. They view the sales floor and the street spot as stages for sales processes and use a dramaturgical analysis of framed sales encounters (Goffman 1959, 1961). Sales encounters can be seen as involving structured forms of action

which repeats themselves in similar situations, re Goffman concept of “*script*”. In the process of sales encounters Darr and Pinch (2013) finds three “*scripts*”; “*material scripts*”, “*identity scripts*” and “*morality scripts*”. The sales encounters leads to social obligation – a stated situation where social actors feel more or less compelled to carry out a social action, in the case the purchasing.

Both the salesperson and the potential customer perform identity scripts during the sales encounter. The identity scripts can, according to Darr and Pinch (2013) go far beyond the immediately available script of seller and customer. More over identity script is “*asking*” for a particular response from the audience, in this case most often the other person as the studied interactions are involving, but also others.

Morality scripts are invoked during the sales encounter as part of obtaining trust and later social obligation (of buying) according to Darr and Pinch (2013). Acting a moral script can be related to the quality of the product, the habitus of the seller and/or to how processes of the encounter (here renovation) is carried out. It can refer to that the seller and his company are not “*wide boys*” and the products not “*shoddy*” or the process just or unjust, good or bad (Darr and Pinch 2013).

Materiality scripts describes how materiality can enable these practices directly by, for example, acting as separators between front and back stage, by acting as properties, stage requisites, but it may also constrain the performance of agency (Pinch 2010).

In the theatre there are distinctions in actors’ roles and actions depending on if they are performing in front of an audience (front-stage), or if they are behind the scene, where the audience cannot see them, acting with other actors known to them (backstage). Goffman (1959) shows how these front-stage and back-stage concepts can be applied to social life and human interactions. Front-stage then represents when interactions occurs in public and back-stage is interactions in private or with actors that are trustworthy (McCormick 2007).

Today’s workplaces are often “*fluent*”, without a fixed location, which is the case for the SME owners and craftsmen. This implies that back stage and front stage might be difficult to define. However, Lowe *et al.* (2012) argues that front stage and back stage can be divided depending on how the actors interpret and make assumptions about “*we*” (symbolizing back stage) and “*them*” (symbolizing front stage) in their interactions.

METHOD

This paper draws on three interactions between enterprise representatives and potential customers wanting to renovate their homes. The customers had contacted the enterprises for consultation. To be able to make an approximation about how and what needs to be conducted as well as provide a price, the enterprise sends out a representative for a visual inspection and what might follow. The interactions followed occurred at the customers’ homes.

The methods used to acquire information were participant observation and shadowing (Czarniawska 2007). The clients’ observation and shadowing were enabled through the craftsman that invited the observer to specific customer-visits after been asked to do so of the observer at a prior time. Short interviews were also conducted with two of the three enterprise representatives in the car to and from the customer’s home, as well as with the customers in the end of two of the visits. The empirical material was analysed in an iterative process in the first phase of the study (Alvesson and Sköldbberg 2006).

As the status of the study is explorative we have included the cases we got so far and there is thus not a direct selection occurring. The names used are pseudonyms and they are used to underline that when following the interaction more closely is less simple to assign functional roles to the players. We therefore use Anton, Bosse and Stefan for the enterprise representative/craftsman/ seller/ guest and similar personal names for the customer/hosts. All translations of the rhetoric are made by the authors.

The role as a researcher in relation to staging between two other persons deserves special attention. The researcher is following the enterprise representative to, from and during the encounter with the customer. Yet the researcher's presence might lead to another performance and staging of the enterprise representative. The craftsman might feel the need to stage himself in front of the researcher (for example as competent, experienced, skilled and trustworthy). Also the interaction with the customer might lead to another staging and performance. Moreover the researcher also performs scripts: as a guest (coming in the house, shaking hands, nodding, smiling, interacting with body language, talking about the dog/child), as an enterprise representative (talking about Chalmers), as an outsider (not being part of the discussion of work that the customer and the craftsman had talked about before – seeing they were referring to it in a way that they had discussed it before), as a researcher (talking about the study, asking the customers questions) and then as a guest again (thanking for coffee, wishing a nice weekend and enjoying the weather, saying goodbye).

It is a limitation that we have not yet followed full cases of renovations and we did not here discuss the encounters between SME and customers before and after the one analysed below. As only a limited set of interactions has been studied we might find other scripts or less regularity among scripts, than what is implicitly communicated here. Moreover the staging might be a lot more complex as families are more than one person (i.e. craftsmen told us that they talk to the husband, yet it appears that sometimes it is the wife that decides) and other arenas exist for staging the companies.

CASES

Anton and Sebastian

Arriving at the customer's house, Anton, the enterprise representative/salesperson/craftsman quickly tells me the customer, Sebastian, had called Anton out to look at his house because he did not want to experience another winter as last winter. Stepping through the gate to the house, Sebastian opens the door, shouting if we are afraid of dogs. Seeing we are not, we step just inside the door and gets greeted by a happy Amstaff. Sebastian and his girlfriend are trying to calm her down without luck. For a couple of minutes the dog has everybody's attention.

When the dog finally calms down a little, Anton, still with his shoes and jacket on starts asking questions, about the dog, about Sebastian's job, how does he like it, what does his girlfriend do for a living, how was Christmas and so on. Sebastian is the one taking place and his girlfriend is hiding in the background of Sebastian. After some time Sebastian explicitly says that he bought the house and he is the one who has done some of the renovation made in it. After that statement Anton is focusing on Sebastian only and the questions are becoming more specific for why Anton is there: how long have they lived there, what are the problems they are experiencing, how was it last winter, has he done something to prevent it from becoming the same issue this year (except from calling him). Sebastian is keen on telling us of all problems and what he has done so far to make the house better (warmer) than it was when he bought it.

Anton asks if he may have a look at the attic and Sebastian agrees. The attic is reached from the inside of the house, we are told we do not need to take our shoes off, and then we go up. Anton goes up first, the researcher goes up after and Sebastian is standing in the entrance of the attic, halfway up the ladder.

Anton examines the attic, he is putting a knife in the beams, lifting on existing insulation to find the plastic, flashes the light in the corners and studies existing insulation. He then explains how Sebastian needs to change the ventilation so extra insulation can be added. Sebastian looks nods and says he understands. When Anton is satisfied we all go down to the kitchen where Sebastian's girlfriend is waiting.

Over a cup of coffee, Anton goes through the process of what will happen now and how it will work to add extra insulation by showing a short video clip. Sebastian and his girlfriend are very interested of the video and all other questions and comments need to wait till the clip is finished. Finally price is calculated by Anton and accepted by Sebastian. Thanking for the coffee we are heading off. On our way to the car Anton tells me that Sebastian seemed to be a great guy and he will be surprised if he will not get calls from neighbours to Sebastian by the end of this month, wanting to do the same thing as Sebastian.

Bosse and Christer

Arriving at the house, still in the car, Bosse tells the researcher that the house owner is one of those who have called a few craftsmen in the same area, to get several opinions and prices to compare and choose from.

A man opens the door after we have rung the doorbell. We present ourselves and steps in. Two children comes running, but disappears just as quickly again. Bosse makes a comment about the children and Christer, the house owner says that OS (Olympic winter games) is on the TV. A short conversation about Sweden's accomplishments in OS follows, Christer then shows us down to the basement to look at his present heating system. Bosse takes a look at the system and explains how it works today and asks how Christer and his wife experience its functionality. Christer says they bought the house just a month ago and recently moved here, and therefore have no experience to talk about. They just knew they wanted to invest in a new heating system so they could save some money in heating costs and invest the saved money in a new kitchen.

Bosse asks Christer to have a look around in the house to see the need and potential they have. In one of the rooms Christer asks if there could be a good idea to switch all radiators for fan convectors, Bosse advises against that for several reasons, but when getting to the hobby room, located next to the garage, Bosse explains that this room could be a room where Christer could install fan convectors to get some heat.

The walk through the house ends in the kitchen. Bosse is asking questions to find out what type of heating system would benefit this family the most in relation to price, needs for warm water and wished inside room temperature. He then explains what will happen next. Christer sits quietly and listens, answers Bosses questions. Suddenly Christer asks Bosse if he knows a couple of Bosses companies competitors. He tells Bosse that two of his companies' competitors have been there, supposedly to make offers. He has not gotten anything from them yet though, he said they did not seem to be interested. Bosse replied that he found that strange and that he would give them a ring and talk to them. Christer seemed happy with this.

Once we sat in the car again Bosse tells the researcher that one of the companies that Christer told us about is not reputable so he is not surprised to hear this about him,

however that the other company had not given an offer were on the other hand very surprising, seeing this house represents a job everybody would want: nothing complicated to remove, nothing complicated to install and easy to make some money out of it. He was very surprised they were not already in contract with Christer.

DISCUSSION

In the first case the enterprise representative is trying to get “*a feeling*” for how to address the situation and the customer and claiming that he is aware about building on trust and confidence in his relationships with house-owner/customer (towards their companies as well as their products). There was a distance between the enterprise representative and the customer in the beginning at all the customer visits.

Several identity scripts are in play. Anton, the enterprise representative performs a guest, a salesman, a craftsman (carpenter) and an enterprise representative script. In the first case a guest script and a host script is first mobilized talking about the dog and more.

The materiality of the attic becomes supporting the enterprise performing a craftsman script inspecting the roof sides, insulation and corners and “*explaining*” to the host/customer what needs to be done.

Another materiality, a video clip is mobilized to further the craftsmen professionalism. The social construction leads to that the host/customer and the craftsman construe social obligation and end up calculating a price and agreeing on it.

Also in the second case, the encounter opens playing out the guest and host scripts. The walk through the house creates several occasions for playing out the craftsman’s script, mobilizing expertise on the heating system and fan convectors. Throughout the walk however the sales script is also an element, but is fully played out first in the ending of the encounter. Bosse is actually performing an owner script, not only an enterprise representative one, which however does not appear so strongly for the customer.

A trust and morality issue turns up when Christer (the potential customer) asks Bosse about the competitor’s behavior. We know from the backstage interaction that potential customers are taking offers from others is perceived by Bosse as a bit of a special situation. The morality script played out can be seen as balancing between trust building towards reaching social obligation, and distrust because of taking offers from others and even an unserious competitor is problematic. Again the materiality of the house offers occasions of mobilizing the craftsman expertise distinguishing between rooms with different needs for example. To Bosse the house comes to represent an attractive job, even easy because of its accessibility.

Across the three cases

There are different constellations of Anton’s, Bosse’s and Stefan’s script performance. One is more craftsman-oriented whereas two are more sales-oriented. The clothing reflects that the craftsman being in blue overalls whereas the salesmen (also craftsmen practitioners) are more neatly dressed. One, Bosse is audience to a customer’s performance of criticizing the competitors, evoking morality scripts, whereas Anton and Stefan through the bodily, oral and symbolic behavior relatively smoothless reaches social obligation.

The physical exercise of Stefan leaning forward is used by this craftsman-oriented enterprise representative to convince the potential client, Oscar, to use aluminum framed windows, social obligation appear to be established.

The representatives were initially mobilizing guest scripts asking “*unthreatening things*” and commenting about weather, sport, making pancakes, and the children running around and making parables to their own lives.

The SMEs want to sell and increase their selling to the customers. When a house owner contacts the SMEs for renovation of their house, the SME carpenters are doing an inspection of the house, measuring both issues asked for and of own initiative. They are at the same time interacting with the customers, clarifying what needs to be done. The carpenters, as representatives for the SMEs, are aware that the interactions with the customers are appropriate occasions for increase of selling, despite this they are not trying to expand the selling beyond what derives directly from the encounter. Instead of helping the customer understand possible investment opportunities they perform what they interpret the customers perceives needed.

Through our interviews and other interactions with the companies we are told that the carpenters are first and foremost trying to get “*a feel*” for what the customer wants and needs, and their financial ability. When they experience they understand the customer, they often try to narrow down the customers wishing instead of shifting focus and selling. This can be interpreted as a dominance of the craftsman script as identity orientation. The customer is in this view possibly seen as an obligatory point of passage for doing the real stuff, assembling wood, electricity systems etc. whatever materiality is involved in the craftsman identity script.

The material script is performed through the interaction with the house. One craftsman/enterprise representative (Stefan) taps on an inside of the attic and the “*response*” is saw dust sliding down inside the cavity.

The feeling for the customer is underlying the enterprise representatives’ decisions in how to address the situation and the customer. The carpenters claim they are aware about the importance of trust and confidence building in customer relationships. In the observed interactions there was in the beginning a distance between the carpenter and the customer. Relating this to Goffman (1961) the carpenter is staging himself as unthreatening by asking questions and making comments about weather, and so on. By presenting himself in an unthreatening way to gain trust and to create a relation the carpenter might not dare to push too much for selling, afraid to lose the whole deal.

There are fraudsters in construction businesses, imposing to be knowledgeable carpenters but in reality being scammers. The house owner might therefore be careful and uncertain of the financial ability of the enterprise and the representatives’ competences. By not knowing what or who to trust the house owner becomes hesitant to buy the service and leave the house in the hands of the carpenter he or she does not know.

The carpenter and the house owner are in a sense performing a slow distant dance, facing each other in circles. A dance where no one dares to step a bit further and reach for the other, taking the lead position, instead they are carefully staging themselves using metaphors and stories to slowly move closer the others world. Maybe trying to establish what roles to allocate for oneself as well as the other and to reach a common understanding of the roles as well as getting a sense of the others actions, expectations and if there is a hidden agenda. We note that our interaction encounters involves the

seller/craftsmen in a rich set of scripts, whereas Darr and Pinch (2013) find their richest examples of identity script by the customer.

Front and backstage; in two cases the car transporting the observer and the enterprise representative becomes the backstage before and after the sales encounter. In one sales encounter the garden fence gate provide the material separation allowing the enterprise representative to air that the potential customer is likely not to have enough financial means to realize all his ideas.

At the backstage “we” is performed as the researcher and the enterprise representative and “them” are the customers (see also Lowe *et al.* 2012). It derives that the enterprise representative thinks the researcher can be trusted (parallel to McCormick 2007’s finding).

We note that despite the expected fluidity of staging front and back, various materiality’s performed the separation of front and back in time and space in a relative straightforward manner, counter to McCormick (2007)’s finding.

What and who constitutes the “audience” might shift (a third person, like Sebastian’s girlfriend might be the audience, but when Anton is interacting with the house Sebastian becomes part of the audience).

CONCLUSIONS

This paper set out studying the interaction between craftsman and customer, asking what kind of processes might lead to the scoping of the renovation task. We found multiple scripts in play during the interactive encounters. Assumptions about the partner in the activity involve lack of knowledge, financial resources, morality and professional competences. Moreover materiality played along supporting the craftsman identity script mostly.

We saw how these interactive encounters were performed like a slow distant dance. A dance where mutual distance is incorporated and no one dares to step a bit further and reach for the other taking the lead position, instead they are carefully staging themselves using metaphors and stories to slowly move closer the others world. We interpret this characteristic of the interactive encounter as main explanation for the relatively conservative scoping and outcome of renovation of single family houses. Rather than placing the responsibility for conservative renovation actions on either the craftsmen or the house owners, it is claimed here that the two parties are acting in a routinized play they cannot easily escape, which creates barriers for applying new green technologies and/or renovations in an energy saving manner. We expect to pursue this assumption in the future research work.

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HOUSE BUYERS AND BUILDERS: THE “IDEAL” HOME IN SCOTLAND

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The UK Government has outlined a variety of targets for new build housing to be zero carbon (Zc) from 2016. In realising this ambitious target, house builders will be required to deliver high energy efficient housing adding to the existing rules and regulations bedevilling the construction industry. This, combined with the selection and purchase of a new home being the single, largest capital investment that a person is likely to make in their lifetime has resulted in the success of Zc housing depending, to some extent, on consumer acceptance, which must align with the attitudes, values and wants of potential home buyers, particularly when faced with a variety of factors influencing consumer decisions. Consequently, this research presents the findings from a comprehensive quantitative study of 202 questionnaires undertaken by house buyers relating to energy efficient, private housing which highlights a misalignment between perceptions and reality with regards to what buyers consider to be the “ideal” home. The results obtained are particularly important as they go some way in narrowing the gap between the views and opinions of house buyers and builders relating to energy efficient homes and the home buying process.

Keywords: consumer, energy efficiency, housing.

INTRODUCTION

“The UK house building industry is no stranger to change. For decades, it has frequently altered its processes, building methods, design requirements and quality standards” (Farookhi *et al.*, 2010) in order to align with consumer attitudes, market demands, Government legislation, the economy and more recently, zero carbon (Zc) compliance and the green building movement. As the housing industry contributes to approximately “30% of the UK’s total energy use and 27% of its CO₂ emissions” (National House Building Council, NHBC, 2008) it is imperative that such change is ongoing in order to respond to the biggest change management programme the industry has faced (Farookhi *et al.*, 2010). As a result, the days of inconsiderate construction methods and disregard for the environment are becoming a thing of the past. If Zc standards are to be implemented across all new homes within the UK, it is essential that house builders are willing and able to construct such homes to the necessary standards and to the volumes required; which involves changes to current design and procurement practices as well as implications for all those involved in the construction process and more importantly, the end users (NHBC, 2013).

The problem arises from mounting pressure to reduce CO₂ emissions and the need for the UK Government to enforce energy efficient strategies and targets. In order to assist in achieving the Government’s 2050 carbon emissions targets and 2020 goal of

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supplying 15% of UK's energy from renewable sources, house builders are being forced to innovate whilst maintaining high levels of customer satisfaction. However, as a lack of consumer demand is a potential hindrance to the implementation of energy efficient homes (Zero Carbon Hub, 2010) and as house buyers are seemingly "*non-participants*" in this process, engagement and consumer demand for Zc homes is often low, which is a significant hindrance to the drive towards energy efficient homes.

For the purpose of this paper, an energy efficient home is defined as one which delivers the proposed "*carbon compliance limit of 11 kg CO₂/m²/year by reducing emissions of around 17 kg CO₂/m²/year compared with a similar (semi-detached) home built to 2006 standards. The remaining carbon is the amount that may be addressed using allowable solutions*", which aligns with that of Zero Carbon Hub, (2013). This research area was selected due to a gap in knowledge regarding the alignment of the views and opinions of house buyers and builders in Scotland relating to energy efficient homes; where the few studies undertaken to date, predominantly relate to perceptions of house buyers and builders in England.

LITERATURE

The selection and purchase of a new home is likely to be the single, largest capital investment a person undertakes in their lifetime; and next to marriage and divorce, it is considered to be one of the most stressful events in life (Michaels, 2001). To ensure an easy transaction, it is imperative that house builders maintain high levels of customer satisfaction through the development of strategic management systems. As a result, the construction industry has had the difficult task of encouraging new buyers to purchase homes in the midst of failing markets, low consumer confidence and potential credit difficulties (Adair *et al.*, 2009). As pressures increase and home buyers become better informed; proactive construction organisations are realising the need to redesign and redevelop their business strategy to practice good customer relations (Forsythe, 2007). As a result, house builders need to identify and understand buyer needs in order to continuously improve their service level.

DECISION MAKING PROCESS

It has been suggested by Wright (2006) that consumers undertake a standard decision making process when buying a new home. Initially, this process begins with "*need awareness*" where the consumer recognises that there is a problem with the current situation and that there is a need for change (Wright, 2006). This is followed by the consideration of the "*evoked set*" which is the group of products that instinctively come to mind when considering a purchase (LeBlanc and Turley, 1994). The evoked set is determined by the types of homes available within the marketplace at that particular time, which may include, but is not limited to; an apartment, semi-detached or detached home, bungalow, new modern home or a period, character-full home.

The next stage involves an evaluation of potential alternatives, through an "*information search*", where each criterion is ranked in first, second, third order etc. For example, if a consumer decides to downsize due to their age, then it is likely that a bungalow or apartment will gain the highest rank and thus the other options will feature further down the list – however, they may never be totally discounted. If a decision cannot be made, the consumer will return to the search phase.

Once a consumer has decided to purchase a specific type of home, they will consider vital aspects such as location, price and the type of house builder, also known as the

“*evaluation of alternatives process*”. This is emphasised by research undertaken by the NHBC (2008) which suggests that the location, type and design of a property will have a significant influence on the final purchase deliberations. The results shown in figure 1 overleaf highlights that location is the most influential factor, closely followed by number of bedrooms. Disappointingly, energy efficiency was the least influential factor influencing decisions (NHBC, 2008).

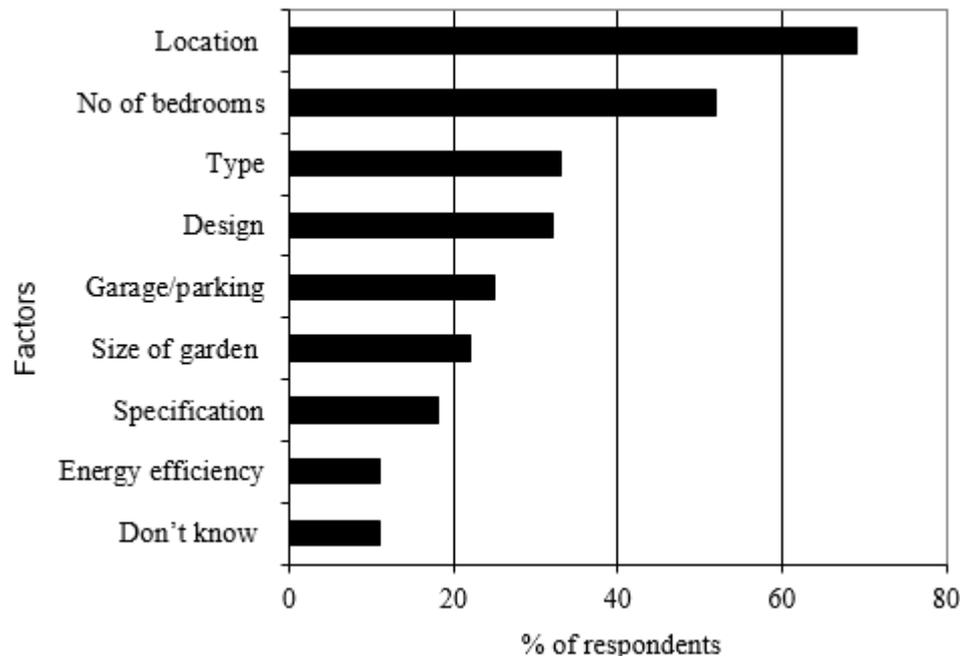


Figure 1: Chart of the most popular factors influencing the choice of home (adapted from NHBC, 2008).

These results are further emphasised by a recent study undertaken on the behalf of the National Association of House Builders (NAHB, 2013) which states that home owner’s rate energy efficiency highly on their “*most wanted*” list. According to the NAHB (2013) “94% of home buyers want energy-star rated appliances, 91% want an energy-star rating for the whole home, 89% want energy-star rated windows and doors, and 80% want ceiling fans”. A survey conducted by Opinion Matters (2011) with a 1,556 UK adults, states that more than 50% of home owners claim that they are happy to pay more for an energy efficient property. In fact, one in five buy willing to pay up to £1,000 extra and one in ten claimed that they would pay an additional £5,000 for energy efficient features; highlighting that energy efficiency is important to house buyers.

Having identified popular factors influencing the choice of home as stated by the NHBC (2008), this paper presents the results of a similar questionnaire developed to determine whether or not public opinion has changed.

METHODOLOGY

This study conducted research with a philosophical underpinning of objectivism, based on a positivism outlook which uses a mixed method research technique in a deductive way.

For many years the adoption of the positivist approach has been the dominant paradigm used to conduct consumer research which is based on the assumption that

consumers are “*rational, stable and knowable entities*” (Pachauri, 2002) and that the causes of behaviour can be “*identified, manipulated and predicted*” (Pachauri, 2002). When related to consumer behaviour, positivism states that consumers have little overall control over their decisions and instead, are influenced by other internal or external forces (O’Shaughnessy, 1985). This particular research, therefore, analysed facts in order to explain whether or not the views and opinions of house buyers and house builders are aligned in order to influence the uptake of more energy efficient homes.

A questionnaire (face to face and postal) technique was selected to primarily gain an understanding of the underlying views and opinions of construction buyers, potential buyers, new home buyers and house builders which provided 202 responses. The response rate for each group is shown in table 1 below.

Table 1: Response Rates

Groups	Number distributed	Number of replies	Response Rate
Construction buyers	90	72	80%
Potential buyers	130	79	61%
New home buyers	76	33	43%
House builders	79	18	23%
Total	375	202	54%

*Note: construction buyers are individuals who work in the construction industry and who are also “*potential*” buyers.

The potential buyer sample relates to anyone living in Scotland who is over the age of sixteen and who may be in a position to either buy or rent a home. This particular sample was selected to represent the views of the “*average*” consumer and the wider population. During the data collection process, an exponential non-discriminative snowball sampling technique began to emerge. This “*chain referral*” process was very simple, cost efficient and required very little planning.

The new home buyer sample, on the other hand, refers to house buyers who had purchased or are currently renting a private new build home which was constructed within the last three years. As energy efficiency ratings and Zc awareness has seemingly increased over the last three years, this sample was selected to provide a comparison between the other groups to determine whether or not house buyers who had moved home recently, had different views from those who moved home many years ago. The data collection for new home buyers was undertaken using a random sampling technique.

The construction buyer sample was chosen to establish the effects of “*informed decisions*”. Whilst working for construction firms, such buyers were expected to have different opinions compared to “*average*” house buyers due to their increased knowledge of energy efficiency and sustainable practices allowing for deeper, more interesting comparisons to take place between the various samples.

Finally, the house builder sample was selected to gain the views and opinions of those at the forefront of the housing industry. The house builders were given a different questionnaire which asked them to provide information about what they thought buyers wanted from their new homes. This allowed a comparison to be made between what house buyers said they wanted and what house builders thought that they

wanted. Although the poor response rate achieved for the number of house builders is subject to some sample limitations which makes generalisation difficult, some basic analysis was undertaken within this group in order to provide an understanding of general trends.

RESULTS

The paper reports a small aspect of a more comprehensive survey where an analysis of the results has been obtained from the stated questionnaires in order to;

Identify the key factors which influence buyer decisions about whether or not to rent or purchase a particular home and compare these to the NHBC study undertaken in 2008.

Determine whether or not a gap exists between the views of house buyers and builders.

Although the following results are subject to some sample limitations, the results aim to provide an understanding of general trends which require further investigation.

Respondents (excluding the house builders) were asked to state the main reasons for deciding to purchase or rent their current home, where 115 terms were identified. From the 184 respondents who answered this question, the most influential factor was location which contributed to 14.94% of the total factors identified. Only 8.7% (n = 10) of the 115 terms were responsible for over 51.39% of the total items analysed.

According to Sanders (1988), Vilfredo Pareto was a nineteenth-century sociologist who reported through observation that approximately 80% of wealth was concentrated in 20% of the population. Table 2 overleaf shows that 22% of the terms used in the main database (26 factors) are responsible for approximately 73% of the total factors observed which demonstrates that the 80/20 rule can be applied to this particular research. This imbalance of terms suggests that focusing on the most influential factors would encourage the uptake of more energy efficient homes by members of the public.

Table 2: Reasons for choosing the home including percentages.

Description	Total	%	Description	Total	%	Description	Total	%
Location	107	14.94	Garage	4	0.56	Suited needs	1	0.14
Cost	57	7.96	Rental income	4	0.56	Market conditions	1	0.14
Size	53	7.40	Own space	4	0.56	Low carbon	1	0.14
Area	36	5.03	Facilities	3	0.42	Low rent	1	0.14
Price	27	3.77	Community	3	0.42	Needed to move fast	1	0.14
Space (actual)	25	3.49	Freedom	3	0.42	New to the market	1	0.14
Garden	20	2.79	Available land	3	0.42	No main roads	1	0.14
Amenities	17	2.37	Better home	3	0.42	Crime levels	1	0.14
Schools	13	1.82	Having a child	3	0.42	Accessibility	1	0.14
Transport network	13	1.82	Responsibility	3	0.42	Accommodation	1	0.14
Close to work	12	1.68	Modern	3	0.42	Aesthetics	1	0.14
Number of rooms	12	1.68	Looks	3	0.42	Future	1	0.14
Close to family	11	1.54	Upgrading	3	0.42	Appearance	1	0.14
Neighbours	11	1.54	Surroundings	3	0.42	Government incentive	1	0.14
Design	11	1.54	Income increase	3	0.42	Room to expand	1	0.14
Investment	11	1.54	Necessary	2	0.28	Heating bills	1	0.14
Energy efficiency	10	1.40	No work to do	2	0.28	Savings	1	0.14
Style	10	1.40	Noise levels	2	0.28	Large kitchen	1	0.14
Right for the family	9	1.26	Own home	2	0.28	Second choice	1	0.14
Independence	9	1.26	Roommate/flatmate	2	0.28	Short term	1	0.14
More (extra) space	8	1.12	Room size	2	0.28	Lifestyle	1	0.14
Parking	8	1.12	New home	2	0.28	Length of lease	1	0.14
Layout	7	0.98	Decoration	2	0.28	Letting agent	1	0.14
Comfort	7	0.98	Driveway	2	0.28	Stamp duty	1	0.14
Quality	7	0.98	Economical	2	0.28	Long term plan	1	0.14
Potential to add value	7	0.98	Personal circumstance	2	0.28	Student	1	0.14
Type of home	6	0.84	Practicality	2	0.28	Bungalow	1	0.14
Availability	6	0.84	Specification	2	0.28	Change	1	0.14
Views/outlook	6	0.84	Standard	2	0.28	Inheritance money	1	0.14
Value for money	6	0.84	Age	2	0.28	Insulation	1	0.14
New build	5	0.70	Convenient	2	0.28	Internal fittings	1	0.14
Maintenance	5	0.70	Bills	2	0.28	Hosting parties	1	0.14
Safety	5	0.70	Central	2	0.28	Games room	1	0.14
First time buyer	5	0.70	Character	2	0.28	Ventilation	1	0.14
Condition	5	0.70	Heating system	2	0.28	Family dispute	1	0.14
Move in with partner	5	0.70	Profit	1	0.14	Homeless (no choice)	1	0.14
Close to motorway	5	0.70	Property developer	1	0.14	Wellbeing	1	0.14
Affordable	5	0.70	Traditional features	1	0.14			
Re-sale	5	0.70	Rent includes bills	1	0.14			
Total no of items = 115; Total count = 716								

When reviewing the literature and research results regarding the reasons why house buyers bought their current home, a level of disagreement was found. The reasons provided by consumers for purchasing their current home fell into 6 distinct categories relating to “*independence, economic, external environment, internal environment, practicality and other*” which were based on 115 individual factors identified.

However, such results largely contradict research previously undertaken by the NHBC (2008) which claims that only 9 individual factors were identified when they asked house builders to spontaneously mention the key factors affecting buyer purchases. The research therefore contributes to the body of knowledge by identifying almost 13 times the number of factors identified by the NHBC. Moreover, the results from the NHBC study showed that house builders believed that energy efficiency was among

the top 8 factors influencing the consumer's choice of home. However, the findings from this research undertaken in 2013 show that energy efficiency was not mentioned within the top 8 factors, as shown in table 3 below.

Table 3: House builder versus house buyer perceptions of housing priorities.

Ranking	NHBC (2008) house builder perceptions of homeowner priorities	Findings from this research i.e. actual house buyers (2013)
1	Location	Location (specific)
2	No of bedrooms	Cost (overall cost of living)
3	Type	Size
4	Design	Area (general area)
5	Parking	Price (of home)
6	Garden	Space
7	Specification	Garden
8	Energy Efficiency	Amenities (nearby)

THE “*IDEAL*” HOME

Respondents were also asked to consider their “*ideal*” home relating to CO₂ emissions, additional cost (over and above their current budget), location, personal involvement (in the buying process), features (hi-tech, low tech, modern and period) and their toleration of problems in order to assess their expectations relating house buying. All 202 questionnaires have been included in the analysis of this question, allowing a comparison between house buyers and builder.

The potential buyers were the most likely group to purchase a Zc home (46.84%) followed by new home buyers (36.36%). Surprisingly, the construction buyers were the least likely group to purchase a Zc home and are in fact, more likely to purchase a home which is being built to current practice standards compared to the other groups. Although the majority of buyers do not wish to pay the additional costs associated with energy efficient homes, new home buyers are however, more likely to accept additional costs in excess of £20,000 for energy saving features within their new home. Furthermore, all of the consumers want homes in the best possible (1st choice) locations, which strongly aligns with the views of the house builders. Figure 2 overleaf, shows some variance in shape between the opinions of the house buyers and house builders was discovered, particularly relating to the toleration of problems and the level of personal effort that buyers would like whilst purchasing a new home. The findings show that consumers believe that they have a medium level of toleration of problems which may be encountered when purchasing a new home, for example, issues relating to defects and snagging. House builders, however, believe that buyers are unwilling to accept such issues and have a low toleration suggesting that house builders underestimate their buyers to some extent. On the other hand, the majority of house builders believe that consumers want more involvement in the purchase process, when in fact; the house buyers opted for medium personal effort, suggesting that they want a “*hassle*” free option.

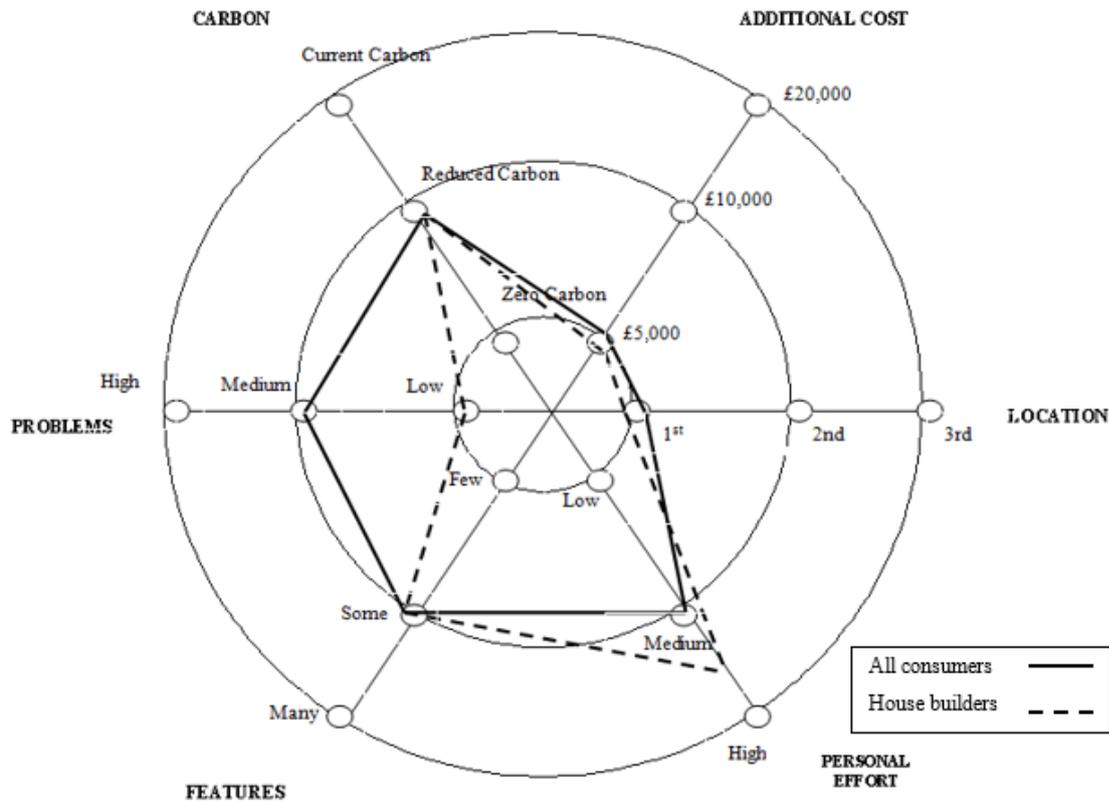


Figure 2: Radar diagram of the ideal home, house buyers versus house builders.

Additional results found that although house buyers believe that the range of homes currently available within the marketplace is good; many house builders believe that the choice is very good. Similarly, house buyers perceive show homes as being helpful; again house builders believe that they are very helpful. This overestimation was also apparent in the results obtained when asked about the level of new home buyer satisfaction, where the house builders overestimated their ability of delivering homes in accordance with time, cost, quality and safety by 18%. Such overestimations and underestimations can be seen in table 4 below.

Table 4: Over and Underestimations.

Factor	House builder	House buyer	Over or underestimation
Choice within the marketplace	Very good	Good	Overestimation
Show homes	Very helpful	Helpful	Overestimation
Kind of home	Low tech	High tech	Underestimate
Toleration of problems	Low toleration	Medium toleration	Underestimate
Satisfaction of time, cost, quality and safety	94%	76%	Overestimation
Satisfaction of needs, wants and desires	79%	75%	Minor overestimation

CONCLUSIONS

The findings from this research show that energy efficiency did not feature within the top 8 factors influencing buyer decisions. Instead, the results obtained from this study are much more monetary focused as both the overall living cost and price of the home were included within the top 7 factors influencing home buying decisions. This undoubtedly relates to the unstable conditions of the Scottish (and indeed wider UK) housing market over the last few years, where lower house prices, unstable mortgage

advances, high unemployment and job uncertainty are having a negative impact on consumer buyer behaviour.

However, this contradicts the findings when compared to the “*ideal*” home where buyers opted for a reduced carbon home. This suggests that there is a misalignment between perceptions and reality. The impact of this finding is that the Government must recognise that consumers believe that energy efficient homes are out with their current capability and although they would be open to living in a reduced carbon home in the future, financially they are not willing to pay the inflated premiums.

Throughout the research findings and discussions, it was discovered that house builders often overestimate their own abilities and underestimate their buyers. The significance of this finding is that it highlights a need for house builders to actively undertake more research relating to the views and opinions of their home buyers.

Although the results obtained can only be used as an indication of general trends due to the restricted sample size, with the knowledge gained as part of this research, house builders should have a clearer idea of the needs, wants and desires of their house buyers, relating to energy efficiency.

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LEARNING AND EDUCATION

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PROMOTING DOUBLE LOOP LEARNING IN FLOOD RISK MANAGEMENT IN THE SCOTTISH CONTEXT

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In Scotland, flood risk is predicted to double by 2100 due to climate change and land use changes within river basins. Flood Risk Management (FRM) has emerged as a strategic framework to encourage resilience through collaboration, risk assessment and flood plans designed to target investment for prevention and defence schemes. Learning in this context has often been criticised for being single loop, reactive, narrow, and fragmented and ignoring wider socio-technical issues. The Scottish Flood Risk Management Act (2009) has shifted focus from flood defence to a holistic prevention based approach which encourages the double loop learning (DLL) necessary to promote sustainability and greater resiliency within the social system. This research explores the extent FRM in Scotland has promoted DLL at both a strategic and project levels following the application of the 2009 Act. A literature review identifies that to promote DLL requires FRM to be proactive, seek new knowledge, be creative, question, and be holistic when making future based decisions. These characteristics were considered in two research phases, 1) a survey of Scottish local authorities (response from 22 of 32) in 2011, supplemented by stakeholder interviews focused on the strategic level and 2) follow up stakeholder interviews in 2014, and case study exploring operational implications at a project level. The research found that changes in FRM since 2009 have provided a framework where DLL can potentially flourish but this is a transitional phase with social-technical barriers restricting its delivery in practice at both strategic and project levels. Findings stress the importance of fostering a proactive and learning culture surrounding FRM which supports the management of explicit and tacit knowledge between strategic and project levels maximising opportunity for DLL during and post flood events, but also in identifying and managing individual projects.

Keywords: flood risk management, double loop learning, knowledge management, case study.

INTRODUCTION

The significant risk posed by flooding within the UK has been highlighted during the winter of 2013/4 by flood events in Humberside and across the South of England. Many argued that severe floods in 2007 and periodic floods in Cumbria in 2009 and 2012 had acted as a “wake-up call” to a naive British society (Pitt 2008). However, despite increased investment in flood defence schemes the resilience of the infrastructure remains incomplete and unable to cope with the frequency and severity of recent flood events. The cost to the wider economy, societal inconvenience, property damage, risk to life and animals, insurance concerns, coupled with a growing awareness of the link between river basin development patterns and flood risk is

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placing pressure on governments. The social system is unprepared, with the dominant approach focused on hazard management defending previously flooded locations through costly, disproportionate, heavily engineered reconstruction projects (Schmidt-Thome and Schmidt-Thome 2007).

Flood Risk Management (FRM) aspires to provide a proactive process based approach which examines the effects of flooding on the system by integrating stakeholders and considering their common problems and concerns, as well as learning from best practice and collective experience (McFadden *et al.* 2009). It intends to change the perception that flood events are extraordinary and reactively managed, but instead to be viewed as an ever present threat (Hillson 2007). This approach intends to be less responsive and instead planned, holistic, and proactive in identifying and then mitigating potential flood risk. Shaped around a classic risk management model of risk identification, risk analysis, risk assessment and risk reduction it is intended FRM will provide the basis for action plans which reflect the needs of the social system and enable targeted investment in a range of integrated measures based on adaptation and mitigation. Such an approach to risk aims to promote continual improvement and assessment of the system (economic, social and environmental) to proactively deal with risk (BS ISO 31000:2009). Under EU Floods Directive all member states must create and update flood maps and management plans to minimise the risk and create resiliency. Despite this rationale, many have questioned its current application in practice (Bosher *et al.* 2009); citing a retained inability to capture, acquire learned knowledge from past floods and to apply this effectively in flood mitigation management (Steinfuhrer 2009; McFadden *et al.* 2009). FRM principally aims to value knowledge and learning within its practice (Fleming 2001); however, the recent floods in the UK have promoted many to question the delivery of its basic principles in current practice and to call for prompt action from policy makers.

This research focuses on the practice of FRM in the context of Scotland. Due to differences in topography, land use patterns and population densities when compared to the rest of UK, Scotland is argued to experience lower flood risk; however this is predicted to double by 2010 (Scottish Government 2014). Record investment has already been placed in flood defence schemes over the last decade and The Scottish Flood Risk Management Act (2009) (referred to as 'the Act') passed to guide future action and investment plans through its intended inclusive and proactive approach. At a strategic level, districts and sub-districts have been created with local authorities identified through legalisation to co-ordinate development of tailored flood plans with the Scottish Environmental Protection Agency (SEPA) guiding the process and developing flood risk maps. These maps aim to promote a better understanding of the nature of flood risks at a local level and to encourage co-ordination between agencies and service providers. As well as identifying hard engineering solutions in flood defence, the maps aim to promote the potential for natural flood management and to facilitate greater awareness amongst the various stakeholders and agencies of the nature of the risk highlighting interdependencies. The Act is phased in its introduction, with the Flood Risk Management Strategies to be developed by 2015, and Local Flood Risk Management Plans by 2016.

Since 2009, Scotland hasn't been tested with the scale of flooding seen in other parts of the UK and a legitimate question remains over whether the Act has delivered the desired proactive inclusive approach in practice required to facilitate resilience or whether there are problems in the transition.

FRM Act and double loop learning

A change in culture is needed and whilst authors have challenged the nature of the learning approach within FRM, few have explored the type of learning required. In Scotland, the Act has sought to promote double loop learning (DLL) through a governance structure which encourages a questioning of the system, challenges the existing norms and permits a more sophisticated management response able to consider innovative solutions based on a wider evidence base. The Act outlines a process for developing flood risk strategies and plans at national and local levels which moves away from single loop learning (SLL) and its association with reactive approaches responding to the perception of risk (Argiris and Schon 1978). To achieve this, a clear process with defined roles and responsibilities for stakeholders (including created role of FRM officer), stipulated requirements and mechanisms for stakeholder inclusion have been specified. Local Flood Risk Management Plans will be fully developed in 2016 with a review after 6 years as part of the FRM planning cycle, and the overall national FRM strategies spanning three of these cycles (i.e. 18 years). The process is structured to provide feedback and reflection aiming to promote DLL by enabling previous assumptions to be challenged through evidence and consideration of best practice. To support the process, the Act stipulates the need for an inclusive partnership of key stakeholders (local authorities, MET Office, SEPA and Scottish Water- SW) and to encourage active participation with the wider community in the development of the evidence base but also in formulation. A change in the way public bodies work together and gather evidence is recognised, with SEPA arguing that establishing knowledge and understanding collectively across administrative boundaries reflects the whole river catchment and is key to addressing wider causes and impacts of flooding. Whilst not fully applied till 2016, there is a need to consider how effective initial phases since 2009 have been in promoting DLL through structural and cultural changes at both a district level (strategic) and in its implications at an operational project level.

Requirements for promoting DLL

Despite its intentions and implementation, evidence from the winter floods of 2013/14 in England reveals high profile instances where authorities have been unable to predict accurately the flood risk and have been slow to respond in practice through mitigation and adaptation measures (Wedawatta *et al.* 2014). Voss and Wagner (2010) point to empirical evidence suggesting that FRM has often failed to achieve DLL due to limited participation of wider stakeholders thus restricting the potential to learn from previous flood events, incorporate alternate views and expertise, engage with socio-technical issues in the future infrastructure design and post flood reconstruction and response planning (a view supported by White *et al.* (2010)), with Frantzeskaki *et al.* (2014) calling for adoption of partnerships models to promote inclusion and learning

A key barrier identified within the literature relates to FRM's struggle to achieve its intended objectives due to a failure to move away from a traditional engineering mindset to the problem (Voss and Wagner, 2010; Steinfuhrer, 2009). In practice, FRM officers are emergency planners and/ or engineers who operate within a top-down structure and are often argued to restrict the opportunity for engagement with frontline stakeholders limiting their ability to contribute to future decisions (McFadden *et al.* 2009; Coaffe 2008). Many have experience of delivering flood defence schemes and display a preference through their training for a technocratic approach which can result in knowledge being considered in "*silos*", narrow, hierarchical and exclusive by

manner with a preference for quantitative measures. Whilst their experience is valuable and plays a key role in decision making (Dawson *et al.* 2011), its retained dominance fails to reflect the intended wider socio-economic context, long- and short-term implications and variability of flood risk in FRM (Messner and Meyer 2005). In retaining a reliance on technocratic protocols and language, the potential exists for wider stakeholders to be excluded from decision making and learning processes (Steinfuhrer 2009). Such an approach retains SLL, and runs the danger of promoting apathy for FRM amongst decision makers during periods of limited flood events.

Widening participation during FRM is key to providing the potential for an exchange of knowledge both explicit (codified held, for example, in documents) and tacit (uncodified and held by individuals reflective of their role and experience) between stakeholders (Nonaka & Takeuchi 1995). DLL relies on both forms of knowledge to be effective but in retaining an engineering approach the potential exists to exclude the tacit knowledge stakeholders bring as professionals (expert knowledge) and as residents (local context and observed experience). Explicit forms of knowledge (e.g. quantitative data, best practice recommendations by government i.e. protocols) are important, but without tacit learnt experience of the local system (tacit knowledge) it is difficult to stimulate questions, be innovative and to foster tailored solutions reflective of the context and appropriateness of any intervention required from FRM.

In order to flourish, there is a need to provide a structure to the FRM process and to evolve the culture to: 1) be proactive, 2) provide new knowledge, 3) support creative thinking, 4) be questioning and 5) be holistic by nature. A limited number of successful examples highlighting that to deliver such a transition in practice leadership, guidance, and importantly enthusiasm need to be provided (Voss and Wanger 2010; White *et al.* 2014).

RESEARCH STRATEGY AND METHODS

A constructivist approach was followed in order to establish an understanding of current FRM practice and its promotion of DLL from the perspective of those involved. The high degree of change since 2009, and a lack of empirical studies in the Scottish context provide the basis for a study. Two research phases were undertaken: 1) in 2011 and 2) in 2014.

In 2011, a questionnaire survey was issued through email to the named FRM representative within the 32 Scottish local authorities as they were legally responsible for developing FRM strategy and plan in their district, establishing a base line of practice. 22 (69%) of the local authorities responded, representing a cross section in terms of size, rural/ urban split and geographical spread. Of the other 10, three failed to respond, and others cited reasons such as lack of time and newness to role. The survey was designed around attitudinal questions (using 5 point likert scale) to gauge views of established themes from the literature, with open questions to capture depth. The themes considered: background/ context, current flood plans and review process, nature of stakeholder involvement, learning styles (reactive/ proactive), knowledge (type, depth and creation), communication method (knowledge flow), and stimulus requirements for proactive learning (leadership, culture, resources). Five semi-structured interviews (each 30-40 minutes) with key stakeholders (FRM officers from two local authorities, SW and SEPA) were conducted to follow up findings from the survey with transcripts thematically analysed using Nvivo software.

A second phase was initiated in 2014 to explore further emerging themes but also to ensure the research reflected contemporary practice. Interviews were undertaken with a local authority Principle Flood Engineer (FRM Officer) and Flooding Project Engineer to explore practice at district and project levels. In order to consider the implications in practice, a case study project was considered which had been suggested by those interviewed as high profile and reflective of contemporary practice. The Bervie Braes slope stability project in Stonehaven (Aberdeenshire) is a complex project and represented an active flood risk threat.

RESEARCH ANALYSIS AND FINDINGS

This section explores themes emerging initially during the survey and interviews in 2011, but reflected on further in 2014.

Need to strengthen the role of a FRM officer

The survey revealed that FRM officer had emerged as a recognisable role with responsibility for overseeing the development of the flood risk strategy and plans. However, only five local authorities had created a full time position with the other 17 identifying this as a part time role held together with other positions commonly as emergency planners or civil engineers in roads and technical services. The interviews revealed a strong desire to elevate the position to a full time Senior FRM officer to raise the profile of flooding, but at the time, insufficient funds were available. The fragmentation of the role meant the ability and knowledge held by officers varied and had an impact on the delivery of FRM at a strategic and operation level. Indeed, 19 (of 22) either agreed or strongly agreed that the depth and desire for in FRM is dependent on the officer's motivation and ability to interpret knowledge. In 2014, outwith of some key authorities the situation had not changed.

Retained technocratic bias in decision making

The Act, has stipulated a rounded role for a FRM officer with structured duties designed to mitigate reliance on an individual's own perspective and attributes. Despite this, legalisation was felt to be vague on non-engineering factors and with FRM officers being predominantly engineers this has restricted the degree of questioning and creative thought around socio-technical issues. A FRM officer felt that whilst engagement with local residents and stakeholders had increased, it remained in response to historic and visible flood risk retaining the dominance of SLL and limiting the ability to think proactively and holistically. SEPA and SW representatives argued that when placed in a culture of budget cuts, this mindset limits stakeholder engagement as a minimum requirement, a view encountered also in 2014.

Development of dictated flood maps, plans and procedures

FRM officers argued the Act has outlined a structure which will create an environment where plans are created and periodically reviewed in depth, thus promoting learning by the set approach to evaluating flood risk data. Prior to the Act, councils produced bi-annual reports where projects are added to by members only promoting major changes should a flood event occur; embodying SLL. In 2011 it was too early to observe the full impact of the Act in practice with 13 (out of 22) councils still having no flood plan and with 18 indicating they had no procedure underpinning the identification of risk. In 2014, delays in district level flood risk maps were observed to be retaining a reactive approach identifying future projects.

Knowledge gaps in reporting

17 (of 22) respondents concluded that there remained knowledge gaps within FRM both in terms of its delivery as a process and in terms of its analysis. Prior to the Act,

knowledge needed to be explicit, factual and evidence based with risk assessed largely on past events. The Act aims to promote stakeholder engagement and brainstorming in order to capture tacit knowledge and promote learning around the development of the bi-annual report. Several FRM officers observed that these reports cannot realistically deal with all of the issues surrounding flooding and there was a tendency for those involved to primarily focus on the physical damage caused, the environment that caused it and the council's response to it. However, the SEPA representative stated that guidance is provided for methods of data gathering and storage of flood data and knowledge. Local authorities widely reported a shortfall in the reflection of tacit knowledge in these reports, and from a project perspective a need exists to capture lessons learnt to inform future FRM strategy and other projects essential for DLL, and no change was observed in 2014.

Moves towards proactive learning

20 (of 22) observed that learning takes place largely due to new knowledge gained after a flood event; however 19 felt that in retrospect much of this could be learned prior to the actual flood. In spite of the Act, nine respondents felt that learning remains reactive, relying heavily on flood events for evidence. However, the potential exists through the Act for a proactive approach but the wider view was its implementation needs better support. A strong barrier observed to promoting a proactive approach was the potential reaction of unaware residents that their properties were now at risk.

Sub-district Advisory Groups

The introduction of the Bi-annual Sub-district Advisory Group was bringing greater creativity through its increased membership and diversity but it was observed to be confined to engineering aspects and limited concern for socio-technical issues. Although chaired by SEPA, its success depends on the local FRM officer to facilitate an environment where local stakeholders provide this knowledge. However, involving and documenting the views of large numbers of stakeholders will present resource pressures which could limit potential for inclusion and ultimately DLL.

Guarding against apathy

A culture of budget cuts forcing mergers of roles and increased workload was argued to present the potential for complacency and apathy to flood risk especially with long periods between major flood events. Respondents revealed that successful FRM takes place when politicians recognise the severity of the problem, and when a proactive FRM officer drives the process to foster DLL. Highlighted in both 2011 and 2014 the desire to engage with wider stakeholders and develop a high level of collective knowledge is difficult in a culture of apathy.

Significance of tacit knowledge and its management

The survey identified reliance during FRM on explicit sources of knowledge such as best practice guidelines, statistical data and records, stakeholder reports. An awareness of the value of advice from experts, locals, and stakeholders was presented but such tacit sources remained low in priority. The value of tacit knowledge was highlighted where local knowledge of coastal conditions greatly informed the development of flood maps resulting in significant cost saving through design changes on a flood defence project. The challenge of managing and retaining access to this resource during the planning cycle was revealed as the individual (local authority employee) was retiring.

SW argued that the Act should result in a greater volume of learning, however the depth and quality of learning is dependent on the willingness of the parties to

cooperate and it is this interaction which creates new knowledge and facilitates DLL. The Act creates the structural conditions; however the FRM officer was identified as playing a key role in the delivery of more tacit knowledge and aiding the transition from SLL to DLL. Despite this, interviews in 2011 and 2014 questioned the ability of the FRM officer to capture the vast amounts of knowledge held by frontline staff and local stakeholders relating to flood risk. The interviews revealed concern that through the absence of techniques such as lessons learnt at the project level, only the most important tacit knowledge is captured by the FRM officer, often in a general way thus restricting DLL.

Communication pathways

At a strategic level, a traditional focus on meetings and reports was slowly evolving to include more informal communication pathways between stakeholders. The Bi-annual Sub-district Advisory Group was seen as encouraging wider inclusion, but many felt that the frequency should be limited as too much knowledge exchange could prove counterproductive and result in a 'talking shop'. The FRM officer is key to ensuring a meaningful transfer of knowledge between FRM at a district level into individual projects. Their organisational skills and enthusiasm for the Act were identified as crucial to its success as they set the strategic context and provide guidance to project teams providing legitimacy for decisions which may not seem intuitive within the context of an individual project. As the knowledge 'broker', an apathetic officer has the potential to restrict the process and fail to create the opportunity to learn. However, a lack of formal guidance was observed in 2011 and 2014 as causing problems at an operational level.

Skills gap in those delivering FRM

An inability for local authorities to build capacity due to budget restrictions was been identified to have led to a reliance on consultants who provide a specialist service such as flood modelling. However, a consultant is often removed from the local context, and therefore isolated from the knowledge exchange necessary for DLL. This approach may further reduce the skill levels in local authorities, as they rely on this expertise without being able to learn from it. In this position, the officers need to learn to ask the right questions, with a clear need to provide integration between strategic and project levels

Integration of FRM between strategic and project levels

Emerging across both research phases was the need for better integration between the national, district and project levels in delivering FRM something which the increased availability of flood risk maps over the next year or so will promote aiding a shift towards a proactive approach. Until then, many districts will still identify future projects based on budget and perceived need, but the potential exists for the maps to transform how local authorities approach FRM within their district towards a proactive standpoint. Whilst a transition is emerging in project identification, by 2014 evidence suggested that DLL was further promoted by FRM being tied to developing the local plan and therefore shaping planning requirements. At a project level, to enable DLL increased focus is required to ensure that lessons learnt from previous projects are established but the interviews revealed that there were no specific measures in place to enable the capture, storage and retrieval of key lessons. Explicit knowledge held in project documents can be stored and shared, but it is apparent that more needs to be done to ensure the learned experience of the project team is captured and accessible to help shape future decisions.

BERVIE BRAES SLOPE STABILITY PROJECT, STONEHAVEN

The Bervie Braes comprises a 850m long coastal slope bisected by a former trunk road which has suffered from instability for a number of years. The project's initial focus was to stabilise the road posing a potential flood risk highlighted following significant flood events in 2009 and 2012, enabling political recognition and resources to be available to support the stabilisation project. Owned by a private trust (although Aberdeenshire Council retain responsibility for the road and its footprint) the future of the slope achieved wide spread engagement from stakeholders. Investigations revealed that the instability is caused by shallow groundwater which promotes increased pore water pressures at times of heavy rainfall which, in turn triggers slope instability especially in the steeper areas of the Braes (Mickovski *et al.* 2013). Stabilisation was proposed involving a design focused on soil nailing and a range of drainage measures to control surface water and ground water levels.

Aberdeenshire Council's flood team (principal engineer for flooding i.e. FRM officer and a project engineer) were interviewed and reported that the project was reactive by nature to a long term problem but, given local interest and political support for a solution, the design was able to consider the long term sustainability of the slope. The planning phase involved preliminary discussions between stakeholders regarding specifics of flood risk, legalisation, budget, timescales and disruption. Engagement with locals and wider stakeholders was reported to be significant compared to comparable projects within the same district due mainly to self-organisation, interest and willingness to be involved amongst the local community. Regular formal and informal meetings during planning (but continuing through the project) helped designers to reflect local knowledge but also facilitated community understanding and acceptance of proposals and eventual disruption. It was stressed that this wasn't initiated by the changes in the Act but was driven in response to local interest, but shares many of the principles encouraged and aids DLL. The planning application was positive, but some design changes were made following hydrological and hydrogeological studies (Mickovski *et al.* 2013), with a decision taken to discharge road drainage directly into the watercourse which was more distant but had higher attenuation capacity. A number of options were presented, and considered by stakeholders in a range of formal (Sub-district Advisory Group, project meetings) and informal (one to one discussions) mechanisms. Implications were explored, and through consultation, and assessment of flood risk a design was agreed. The design changes were costly (time and monetary), however through consultation and an effective flow of communication and local knowledge between designer and stakeholders, the proposals were deemed acceptable and the end cost was reduced. The solution reduced potential of flood risk from the source of very high drainage volumes making this cost minor in comparison to the potential damage from a flood event. To aid engagement with the community, a video fly through was developed to facilitate acceptance and engagement with the project.

Reflecting the transition in practice since 2009, it has lacked district flood risk maps, but has embraced stakeholder engagement in line with the principles outlined in the Act. Political acceptance and a proactive FRM officer have helped provide an environment where the holistic picture can help shape project decisions. Enabling the designer to suggest innovative long term solutions and by promoting these through community engagement facilitate acceptance but benefit the design through local knowledge. In contrast, the same team were presented with another project in the district with less profile, high levels of apathy and a disengaged community resulting

in a less creative design process. This illustrates the importance of a proactive project culture to promoting a dynamic learning environment, and this can't be left to chance.

Three additional issues emerged reflecting a need for integration between strategic and project levels: 1) the project team felt isolated from the flow of the knowledge surrounding FRM as this was held by the officer or SEPA; 2) the process relied heavily on the FRM officer to manage the flow of knowledge and interpret SEPA guidance for individual project teams; and 3) with legalisation interpretation being left to individual councils this presents contrasting experiences.

A key observation in terms of promoting DLL was a gap existing in the flow of knowledge between this and other projects. Projects identified in a district FRM plan tend to operate in parallel, but managed by different teams. FRM officer stated that greater communication is being encouraged between teams to share their experiences but this remains at a high level and not on detail or technical issues which could have highest impact. This aligns with findings from earlier interviews where establishing lessons learnt has potential to support the transfer of knowledge between strategic and project levels, but also individual projects and thus enhances DLL.

CONCLUSIONS

The research revealed that since the Act 2009 the application of FRM in Scotland is in a period of transition, with full implementation not due to 2016. The Act intended to foster a holistic and proactive approach to FRM through a structured process designed to promote evidence based decisions within an inclusive stakeholder centred environment aiming to promote DLL. FRM officers broadly supported the principles advocated through the Act and recognised the intention of the structural process outlined and its potential to promote DLL. A recent delay in the production of complete flood risk maps across Scotland is making it difficult to fully implement the desired proactive approach to FRM. However even in its transition, stakeholder engagement has emerged as a recognised part of the process at both strategic and project levels responding to structural requirements but importantly a growing cultural awareness is emerging amongst decision makers of its value for DLL. Evidence suggested that enabling a wide range of stakeholders to participate allowed tacit knowledge from communities to contribute towards decision making but also aided acceptance. Despite this, a number of social-technical barriers were identified which currently impede the ability of FRM to promote DLL: the fragmented role of FRM officer, retained engineering mindset, skills gap in those delivering FRM at district level, resource limitations, apathy, knowledge gaps in reporting, absence of flood risk maps, challenge of managing tacit knowledge, and a lack of inter and intra project learning. The case study reveals a positive picture, highlighting the value of local knowledge and stakeholder collaboration to ensure the strategic and local flood risk considerations are incorporated at a project level. This project displayed many of the proactive and questioning characteristics associated with DLL, but instilling these characteristics in other projects is largely dependent on removing the socio-technical barriers and recognition of the value of knowledge for stimulating learning. Finally, interviews in 2014 highlighted the need to strengthen opportunities to learn from flood events in different contexts and between projects, with research needed to support the capture, storage and retrieval of knowledge.

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WIND TURBINE RESCUE: EMERGING SKILL RETENTION ISSUES AND CHALLENGES

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The wind energy sector is becoming an increasingly important one for those involved in construction and with the increasing number of technicians employed in the industry, issues of occupational health and safety becomes of paramount interest. This paper explores the occupational health and safety challenges in the wind energy industry in relation to wind technicians' safe and competent use of a rescue and evacuation device in emergency situations whilst working at height. The study reported here evaluated the magnitude of procedural skill and knowledge retention over a three-month period after acquisition; the significant factors influencing procedural skill retention during safe rescue and evacuation; and the impact of cued recognition/recall methods on skill retention. Thirty trainees fully participated in the retention study at intervals of 28 and 90 days. The results suggest that refresher participants should undertake rescue and evacuation practice drills between three and six months after acquisition while fresher participants should undergo practice drills within the first three months. The contributing factors influencing the technicians' procedural rate of retention are the length of time after acquisition and practice, experience, feedback and it is advisable that cues be embedded within the training because with fundamental cues, there is increased retention of procedural tasks. This has implications for the wider construction industry where work at height in harness are carried out in isolated places.

Keywords: competency, rescue and evacuation, skill decay/retention, refresher and fresher, cued recognition/recall.

INTRODUCTION

Construction within the wind energy industry is hazardous and with the on-going growth and large numbers of turbines being built, issues of competency of qualified technicians become increasingly important as wind competes with other industries. With the growth of EU's wind energy and as the number of technicians employed in the industry continues to increase, issues of occupational health and safety becomes of paramount interest (EU-OSHA, 2013), and an integral part of the work life cycle. One obvious hazardous activity is working at height, which is often performed using harness equipment in remote areas. The management of wind farms must therefore take into account the competency of those technicians working on such structures as comparable to other industries.

Regulatory requirements such as Management of Health and Safety at Work Regulations 1999, (Reg. 8); and others identify the need for operational wind farms to have a secured and effective emergency response to incidents/accidents affecting

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persons on an onshore or offshore installation or engaged in activities in connection with it. Currently, there is no strategic incorporation of emergency response units and international consistency within the wind industry. Therefore, the initial response in times of emergency rescue and evacuation solely depends on the skills of the technicians and these skills make up part of their basic safety training.

The GWO, (Global Wind Organisation Standard, 2013) and RUK (RenewableUK, 2014) have been involved in developing a common training standard for the wind energy sector. These have resulted in the development of a standard for basic safety training which covers aspects such as first aid, manual handling, working at heights, fire awareness and offshore sea survival. Within the EU, the European wind turbine standard (BS EN 50308:2004) which is the current legislative development in the wind energy industry does not take appropriate account of offshore facilities, turbine erection, access hatch sizes and machinery guards to emergency escape lift requirements and lighting, though a revised update is being worked on which will ensure that safety is considered from the start of the turbines' life cycle.

The reliable and safe operation of a wind turbine rescue and evacuation device requires the use of a number of engineering safety features which is similar to other engineering devices and the significance of a wind technician to be trained, competent and respond to initial onshore or offshore rescue emergency situations cannot be over emphasized. Though there are no mandatory training schemes or standards that specifically apply to large wind projects in the UK (RenewableUK, 2014), however, standards and schemes that have been developed and supported through industry consensus (e.g. RUK standards) are likely to be regarded as a 'benchmark of good practice'. Within the wind industry, benchmark standards have been developed by the industry to address significant risks specific to the wind sector and these are supported by suitable third party accreditation systems like RUK Training Standards and GWO – Basic Safety Training.

The legislations relevant to Health and Safety training include but are not limited to the following: Health and Safety at Work etc. Act 1974, Health and Safety (First Aid) Regulations 1981 (as amended), Lifting Operations and Lifting Equipment Regulations 1998, Management of Health and Safety at Work Regulations 1999, Manual Handling Operations Regulations 1992 (as amended), Work at Height Regulations 2005, and Provision and Use of Work Equipment Regulations. It is therefore the legal requirement of employers to ensure that suitable information, instruction and training is provided to employees and others who may be exposed to risk, (RenewableUK, 2014).

This paper explores the emerging skill retention issues and challenges faced by wind turbine technicians in procedural use of a standard rescue and evacuation device, (type RG9A – see Figure 2). Skill decay or retention is the progressive deterioration of knowledge and skill when they are not put into use over extended periods of time; as more time elapses, there comes more decay (Arthur Jr., *et al*, 1998; Arthur, Jr, *et al*, 2007). According to Tarr (1986) in Kim, *et al.*, (2007), surveys have shown that personnel in technical jobs mostly perform procedural tasks. Procedural tasks are those that involve a number of coherent steps that may include any combination of cognitive and motor skills, (Stothard and Nicholson, 2001). Konoske and Ellis (1991) noted that many procedural tasks can be viewed as an ordered sequence of steps or operations which are performed on a single object or in a specific situation to accomplish a goal.

Consequently, the objective in relation to emergency rescue and evacuation was to study skill retention using cued recognition and recall processes and observe the skill retention path and impacts on the research participants who work at height. Retention which is the outcome of successful learning is typically evaluated by having the learner recognize, recall, repeat or reproduce skills they have acquired. Retention can be assessed both directly and indirectly, by employing recognition tests and priming paradigms respectively, (Schacter, 1992; Fischer and Yan, 2002). Though complex procedural tasks have been found in general to be more fragile, the importance of intrinsic cues in overcoming this problem was illustrated by Shields, *et al.*, (1979). Healy *et al* (1998) also reviewed studies that found both good and bad retention of procedural skills by putting forward the proposal of procedural reinstatement, which contributes to the recall of complex tasks.

Flexer and Tulving (1978) stated that recall and recognition tests are in various cases autonomous processes such that an individual's ability to recognise an event has no relationship to their ability to recall it. Though different retention measures can yield different degrees of superficial retention, recall tests are usually of lower scores than the recognition tests (Farr, 1986). Therefore, this study designed its retention method by blending cued recognition and recall techniques using pictographic displays as the tool of assessment and monitor the rate of skill decay within an interval of one and three-months after acquisition, (Hancock, 2006; Meador and Hill, 2011).

The hypothesis is that after the initial skill and knowledge acquisition by wind technicians and due to the infrequent nature of practically carrying out on-the-job rescue and evacuation roles, there is a likelihood of skill decay in times of significant emergencies except where there is a support system available to the technicians.

RESEARCH QUESTIONS

This paper addresses the following questions:

8. What is the magnitude of procedural skill and knowledge retention over a three-month period after acquisition?
9. What are the significant factors influencing procedural skill retention during rescue and evacuation?
10. Does cued recognition/recall method influence the retention of skills?

METHODS

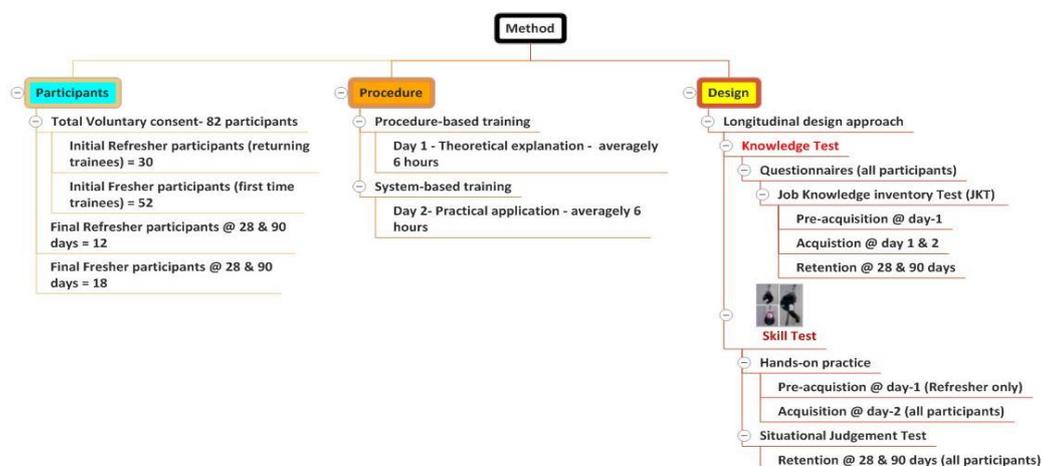


Figure 1: Method of data gathering using basic map explorer

The research participants were those registered to undergo the basic RUK/GWO approved height safety and rescue training and the study recruited a total of 82 wind technicians in three phases: 27 in phase-1; 26 in phase-2; and 29 in phase-3. The training involved procedure- and system-based training averaging 6-hours per day over two-day sessions with emphasis on emergency rescue, how to approach rescue situations in wind turbine generators (WTG) and competent use of rescue equipment.

The research implemented longitudinal design approach for data gathering (de Vaus, 2001) in order to track changes over time and establish the sequence in which events took place. Questionnaires were designed based on 'Job Knowledge inventory Test' (JKT) (Teachout *et al.*, 1993). This was used for the entire knowledge evaluation from pre-acquisition to retention. The knowledge pre-acquisition test was administered before day-1 training session, while the two acquisition tests were after day-1 and day-2 sessions. Retention measures using JKT was administered online at intervals of 28 and 90 days.

Hands-on practical scenarios were used during skill pre-acquisition and acquisition stages using the automatic constant rate descender (CRD) RG9A (see Figure 2). Only refresher participants (returning trainees) were assessed during pre-acquisition stage because they have used this device in previous training sessions. Data for skill acquisition was collected for all participants (refresher and fresher) after day-2 training session. Skill retention assessment at 28 and 90 days was administered online using 'Situational Judgment Test' (SJT) (Lievens *et al.*, 2008), with cued recognition/recall and pictographic displays by prompting the participants to correctly work out the step-by-step sequence and procedures of using the RG9A rescue device. All the research participants were required to evaluate the randomized written performance description and the associated picture by rearranging the correct sequence of procedurally executing the use of RG9A during rescue and evacuation.

JKT is a well-known method for assessing the effectiveness of, or need for training (Paulin, *et al.*, 2002; Lievens *et al.*, 2008). JKT is very useful in the measurement of fundamental knowledge of technical information (Teachout *et al.*, 1993), such as those used in the height safety, rescue and evacuation training course. SJTs are a type of psychological test which present the participants with realistic, hypothetical scenarios (Lievens *et al.*, 2008) and requires the individual to identify the most appropriate response or to rank the responses in the order they feel is most effective and operational.



Figure 2: Automatic constant rate descender (CRD) RG9A

PRELIMINARY RESULTS

This research having been piloted, reviewed and amended is based on results of 30 research participants that fully participated all through the assessment period. This reflected an overall response rate of 36.6% out of a total of 82 initial research participants.

1. What is the magnitude of procedural skill and knowledge decay over a three-month period after acquisition?

The education sector has a history of setting 75% as the benchmark for passing score (McKnight, 1999). For the magnitude of procedural skill and knowledge decay presented in Tables 1 and 2, the refresher participants show an average of 15.9% and 22.7% decline in skill performance after 28 and 90 days respectively while the fresher participants show 18.5% and 29.6% decline in skill performance, (see Table 1). The magnitudes of knowledge decay for refresher participants were 8.4% and 10.5% after 28 and 90 days while the fresher participants were 18.4% and 21.4% respectively, (see Table 2). Result of refreshers' skill (65.9%) and knowledge (29.5%) decay at 24 months after training was based on the mean preliminary performance of refresher participants during pre-acquisition before undergoing the height safety and rescue training (see Fig. 3). Figure 3 estimates that at 24 months after acquisition, refresher participants will be performing at averagely 34% skill and 67% knowledge competency.

Table 1: Magnitude of skill decay over one and three month period – Skill assessment

Time	Skill performance (%)		Magnitude of decay (%)	
	Refresher	Fresher	Refresher	Fresher
T ₀	30	0		
T ₁	88	81		
T ₂	74	66	15.9	18.5
T ₃	68	57	22.7	29.6
*T _{24M}	*30	*	*65.9	*

*T = extrapolated time at 24 months

Table 2: Magnitude of knowledge decay over one and three month period – Knowledge assessment

Time	Knowledge performance (%)		Magnitude of decay (%)	
	Refresher	Fresher	Refresher	Fresher
T ₀	67	55		
T ₁	92	92		
T ₂	95	98		
T ₃	87	80	8.4	18.4
T ₄	85	77	10.5	21.4
*T _{24M}	*67	*	*29.5	*

*T = extrapolated time at 24 months

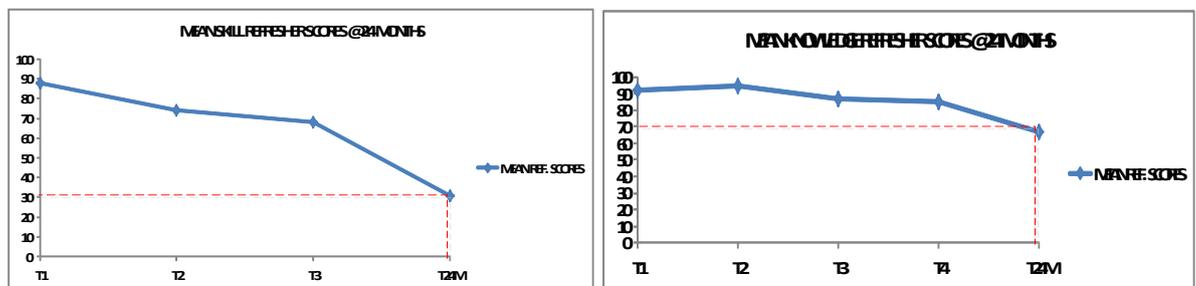


Figure 3: Estimated mean skill and knowledge competency plots for refresher participants at 24 months

2. What are the significant factors influencing procedural skill decay during rescue and evacuation?

Figure 4 show mean performance plots for skill assessments. Refresher participants display significant increase in performance scores from pre-acquisition to acquisition, peaking at 88% while fresher at acquisition show 81% competency. Analysis of skill structures plus control of environmental factors such as practice and familiarity allowed the prediction of special instances of near-perfect synchrony during acquisition, as well as predictions of various degrees of synchrony under differing circumstances, (Fischer, 1980). The refresher participants outperformed the fresher participants from acquisition to retention periods and these suggest the probable influence factor might be as a result of prior training and experience. Table 3 illustrate

the mean relative effect of experience on performance scores for both refresher and fresher participants.

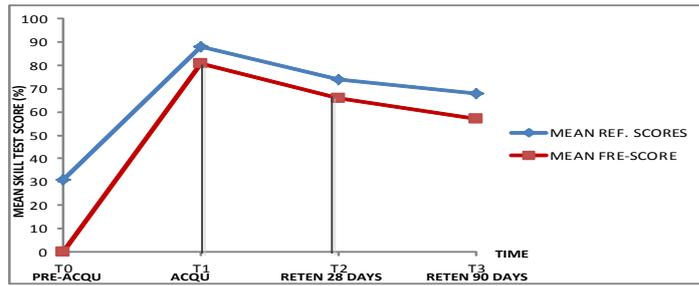


Figure 4: Mean score for skill assessment for refresher and fresher participants

Table 3: Experience of participants versus performance scores – Skill assessment

Skill Test		Experience in Years					
		0-1	2-3	4-5	6-7	8-9	10 +
Mean performance score %	Refresher		73.34 (4)	85 (2)	55 (2)		85 (4)
	Fresher	68.89(15)		62.22(3)			

(*) = number of participants within each group

Figure 5 and Table 4 both illustrate the mean performance scores for knowledge assessments. Figure 5 shows that development is relatively continuous and gradual, and the participants are never at the same level for all skills, (Fischer, 1980). Both sets of participants displayed steady increase in performance scores from pre-acquisition to acquisition averaging 95% and 98% respectively. Though this study demonstrate that at acquisition both set of participants can attain comparable levels of peak performance; over the course of retention, preceding trainings and experience of refresher participants (Table 4) seem to enhance their ability to retain knowledge longer than fresher participants. According to Stothard and Nicholson (2001), an individual’s level of initial proficiency has a direct relationship with the level of skill retention.

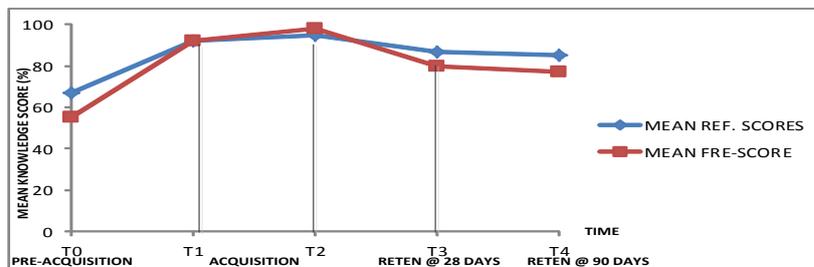


Figure 5: Mean score for knowledge assessment for refresher and fresher participants

Table 4: Experience of participants versus performance scores – Knowledge assessment

Knowledge Test		Experience in Years					
		0-1	2-3	4-5	6-7	8-9	10 +
Mean performance score %	Refresher		87.94(4)	93.75(2)	91.25(2)		87(4)
	Fresher	85.93(15)		87 (3)			

(*) = number of participants within each group

3. Does cued recognition/recall method influence the retention of skills?

The tests for retention typically involve using the recall test or recognition test. As shown in Figures 4 and 5, ‘forgetting’ for refresher and fresher participants occurred at different rates over the assessment period. Based on the proposed benchmark score of 75% and implementing cued recognition and recall methods of assessment, the refresher participants had average performance scores of 68% (skill) and 85% (knowledge) while fresher participants scored 57% (skill) and 77% (knowledge) at 28

and 90 days retention respectively. Overall, the refresher participants performed better than the fresher participants in both skill and knowledge tests. However, despite the influence of cued recognition and recall methods employed, it is considered essential that the absence of repetitive practice drills, experience and feedback seem to be contributing factors influencing the performance level of these participants.

DISCUSSION

The results identify that the magnitude of procedural skill and knowledge retention over a three-month period declined rapidly within 28 days after training and gradually toward 90 days. This result is comparable with the study of Wetzell, *et al.*, (1983) which reveal that immediately after training and a four weeks interval, participants had a 21% drop in scores although Austin and Gilbert, (1973) observed a 16% loss of basic problem solving skills after 8 weeks. A common construct regarding this is based on the feedback the trainees receive during acquisition (Ramaprasad, 1983; Gibbs and Simpson, 2004; Sadler, 2010). When such feedback contains information about the magnitude and direction of performance errors, it directs the trainees towards ways of correcting the error and improving their performance while the infrequent or the total absence of feedback is associated with skill and knowledge loss, (Hurlock and Montague, 1982; Driskell *et al.*, 1992).

Learning is characterised by an initial steep learning period that asymptotes to maximum proficiency, while forgetting is characterised by an initial steep drop in proficiency, which then levels off, dropping more slowly as time goes on (Stothard and Nicholson, 2001). According to Stothard and Nicholson, (2001), the major decay in skill occurs in the first few weeks/months after training, with smaller differences over time. Their findings which is comparable to the results of this paper claimed that instructors believed the drop in proficiency for a variety of skills was greater between time zero and two months, than between the sixth and eight month. Although, there are conflicting results from literature in the consideration of the rate of retention of cognitive skills, Arthur Jr., *et al.*, (1998) have found that these skills are less prone to decay validating this research results. However, this is in contrasts to report by Driskell, *et al.*, (1992) who found that they deteriorate quicker than motor skills. Wisher, *et al.*, (1999) stated that cognitive skills "*tend to be stable for long periods over time, however, people do exhibit forgetting*", thus substantiating the findings reported in this paper. One of the main factors, whether direct or an intervening variable, is the time interval between training and performance. It is therefore not a surprise that the longer the time between training and performance, the greater will be the skill loss. Other contributing factors to procedural skill decay of wind technicians could be associated to their peripatetic nature of work, practice, aptitude, equipment design and task difficulty. Sufficient learning leads to expertise (Stothard and Nicholson, 2001) and an expert organises their knowledge and skills qualitatively differently from a novice. Since safe working requires robust procedures, it is suggested that training and experience are the major contributing factors influencing procedural skill decay during rescue and evacuation.

Osborne *et al.*, (1979), cited in Hagman and Rose, (1983) found that with uncued steps at the beginning and end of a process, as well as those addressing safety and those judged to be "*difficult*", they are least likely to be recalled. The principle of encoding specificity states that cues for retrieval will be effective if and only if encoded at the time of learning (Tulving and Thomson, 1973). Applying this to skill retention, perceptual and cognitive cues are required to regain and perform learned

skills (Bryant and Angel, 2000), and in the absence of such cues during recall, performance will suffer. A reflection of this is in increased retention of procedural tasks; with better retention of tasks with intrinsic cues and specific ordering (Hagman and Rose, 1983). Memory or job aides also help in performing and retaining skills while time limits can constrain the recall of a skill (Arthur *et al.*, 1998). In addressing the proposal of procedural reinstatement, Bryant and Angel, (2000, pp. 29) stated that “*if training employed a job aid or checklist to aid learners in sequencing steps, that aid will be an important cue needed to reinstate the skill at a later time*”. Though this study validates the significance of cued recognition/recall methods, it also found that one of the major predictors of skill loss is task complexity which includes number of steps in a task, whether the steps must be performed in a set sequence and whether there is any built-in feedback that indicates the correct performance steps.

CONCLUSIONS

Using the proposed benchmark performance level of 75%, it is therefore expected that refresher participants should undertake rescue and evacuation practice drills within three to six months after acquisition. For fresher participants, it is recommended that they undertake an early refresher practice drill within 28 and 90 days after skill acquisition to restore their proficiency to a relatively acceptable level. Also, a 24-month retention timeframe is considered too long before technicians can embark on a full refresher training. It is therefore recommended that to keep proficiency within an acceptable limit, support systems (e.g. simulation practice drills or virtual reality training) should be available at regular intervals to the technicians after skill acquisition. However, if there are no support systems in place, the technicians have the tendency of forgetting how to use the device in the event of a ‘live emergency’ rescue and evacuation.

The most significant factors that influence the technicians’ procedural rate of retention are considered to be the length of time after skill acquisition, experience, training, feedback and practice. The retention rates for the refresher and fresher participants are different, with the refresher trainees outperforming the fresher trainees at most levels of assessment. The impact of skill retention is more significant in skill (motor) than knowledge (cognitive) tasks. The longer the time interval between training and performance, the greater will be the skill loss.

Though cued recognition/recall method positively influences the retention of skills based on the participants’ performance, it is advisable that such cues be embedded within the training because with intrinsic cues, there is increased retention of procedural tasks. Also, if simulation practice drill or virtual reality training is introduced, this will have the potential of increasing the technicians’ retention rates over longer timeframe. Finally, skill decay is an obvious problem and with the low probability of rescue and evacuation happening, it is recommended that the proficiency of the technicians be kept at its optimum.

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MOTIVATION OF UNDERGRADUATE CIVIL ENGINEERING STUDENTS FOR HIGHER LEVELS OF ACADEMIC SUCCESS

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It is surmised that more than half of the civil engineering students at the University of the West Indies, St. Augustine campus, fail to complete their degree in the three years prescribed for the completion of the program, suggesting there is need for an intervention strategy. Motivation though often overlooked as a measure of influencing academic success, is being revisited as the strategy to enable success, as it is the thrust behind the desire which drives an individual to achieve a goal. Before the strategy is determined a distinction between the source of motivation and the degree of its contribution must be understood. Determining the effect of intrinsic and extrinsic motivational factors and how they are linked to the academic success of engineering students can provide the basis for the choice of an intervention strategy. Intrinsic motivation was determined as the most important motivational construct towards learning. Principal component analysis determined that the main motivational factors, towards learning present in students currently pursuing an engineering undergraduate degree for all years of study were Personal, Perfectionist, Parental/Family, Job/Career and Social Acceptance. Determining what drives students to their peak performance would assist with the facilitation and design of teaching methods to capture students' interests, promoting learning and understanding as best as possible and consequently, optimizing academic performance.

Keywords: motivation, academic performance, civil engineering, undergraduate.

INTRODUCTION

In the 2012/2013 academic year at the University of the West Indies, out of fifty-seven Civil and Environmental Engineering level three students, there was a total of forty-two graduates, six with first-class honours and thirteen with upper-second class honours. However, only seventeen of these graduates completed their degrees within the three-year stipulated period. From existing statistics, on average only 30% of Civil and Environmental Engineering students complete their degree within the three-year period. This raises questions such as: Why isn't a greater number of students graduating with high honours within the requisite time; Is there a lack of motivation or drive in students to succeed, and Are the courses or grading systems too hard or strict? Whether this is the case or not universities need to make sure that the learning process is strengthened by taking professional and personal development in students into account in the design of instruction and coursework (Kudrinskia and Kubarev 2013).

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Academic success is influenced by a number of factors including ability, motivation and opportunity. In order to be accepted into an engineering programme at the UWI, a basic threshold level is set to filter the potential students (UWI 2013). Upon meeting this benchmark, acceptance is awarded. Therefore, it can be assumed that students at this threshold have the potential or ability and are at the required academic level with sufficient academic background to begin pursuing and completing an engineering undergraduate degree within the requisite time. While it is agreeable that academic success at university level is somewhat linked to ones' capability, this does not always differentiate high-achieving students from low-achieving students (Kitsantas 2002; Schunk and Zimmerman 2008). An alternative that can account for success is motivation which is defined as a physical, psychological or social need, which drives an individual to reach or achieve his goal, fulfil their need and finally feel satisfied owing to the achievement of their aim (Jafari and Mahadi 2012). It is this need to perform well, which translates into a desire to use knowledge and skills mastered in associated learning activities. Therefore, motivation is believed to be a facilitator of learning and academic success (Huang, Jian, Law, and Sandness 2009). Motivation must therefore play a more significant role in academic achievement.

In order to determine the motivational factors currently driving engineering students it is important to understand that since all humans are different, it is therefore expected that motivation (source, type and magnitude) is also different among individuals (Jafari and Mahadi 2012). This inconsistent and varying nature of motivation has resulted in detailed studies and the evolution of numerous motivational theories connecting and combining various types and sources of motivation. These theories include: Maslow's Hierarchy of Needs, McClelland's Need to Achieve, Expectancy Theory, Adam's Equity Theory, Achievement Goal Theory, Reinforcement Theory, the Cognitive Theory and many more.

Benson, Kirn, and Morkos (2013) placed emphasis on the Cognitive Evaluation Theory by concluding that student motivation is related to academic performance and behaviour, and is a major factor in student's progress towards critical thinking and problem solving. Law and Chuah (2009) concluded that, the cognitive ability is found to moderate the relationship between 'need for achievement' and 'performance'. The Cognitive Evaluation Theory has been previously studied regarding intrinsic and extrinsic motivation with unified conclusions that both contribute to learning. This research is therefore centred around the cognitive theory and is aimed at determining if intrinsic motivational factors were more prevalent in students with upper-second or first-class honours. The objective is therefore to determine if intrinsic motivation is the governing motivational factor contributing to their high level of academic success.

Examining students' academic performance is perhaps the most common way to gauge student success and to evaluate the effectiveness of instructional and programmatic reform and innovation. Engineering education, motivation and academic success, need to be linked in order to determine what motivates civil engineering students to perform well. This analysis was never completed for a specific branch of engineering and it will greatly help the engineering education authorities address the present challenges of low throughput. This could further attract, drive and retain students to or in the field of engineering, resulting in more educated specialists and professionals and henceforth produce a greater amount engineering professionals in the near future.

THEORITICAL FRAMEWORK

Maslow's theory called the 'Hierarchy of Needs' explains that there are at least five sets of goals or basic needs arranged in a hierarchy of prepotency, physiological, safety, love, esteem, and self-actualization (Maslow 1943; 1968). It postulates that when a need is fairly well satisfied, the next prepotent ('higher') need emerges in turn to dominate the conscious life and to serve as the centre of organization of behaviour. Therefore, it suggests that we are motivated by the desire to achieve or maintain the various conditions upon which basic satisfactions reside (Maslow 1943). Within a realistic sense students do not satisfy a need for a lower grade then work towards a higher mark. Good students strive towards the highest achievement level, as a result Maslow's (1943; 1968) Theory might not be applicable. McClelland (1966) claimed instead that motivation is driven by an innate need to achieve. This concept is supported by the Achievement Goal Theory which provides a framework to understand students' goals and motivation by highlighting various purposes or reasons and standards of evaluation that a student might have for pursuing particular academic tasks (Ciani *et al.* 2010). Benson, Kirn, and Morkos (2013) have also found that, achievement motivation, which encompasses students' attitudes about their abilities and tasks, can elucidate student choices related to persistence in engineering, solving problems, and the value of tasks encountered in an engineering environment.

The shortcomings of these previously mentioned surveys are that they seek to analyse all the existing and main motivational factors, and do not link these motivational factors to levels of academic performance (specific grade point averages 'GPA'). Frank Fox and Sonnert (2012) believe that GPA's are a key aspect of undergraduate education because, at this level, education is largely a classroom experience in which grades are the 'bottom line', and because grade point averages are widely accepted and consequential indicators of performance. Whether motivation is determined before, during or after the course of study it can be said that intrinsic motivation is a predominant motivational factor prevalent in students (Huang, Jian, Law, and Sandness 2009, Law and Chuah 2009, Haase *et al.* 2013). This study therefore aims to determine if there is a relationship between intrinsic motivational factors and high levels of academic success in engineering students. These arguments leads to the hypothesis that intrinsic motivational factors are more prevalent in civil engineering students with high academic performance levels and are the most important motivational factors contributing to their academic success. This will be tested by taking into consideration the stratification of the year group, as noted by Kudrinskia and Kubarev (2013) the main motivational factors present in a particular year of study were related to the cognitive character of the student at that particular stage/level of study. Within the engineering field this has not been investigated. Huang, Jian, Law, and Sandness (2009), have stated that there is a need to determine motivational factors because, learning will not happen without motivation and a supportive environment and if student motivation is lacking, the effectiveness of any intervention will be reduced. As suggested by Kudrinskia and Kubarev (2013), the findings from motivational studies can give insights into the development of teaching inventories and perfect the forms and methods of instruction, which can help make adjustments in the teaching and learning process. This would result in a greater understanding of exactly what impulses the students are guided by, what meanings their learning activity affords and finally promoting an increased number of true professionals who can help advance society.

METHOD

Questionnaire design

To determine the learning motivational factors of Engineering Undergraduate Students, a structured-written questionnaire formulated from studies carried out by Law and Chuah (2009)[Taiwan], Huang, Jian, Law, and Sandness (2009)[South Asia], Haase *et al.* (2013)[Denmark] and Ahearn *et al.* (2008)[Russia] was utilized, see Table 1.

Table 1: Motivational Factors Assessed Previously

Motivational Factor Assessed		Taiwan	2-South Asia	3-Denmark	4-Russia
Intrinsic	Individual Attitude	✓	✓	✓	✓
	Individual Aspirations/goals	✓	✓	✓	✓
	Clear direction	✓	✓		✓
Extrinsic	Punishment	✓	✓		
	Reward and recognition	✓	✓	✓	
	Social or group motivation	✓	✓	✓	
	Parental or Mentor motivation			✓	
	Group or social Pressure/Competition	✓	✓		

Pilot study and finalized questionnaire

Huang, Jian, Law, and Sandness (2009), and Law and Chuah (2009), suggested that for the validity and clarity of the final questionnaire, pilot studies should be employed. For this study, comments on the draft questionnaire by two (2) lecturers and three (3) current students within the Civil and Environmental Engineering Department were used to remove ambiguity from the final survey instrument.

The final questionnaire comprised of two sections. The first section, Demographic Information and Academic Level asked questions on level of study, gender, country of origin and GPA range. The second part, Motivational Attributes, enabled the identification of the positive and negative variables contributing to choice of study and current student learning motivation. There were twenty-two (22) variables (statements) assessing the various motivating factor groupings. Similar to a study carried out by Haase *et al.* (2013), a 1-5 Likert-scale scoring system was adopted starting from disagree very much to agree very much with a high score (5) representing a strong positive motivating effect on learning. The discerning point is set at 3, the middle of the scale.

Participants and data collection

A total population of 148 students, from the Faculty of Engineering at the University of the West Indies, St. Augustine campus were surveyed; 56 from Year 1, 46 from Year 2 and 46 from Year 3. The students were contacted during their class time to secure a high response rate and were invited to participate in the survey on a voluntary basis. Hair *et al.* (1998) suggested a minimum case to variable ratio of 5:1 to guarantee a reliable factor analysis. However, as noted by Costello and Osborne (2005), some researchers have worked with ratios as low as 2:1 and ratios below 5:1

have accounted for more than 40% of all studies. For this study after the removal of all unsuitable variables the ratio is positioned at 10.5:1.

Identification of positive and negative motivational variables

The mean response on the (1-5) point Likert scale was determined for each variable. It was hypothesized that the mean above 3, was a positively motivating variable towards learning. The variables with $\mu < 3$ were assumed to be demotivating factors and henceforth would not encourage students to perform well. Therefore, these variables were removed from further analyses.

Reliability of survey instrument

Similar to the study by Law and Chuah (2009), the internal reliability of the positive motivational factors was tested based on the average inter-item correlation using Cronbach alpha. The high value of alpha ($\alpha = 0.786$) attained suggests a high level of data consistency.

Validation of the motivational constructs/variables by factor analysis

Factor analysis was used to validate and group the motivating variables. The correlation matrix was examined to ensure all variables had a correlation of at least 0.3. To justify the measure of sample adequacy for the individual variables, the diagonal of the anti-imaging correlation matrix was reviewed to ensure all values were greater than 0.5, supporting their retention in the analysis. To determine sample adequacy for the group of variables, it was ensured that a Kaiser Meyer Olkin (KMO) value greater than 0.5 existed (KMO=0.803) (Das 2012). This indicates that the pattern of correlations is relatively compact and hence factor analysis should give distinct and reliable results (Field 2009). For the Barlett's test of sphericity, a significance value of 0.000 was obtained therefore indicating that the correlation matrix is not an identity matrix. These values are sufficient to justify the applicability of the Factor Analysis method to the sample (Tang and Shen 2013).

Wold, Esbensen, and Geladi (1987), explain that the principal component analysis is a least-squares method, and outliers can severely influence the model. Hence, it is essential to find and correct or eliminate outliers before the final principal component model is developed. Hoaglin and Iglewics (1987) modification of 2.2 was applied to determine the lower and upper bound and factor analysis was repeated excluding outliers. Subsequently, the removal of the outliers did not have an effect on the final solution and hence they were retained for further analysis. For brevity this further analysis is not presented here.

RESULTS

Demographics

All the respondent demographical data is shown in Table 2. The average age range (77.7%) of the Civil/Environmental engineering undergraduate students was 19–22. The amount of students with a GPA ≥ 3.00 is 27.6%, (approximately 1/4) of the entire respondent population. The majority of students are from Trinidad and Tobago 64.2%, whereas 33.8% are from other Caribbean countries and 2% are international students.

Current motivation

In order to determine what motivational factors encourage learning and academic success, it is imperative to determine what variables are currently motivating students; because it is either one or a combination of these positively motivating variables

which will inevitably encourage students to succeed. When the students were asked ‘What do you think is currently driving your desire to complete your degree?’

Table 2: Demographic details of respondents

Academic Level	#	%	Country	#	%	Age	#	%	GPA*	#	%
Year 1	56	37.8	Trinidad	95	64.2	<18	5	3.4	GPA > 3.0	40	27.6
Year 2	46	31.1	Other Caribbean Countries	51	33.8	19-20	64	43.2	GPA < 3.0	105	72.4
Year 3	46	31.1	International Students	3	2	21-22	51	34.5	Gender	#	%
Total Student Population	162		Total survey responses	148	91%	23-34	11	7.4	Male	95	64.2
						>24	17	11.5	Female	53	35.8

the highest rated responses were the two intrinsic variables; Clear Direction: ‘Studying, understanding and learning increases my knowledge and makes me feel accomplished’ and Individual attitude: ‘I don’t want to let myself down’ both with means of 4.32. Table 3 shows the means of all the variables in descending order with regard to positive motivational contribution. It is also important to note that all the negatively motivating factors ($\alpha < 3$) are all extrinsic.

In order for students to effectively apply their intellectual resources in their educational experiences, they must be motivated to do so. Educators should first understand factors in students’ development that contribute to motivation (e.g. expectations, values, goals, and attitudes) as well as their cognition and academic performance (Benson, Kim, and Morkos 2013). Therefore, a major aim of universities should be ensuring that students’ progress well through their degree, graduate and become professionals.

It is believed that some degree of intrinsic motivation is prevalent in all students due to the fact that it’s an individual’s own decision, will or acceptance to understand, learn or retain information, as knowledge cannot be forced upon an individual. This could be the reason why the intrinsic motivational variables were found to be most important to the engineering students. The subgroup of intrinsic motivation found to be highly motivating was the individual’s self-attitude and one’s clear direction or understanding of what one wants to accomplish. Subsequent to the intrinsic motivational variables, was an extrinsic variable categorized as reward or recognition which is understandable, as it is expected that most people want to get a good job to be able to support themselves financially. It is important to note that all the variables thought to be demotivating towards learning were all extrinsic. The variable with the lowest rating of motivation was parental motivation i.e. striving to be like one’s parents. This indicates that most of the students currently pursuing civil or environmental engineering do not have parents within this field of engineering. This could lead to the reason behind parental encouragement being the 4th most important positive variable towards motivation, as parents would want their children to explore a field or career into which they did not enter.

Factor analysis

Stevens (2009), states that the total variance in the solution should be greater than 60% of the phenomena being measured. SPSS principal component factor analysis

confirmed five (5) factors containing an Eigen value greater than 1, which accounted for 66.506% of variance.

Table 3: Motivational variables and their perceived importance

Positive Variable	Mean Response
Studying, understanding and learning increases my knowledge and makes me feel accomplished	4.32
I don't want to let myself down	4.32
Completing this degree will help me get a good, well-paying and respectable job	4.25
I am keen to learn about new aspects of my subject and to explore new ideas	4.24
My parents/guardians/family encourage me	4.23
I want to accomplish my own learning goals	4.21
I want to get good grades and graduate with high honours	4.20
Studying, learning and achieving something makes my parents/family proud	4.18
I want to make a difference or contribution to engineering in the world	4.17
I get satisfaction from meeting intellectual challenges and pushing my limits	4.10
I believe that what I am learning now will be beneficial to my future job	4.05
I want to prove something to myself	3.99
I don't want to disappoint my family	3.95
I want to do well to avoid mistakes (Losing scholarship, sponsorship, failing etc.)	3.78
I enjoy working with my study group/friends and they encourage me	3.55
I want to be the top student	3.30
I just want to get a degree at the end of the day	3.23
Negative Variable	Mean Response
The lecturers are informative, encouraging and good role models	2.95
All my friends are doing well so I need to do well also	2.91
If I don't do well I will be humiliated	2.91
I want to outperform my classmates and friends	2.79
I want to be like my mother or father	2.44

The communality values for each variable were greater than 0.5 and less than 1. Table 4 illustrates the final derived solution from the factor analysis.

Factor 1 ‘*Personal Motivation*’ comprised of four (4) variables, each contributing towards intrinsic motivation. This intrinsic factor included variables supporting an individual’s clear understanding of his personal aspirations, satisfaction, accomplishments and also personal feelings towards making a valuable contribution to engineering.

Factor 2 ‘*Perfectionist Motivation*’, comprised of three (3) variables under the extrinsic motivation category. These variables indicate an individual’s desire to be the best, on top or to be idolized. This type of motivation falls under the heading of reward or recognition motivation. This motivation encompasses variables including an individual’s desire to be the top student, and to get good grades or graduate with high honours.

Table 4: Factor Analysis- Final Solution (Rotated Component Matrix)

Variables	Factor				
	1	2	3	4	5
I get satisfaction from meeting intellectual challenges and pushing my limits	0.797				
Studying, understanding and learning increases my knowledge and makes me feel accomplished	0.787				
I am keen to learn about new aspects of my subject and to explore new ideas	0.691		0.348		
I want to make a difference or contribution to engineering in the world	0.659	0.426			
I want to be the top student		0.803			
I want to get good grades and graduate with high honours		0.746			
I want to do well to avoid mistakes (losing scholarship, sponsorship, failing etc.		0.705	0.306		
My parents/guardians/family encourage me			0.747		
Studying, learning and achieving something makes my parents/family proud			0.738		
I don't want to disappoint my family			0.611	0.486	
Completing this degree will help me to get a good, well-paying and respectable job				0.770	
I believe that what I am learning will now be beneficial to my future job	0.379			0.677	
I just want to get a degree at the end of the day					0.755
I enjoy working with my study group/ friends and they encourage me					0.718

Another extrinsic motivational sub-group called 'punishment motivation' includes the variable doing well to avoid mistakes. This punishment variable provides support to the perfectionist title, as it is obvious that a perfectionist would do everything he could to avoid making errors, which inevitably involves negative consequences.

Factor 3, also a group of extrinsic factors, is titled 'Parental or Family motivation'. Under this factor there is direct encouragement by parents/family, recognition or kudos from parents/family towards the student's achievements and also student motivation to avoid parental/family disappointment and inevitably motivation of the student is centred around and driven by the family.

Factor 4 contains two (2) variables grouped into Job/Career Motivation. This extrinsic factor includes the variable indicating 'motivation to succeed and learn to obtain a well-paying and/or respectable job', which is categorized by the subgroup of extrinsic motivation called reward and recognition. The other variable in Factor 4 displays motivation to a job/career by indicating the perceived importance of learning and understanding as it will be beneficial and applicable to a future job, which is classified as motivation due to a future reward.

Factor 5 called 'Social Acceptance Motivation' is also an extrinsic factor. The variable stating 'I just want to get a degree at the end of the day' does not specify the class of degree (as previous variables did) but indicates that any class of degree will suffice. This variable can be associated with the fact that in modern society, being educated at the tertiary level is becoming the norm in most Caribbean countries and

especially in Trinidad and Tobago due to the increase in government assistance which provides free tertiary education to citizens through the Government Assisted Tertiary Education (GATE.). These universal tertiary education programmes result in employers recruiting individuals with minimum tertiary level education.

Without this level of education the 'eligibility' to be part of society therefore significantly decreases. The other variable indicates the enjoyment of encouragement due to friends or a study group. This variable demonstrates the need to be accepted by a group of people in order to be motivated, and shows the importance of social acceptance toward motivation.

CONCLUSIONS

This study arose from the question "What motivational factor(s) encourages students to do well?" Cognitive Evaluation theory was adopted to determine the positive motivational factors towards learning. Most studies utilizing the cognitive evaluation theory have concluded that intrinsic factors were the main causes of learning motivation, which is in line with the conclusion of this study. Principal component analysis revealed five factors contributing to learning: personal, perfectionist, parental/family, job/career, and social acceptance.

The recommendation that arises from this study is that faculty should use multiple motivational methods in each class setting to enhance existing intrinsic and extrinsic motivation. Since motivation and encouragement from lecturers was seen as a negative motivational variable, faculty members wishing to motivate their classes should challenge the students, provide connections to real-world applications for those students motivated by the useable content of the course, and increase compassion toward students which could inevitably change their attitude towards lecturers. Additionally, professors teaching upper level or more demanding courses should use different context-specific methods to instil a positive sense of efficacy in their students to enhance personal motivation, since this was the strongest motivational factor towards learning. Lecturers can provide examples of past projects to their current students that allow them to observe their peers' successes and encourage them to see that they can succeed. Lecturers of introductory-level classes can provide first-year students with other successful peer role models to enhance their personal beliefs to excel in their courses and enhance their job/career and perfectionist motivation. As suggested by Castiglia (2005), the recommendations for faculty members are not much different than those given countless times to managers working in business settings: avoid a one-size-fits all motivational approach and recognize that students in the classroom, like employees in a corporate setting, are individuals who are motivated by various tactics. Effective teaching, like good management, hinges upon personalizing the motivation to fit the individual.

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BUILDING ECONOMICS PRE-COURSE STUDENT PERCEPTIONS

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Tertiary Students' pre-course perceptions of a subject provide insight relative to their understanding and appreciation of a subject and challenges that the lecturer may encounter. Furthermore, post-course perceptions can be compared with pre-course perceptions to determine the impact of the presentation of the subject, if any. The purpose of the study reported on is to determine the pre-course Building Economics perceptions of construction management and quantity surveying students, based upon a self-administered questionnaire survey conducted in a South African university. The students were surveyed at the inception of the presentation of the subjects. Findings include: material costs, labour rates, and profit margins predominate in terms of the importance of Building Economics knowledge areas to CMs, and cost control, measuring (quantities), and estimating relative to QS; accurate estimating, design and specification changes, material availability, labour productivity, material availability, and inflation predominate in terms of the extent various aspects contribute to project cost control, and the knowledge gained from the subject will assist students in other modules, and the subject teaches students skills which they can apply in everyday life. Based upon the findings it can be concluded that students have a degree of understanding and appreciation of the subject Building Economics prior to exposure thereto, and they understand and appreciate the importance and role of the subject Building Economics to their programmes and disciplines. It is recommended that such research be conducted on an annual basis, and a preparatory lecture module 'The role and importance of Building Economics' should be evolved for first time Building Economics students.

Keywords: Building Economics, perceptions, students, South Africa

INTRODUCTION

The Literature indicates that students commence courses with pre-conceived notions with respect to the courses, which are possibly influenced by normative views of members of the larger campus community (Heise, 1979, 2002 in Francis, 2011). Furthermore, results of prior research have shown student attitudes toward a course before the start of the semester affect student course evaluations (Barke, Tollefson and Tracy, 1983 in Francis, 2011). Research conducted by Barth (2008) in Francis (2011) relative to student evaluations, using factor analysis, determined that prior 'interest in the subject matter' was shown to have a significant impact on the overall course ratings.

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Given the aforementioned, and the Department of Construction Management's focus on 'lecturing and learning' research in addition to general assessment of courses, programmes, and related interventions such as portfolio and integrative projects and vacation work, a survey was conducted among construction management (CM) and quantity surveying (QS) students registered for the subject Building Economics to determine the perceived:

- importance of Building Economics knowledge areas to CMs and QSS;
- extent to which twelve aspects impact on project cost control, and
- relevance of the subject Building Economics in terms of the other modules in the CM and QS programmes, practice post-graduation, and everyday life.

REVIEW OF THE LITERATURE

Programme evaluation

According to Springer (2010), programme evaluation is the process of evaluating the merit and effectiveness of educational programmes. Although evaluations are research-based, the goal is not simply to understand programmes, but also to arrive at judgments about their impact and worth.

Two studies conducted by Gigliotti (1987) and Koermer and Petelle (1991) cited in Francis (2011) addressed the effect of student pre-course expectations on subsequent course evaluations. These significant associations with student evaluations included expected relevance and expected stimulation and communications as types of interaction in a course. Research also shows student ratings of courses vary significantly by field of study (Cashin, 1990 in Francis, 2011), suggesting the presence of normative attitudes toward various disciplines on a campus.

Francis (2011, citing Cashin, 1990) says that students rated the management field low for instructor and course effectiveness in contrast to higher ratings for courses in the 'hard sciences' such as physics. Biglan (1973, cited by Francis 2011) provide insight on distinguishing between academic fields with three dimensions to classify specific courses. For example, 'hard' versus 'soft' addresses the extent of competing theories within a field; 'pure' versus 'applied' considers the practical application of a field, and the third dimension is whether a field is concerned with living objects or not. The subject of the empirical study, Building Economics, could be described as 'hard', 'applied', and not concerned with 'living objects'. Related to this topic is a study which determined that student perceptions of course relevance at the second class meeting were lower for an organisational behaviour course as a 'social science' compared to perceptions of a computing course (Burke and Moore, cited by Francis 2011). The subject of the empirical study, Building Economics, could be construed to be similar to a computing course. These results suggest two antecedents impact student course evaluations, namely pre-course attitudes and discipline of the course.

Education Frameworks

The 'Economic Principles and Financial Management' theme of Section 2.2 'The Construction Environment' of 'The Education Framework for Undergraduate Degrees' of the Chartered Institute of Building (CIOB) (CIOB, 2012) records, inter alia, as requirements for Construction Management programmes at:

- Level 4: finance for construction activities; cash flow, and price and cost estimation for construction activities;
- Level 5: produce examples of price and cost estimation for construction activities; appraise the use of financial information as it relates to the management of construction projects: cash flow, cost and finance; value management / engineering, and decision making, and
- Level 6: implement procedures and practices associated with the settlement of final accounts, claims, and dispute resolution.

Importance of Building Economics

A study conducted by Crafford (2007) determined the top three out of thirty-three quantity surveying competencies in terms of percentage importance to be:

- cost control (94.6%);
- estimating (94.5%), and
- measurement (quantities) (94.4%).

Thereafter, valuation was ranked twelfth (82.0%), and advanced financial management twenty-second (76.5%). Furthermore, it is notable that four of the top five competencies in terms of deficiency as determined by a gap analysis conducted by comparing importance versus evidence, are estimating, economics of construction, cost control, and measurement.

Then, in terms of thirty-two construction management competencies:

- measurement (quantities) was ranked fifth (76.5%);
- cost control ninth (75.3%);
- estimating tenth (75.2%);
- valuation twenty-fourth (69.2%), and
- advanced financial management twenty-seventh (67.8%).

Although some of the aforementioned Building Economics competencies were ranked low, their percentage importance scores were high, which belies their importance. In terms of deficiency, advanced financial management was ranked sixth among the top six competencies.

A study conducted by Manthe (2008) investigated the appropriateness of, inter alia, CM and QS tertiary built environment education. The responses of built environment practitioners that were members of the Association of South African Quantity Surveyors (ASAQS) and registered with the South African Construction and Project Management Professions (SACPCMP) are included in Table 1 below. With the exception of the subject Construction Economics relative to CM according to members of the ASAQS, the majority of respondents responded in the affirmative to Price Analysis and Estimating, Quantities and Measurement, and Construction Economics.

Table 1: Importance of Building Economics related subject areas to CM and QS

Subject Area	Association	Response (%)	
		CM	QS
Price Analysis and Estimating	ASAQS	69.4	97.2
	SACPCMP	78.3	87.0
Quantities and Measurement	ASAQS	66.7	94.4
	SACPCMP	73.9	91.3
Construction Economics	ASAQS	58.3	97.2
	SACPCMP	91.3	87.0

A study conducted by Smallwood (2006) investigated, inter alia, the importance of seventy-eight knowledge areas and forty-five skills to three levels of management, namely, operational, middle, and top. In terms of Building Economics related knowledge areas the mean rankings and importance index (between 0 and 4) are as follows:

- cost control was ranked joint sixth (2.53, but 2.73 for middle);
- measuring (quantities) thirteenth (2.30, but 2.81 for operational);
- estimating twenty-first (2.03, but 2.38 for top);
- financial management twenty-eighth (1.81, but 2.70 for top);
- cost engineering thirty-seventh (1.60, but 1.81 for middle);
- cash flow forecasting joint forty-eighth (1.25, but 1.81 for top);
- final accounts joint forty-eighth (1.25, but 1.53 for top), and
- valuing sixty-ninth (0.86).

In terms of skills:

- costing was ranked eighteenth (2.51);
- measuring (quantities) nineteenth (2.38, but operational 2.92);
- financial twenty-fifth (2.21, but 3.10 for top), and
- estimating joint twenty-ninth (1.90, but 2.36 for top).

Generally, the subject Building Economics and related aspects are important to both CMs and Qs according to practitioners.

RESEARCH METHOD

Subject content

Although the module name is Building Economics 2, it is the first instance that Building Economics as a subject stream is introduced to the students, i.e. there is no Building Economics 1.

In the course Building Economics 2, students learn the theory and methodology of calculating unit rates and pricing for all building trades as well as pricing for preliminaries, preparing cash flow calculations, and contractor tender approaches.

Building Economics 3 exposes students to a variety of factors which can affect the 'economics' of a project, such as town planning schemes, building shape, and site location, as well as introducing them to various methods of measurement and

estimating, although the course is focused on elemental estimating and elemental cost analysis. The effects of inflation as well as the requirements for allowances for contingencies and taxation are also addressed.

It should be noted that Building Economics 2 is attended by 2nd year QS students and 3rd year CM students. Building Economics 3 is attended by 3rd year QS students and 4th year (honours level) CM students. There is a Building Economics 4 course which covers forecasting and analysis of construction costs as integrated into the property development process. This course was not included in the study as only 4th year QS students attend.

Sample stratum

The sample stratum consisted of construction management (CM) and quantity surveying (QS) students registered for the subject Building Economics. The students were surveyed during the first lecture of the first semester using a self-administered questionnaire consisting of six questions, five of which were five-point Likert scale type questions. 69 Students responded, 35.9% of which were CM and 64.1% were QS. 35.8% of the students have some form of construction work related experience, and 64.2% did not.

Research findings

Table 2 indicates the importance of twenty knowledge areas to construction managers and quantity surveyors in terms of means scores (MSs) between 1.00 and 5.00, based upon percentage responses to a five point scale of 1 (not) to 5 (very). The results have been presented per discipline according to each of the responding disciplines. Based upon CM responses, 15 (75%) of the CM MSs are $> 4.20 \leq 5.00$ (between more than important to very important / very important), whereas only 3 (15%) of the QS MSs are. The three common knowledge areas are: labour rates; material costs, and overheads. Furthermore, every CM MS is higher than the corresponding QS MS. Due to the lower QS MSs, only 5 (25%) of the mean MSs are $> 4.20 \leq 5.00$. The top five CM knowledge areas in terms of the mean are: material costs; labour rates; profit margins; overheads, and budgeting. The top five QS knowledge areas in terms of the mean are: cost control; measuring (quantities); estimating; cost analysis, and pricing. Notable differences in importance include the following knowledge areas, which in fact are very important in terms of the practice of construction management: cost control; measuring quantities; estimating; pricing; schedules of rates; cash flow forecasting; financial management; budgeting, and cost analysis.

Based upon QS responses, 17 (85%) of the CM student MSs are $> 4.20 \leq 5.00$, and 18 (90%) of the QS student MSs are. It is notable that 12 (60%) of the CM MSs are higher than the corresponding QS MSs, however marginally so, with the exception of town planning conditions, programming, and interest rates. Due to the generally high CM and QS MSs, 18 (90%) of the mean MSs are $> 4.20 \leq 5.00$.

Table 2: Importance of knowledge areas to Construction Managers (CMs) and Quantity Surveyors (Qs) according to CM and QS students

Knowledge area	CM responses				QS responses			
	MS		Mean	rank	MS		Mean	rank
	CM	QS			CM	QS		
Cost control	4.61	3.77	4.19	6	4.86	4.87	4.87	1
Measuring (Quantities)	4.09	3.58	3.83	18	4.82	4.83	4.82	2
Mathematics	3.83	3.73	3.78	19=	4.23	4.30	4.26	17
Inflation	4.05	3.72	3.88	17	4.41	4.35	4.38	16
Estimating	4.30	3.26	3.78	19=	4.77	4.83	4.80	3
Pricing	4.43	3.78	4.10	9	4.73	4.80	4.76	5
Schedules of rates	4.39	3.61	4.00	11	4.64	4.50	4.57	9
Cash flow forecasting	4.52	3.43	3.98	14=	4.50	4.44	4.47	14
Financial management	4.65	3.65	4.15	7	4.41	4.56	4.49	13
Town Planning conditions	4.33	3.82	4.07	10	3.59	3.11	3.35	20
Programming	4.26	4.03	4.14	8	3.73	3.46	3.59	19
Budgeting	4.57	4.00	4.28	5	4.50	4.53	4.51	11
Cost analysis	4.35	3.62	3.98	14=	4.77	4.77	4.77	4
Labour rates	4.57	4.40	4.48	2	4.18	4.25	4.22	18
Material costs	4.57	4.50	4.53	1	4.45	4.67	4.56	10
Overheads	4.48	4.30	4.39	4	4.55	4.38	4.46	15
Profit margins	4.77	4.18	4.47	3	4.64	4.59	4.61	8
Analysis of final accounts	4.09	3.89	3.99	12=	4.68	4.74	4.71	6=
Interest rates	4.13	3.66	3.89	16	4.64	4.36	4.50	12
Cost planning	4.36	3.63	3.99	12=	4.64	4.78	4.71	6=

Table 3 indicates the perceived extent to which twelve aspects impact on project cost control in terms of MSs between 1.00 and 5.00, based upon percentage responses to a five point scale of 1 (minor) to 5 (major). The results have been presented per discipline and then in terms of a mean of the aforementioned. 6 (50%) of the CM student MSs are $> 4.20 \leq 5.00$ (between a near major to major / major extent), whereas only 2 (16.7%) of the QS student MSs are. However, a further 3 (25%) of the CM student MSs are marginally below 4.20, and similarly 4 (33.3%) of the QS student MSs. It is notable that 11 (91.7%) of the CM MSs are higher than the corresponding QS MSs. Due to the generally lower QS student MSs, only 4 (33.3%) of the mean MSs are $> 4.20 \leq 5.00$. 1 (8.5%) MS is marginally below 4.20. The top five CM aspects are: accurate estimating; design and specification changes; labour productivity; material availability, and contingencies. The top five QS aspects are: design and specification changes; accurate estimating; labour productivity; inflation, and provisional sums. It is notable that 3 / 5 (60%) of the top five aspects are common to both the CMs and Qs. Although the results constitute pre-course perceptions, the aforementioned need to be noted and emphasis placed on the aspects that do in fact impact on project cost control to a greater extent than that as perceived by the respondents.

Table 3: Extent to which twelve aspects impact on project cost control.

Aspect	CM		QS		Mean	
	MS	Rank	MS	Rank	MS	Rank
Accurate estimating	4.64	1	4.31	2	4.42	1
Design and specification changes	4.50	2	4.38	1	4.39	2
Labour productivity	4.41	3	4.18	3	4.22	3
Material availability	4.36	4	4.15	6	4.22	4
Inflation	4.26	6	4.16	4	4.19	5
Provisional sums	4.05	10	4.16	5	4.11	6
Size of construction firm	4.18	7	4.03	7	4.02	7
Contingencies	4.26	5	3.94	8	4.02	8
Site conditions	4.18	8	3.88	9	3.96	9
Tender methods	4.05	11	3.84	10	3.90	10
Type of contract	3.95	12	3.63	11	3.80	11
Type of subcontractor	4.14	9	3.45	12	3.70	12

Table 4 indicates the degree of concurrence with three Building Economics (QBE) subject related statements. Whereas the CM MS relative to ‘QBE knowledge will assist me in other modules’ is $> 4.20 \leq 5.00$ (between agree to strongly agree / strongly agree), the QS MS was marginally below 4.20. This constitutes an appropriate response as it is the case. Both the CM and QS MSs relative to ‘I will never apply my QBE knowledge after completing my degree’ are $\geq 1.00 \leq 1.80$ (strongly disagree to disagree). The response relative to ‘QBE teaches me skills which I can apply in everyday life’ is notable as it constitutes recognition of the value and relevance of the subject in general. The respective MSs are both $> 3.40 \leq 4.20$ (neutral to agree / agree). The knowledge and skills acquired will, *inter alia*, assist in terms of managing most businesses, and also most aspects of individuals’ personal life.

Table 4: Degree of concurrence with Building Economics (QBE) subject related statements.

Knowledge Area	MS		
	CM	QS	Mean
QBE knowledge will assist me in other modules	4.43	4.11	4.23
I will never apply my QBE knowledge after completing my degree	1.50	1.21	1.32
QBE teaches me skills which I can apply in everyday life	4.00	3.68	3.80

CONCLUSIONS

Generally, the subject Building Economics and related aspects are important to both CMs and Qs according to practitioners. Furthermore, the education frameworks of the CIOB and RICS require that these be addressed.

The students have an understanding and appreciation of the importance of twenty Building Economics related knowledge areas to CMs and Qs. However, the QS students’ understanding and appreciation thereof relative to CMs is lacking. Similarly, the students have an understanding and appreciation of the extent to which twelve aspects impact on project cost control.

The students have a positive disposition towards the subject Building Economics in terms of use of the related knowledge relative to other modules in the respective programmes, and the practice of the respective disciplines post-graduation. This is likely to engender commitment to the subject, and consequently complement performance relative to the subject.

RECOMMENDATIONS

It is recommended that pre-course perception based research be conducted on an annual basis, and a preparatory lecture module 'The role and importance of Building Economics' should be evolved for first time Building Economics students. The latter should address the relevance of the subject Building Economics and related aspects to both CMs and Qs during their studies and practice after graduating. The linkages with other subjects should also be highlighted to raise the level of awareness of the complementary role of subjects in the respective programmes and also the 'integration' of knowledge even though 'integrative' projects may be included in the respective programmes.

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INFORMATION MANAGEMENT

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CONCEPTUALISING ACTORS' INFORMATION BEHAVIOUR: AN INVESTIGATION INTO PROJECT INFORMATION DYNAMICS

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Research into information technology in construction has received considerable attention in recent years. However, information behaviour (IB) of actors' in the project environment can be undefined, unstructured and suboptimal. The way information is obtained and shared to support project design development, organisational management and site operational activities continue to change rapidly. Major problems that continue to affect actors' performance are their exposure to different information sources and channels, unstructured Information Seeking Behaviour (ISB), and the large amount of time they spend sifting through these sources and channels to obtain context specific information just-in-time for use. Hence, this research uses comprehensive review of IB literature and interviews to investigate the information seeking activities of industry professionals in the project environment. It was found that project actors exhibited five distinct ISBs during the project delivery process which are presented and discussed with a conceptual framework to establish an agenda for future study into effective IB culture. The significance of this research is to investigate the current practices of actors' ISBs in order to define strategies to help improve performance in information seeking, project design and delivery process.

Keywords: actors, information seeking behaviour, performance, project life cycle.

INTRODUCTION

The nature and composition of construction projects is such that reliable and up-to date information underpins the processes involved in successful project delivery. Project actors (especially architects/designers) require reliable and context specific information in real time to execute projects or provide solutions to problems, and /or manage critical construction issues. To achieve such reliability, project actors require a relative ease of access to information in order to make the vital decisions involved in the construction and design process. Through the project life cycle (PLC), the level of information required by actors varies with respect to the significance of work to be done at the different phases. The most information demanding phase which influences the outcome of a project is design. The RIBA defines the design phase to comprise of concept design, design development, technical design, and specialist design. These phases culminate into the pre-construction/construction stage to define the outcome of the project and the subsequent aftercare of the infrastructure/facility. However, it is noted that the manner in which information is obtained through the exposure of actors to different fragmented sources and channels is linked to the problem of information

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overload (IO) (Allen and Wilson 2003, Bawden and Robinson 2008). Other researchers argue that actors' exposure to multiple information sources and channels can be beneficial to their information acquisition. This is because different information sources and channels actually help to reduce gaps in the acquired information from any one source (Kwasitsu 2003, Aurisicchio *et al.* 2012, Robinson 2010). Dzokoto *et al.* (2013) posits that the problem of IO can be controlled by firms adopting a SMART push information capturing system to free-up actors' from active information seeking to focus their time and attention on the project delivery process.

According to Patrashkova-Volzdoska *et al.* (2003), too much information can be as detrimental as too little information; hence a moderate level of information and communication leads to effective performance in engineering teams. Yunjie *et al.* (2006) affirms that the lack of effective ISB of employees in modern organisations is found to affect performance, ability to cope with uncertainty, knowledge acquisition, and maintenance of comfortable social relationships. However, the process of actively or passively seeking information from such sources is evidently found to take longer, and is cognitively demanding (Robinson 2010). Researchers have established that time savings, information relevance, technical quality, and ease of access are the main reasons behind actors' information sources and channels selection (Fidel and Green 2004, Pinelli 1991). However, research in this area has failed to establish the phenomena behind actors' information source preferences. Hence this paper presents findings from critical review of IB literature and exploratory study of ISBs exhibited by construction professionals during their information seeking activities in the PLC.

REVIEW OF RELATED RESEARCH THE DYNAMICS OF INFORMATION BEHAVIOUR RESEARCH

Wilson (2000) defines IB as the “*totality of human behaviour in relation to sources and channels of information, including both active and passive information seeking and information use*”. Thus, the processes employed by professionals and nonprofessionals to seek, search, store, use, share and retrieve information for use.

Researchers in the library and information sciences and knowledge management areas have traditionally used models to exhibit human IBs as a linear process in a broader spectrum. However, IB studies in recent years have narrowed to specific functions, and the relationships that exist within demographic factors. Most IB studies have ignored profiling specific IB types of individuals in context to behaviour of individuals in areas such as information sharing (Hyldegård 2009), collaborative information seeking (Talja 2002, Hertzum and Pejtersen 2000), information search process (Kuhlthau 2005), serendipitous information seeking (Foster and Ford 2003, Erdelez 2005), information foraging (Pirulli and Card 1995, Pirulli 2009), and other kinds. A fundamental contribution to understanding information discovery in context is the theory of sense-making (Savolainen 1993), and sense-making methodology by Dervin (1999). It is through these studies that the distinct ISBs of professionals in the project environment were discovered and classified to form the bases for this research.

Information seeking behaviour of actors in project design development process

Information used by designers to make decisions during the design development phase in the PLC may have significant impacts on downstream activities such as delivery delays, constructability and cost. This may be due to actors' exposure to numerous information sources and channels and the complexities in capturing relevant information in a fragmented organisation. Using the information may not be a problem, but identifying what information to retrieve, where and how to seek that

information are the major issues that need to be addressed. As the construction sector continues to change rapidly in terms of technology, lean thinking and others, it is practical for design development operations to respond to these changes in order to meet clients' needs. As a result, actors tend to use any means to meet their information requirements. Whereas some actors prefer face-to-face or systematic information seeking processes, others tend to social media or accidental/incidental information seeking process. In other situations, actors rely on their cognitive ability to meet their information needs. All these ISBs may occur at different phases of problem solving or project delivery. During the PLC, the quality and quantity of information required, and the ISB of actors varies. For example, at the idea conception phase, actors primarily rely on their intuition, knowledge and experience to generate information. Some actors consult other sources or experts for verification, but the majority of their information at this stage can be said to be cognitive dependant. As the project progresses, actors tend to adopt other information seeking preferences to capture information. According to Hertzum and Pejtersen (2000), engineers rely on their colleagues and internal documents to meet their information needs. However, the majority of information from colleagues is unstructured, and often based on tacit knowledge and experience (Robinson 2010). Evidence shows that actors in information rich environments spend the majority of their time looking for context specific information from repositories containing unstructured information, and this pattern reflects in the negative impact on their ISBs (Hertzum 2002, Robinson 2010).

These negative impacts are further exacerbated by the lack of specific processes to seek, share, and use information which can contribute to the many problems associated with project delivery, including delays, process duplication, and cost overruns. Evidence shows that a lack of effective communication and coordination between actors in the PLC are among the most important reasons behind these problems (Sebastian 2011). Often, communication between actors becomes critical, as each actor possesses different set of information. Hence it is important to establish the relationship between actors' ISB and performance, and the information systems employed for decisions and judgments making process. This will help unlock the problem of suboptimal ISBs, and pave the way for effective information seeking and sharing processes through technological solutions deployed in the sector.

RESEARCH METHODOLOGY

Throughout this study, IB literature was reviewed to identify significant patterns of ISBs exhibited by professionals in the project environment. Inductive approach was chosen with the aim to investigate and understand the information seeking activities undertaken by construction project actors in order to access and establish their ISBs in the PLC. According to Creswell (2009), qualitative research combines perspectives and expert experiences. Hence a semi-structured (face-to-face and telephone) interview was adopted because it was impractical to observe participants directly. Experts from prominent construction companies in the UK were purposefully selected on the basis of their roles and experience levels for the exploratory study. Six interviews were initially conducted, where data was audio-recorded and transcribed verbatim. Analysis of data from the six interviews showed comparable but significant differences in responses. Hence two additional interviews were conducted. At this point, there were no significant variations in responses, indicating a point of data saturation. In all, eight interviews were conducted to a desired data saturation point.

Each interview lasted an average of one hour (the point where all questions in the research instrument were answered). Hence the limited number of participants interviewed was sufficient to establish significant parallels and differences in actors' ISBs in the project environment. During the interviews, the participants were asked about their ISBs and how it impacts on their performance in the project delivery process. The collected data was analysed thematically from which five significant types of project actors ISBs emerged to establish the foundation for this research.

RESULTS CLASSIFICATION OF ACTORS' INFORMATION SEEKING BEHAVIOUR

The findings from thematic analysis of data collected from the semi-structured interviews showed significant variations and lots of parallels in actors' ISBs in the PLC. Interviewees indicated that where tasks/projects had been executed before, they normally sought information from repositories, databases or common data environments and other social media sources. However, for new tasks/projects where similar tasks had not been executed before, they relied on primary information (visit sites, create new materials, and others) to meet their information needs. In general, interviewees indicated that their first point of call when seeking information was to consider their knowledge, experiences and skills to map-out information seeking strategies in order to identify the "where", "who" and "how" before initiating the search process. They also indicated that they follow stages of appraisal to ensure that correct procedures are followed to identify information channels to help capture the appropriate information. The consensus was that interviewees use both formal and informal information seeking sources and channels (including accidental/incidental, face-to-face, social media, structured or unstructured) to obtain appropriate information. In all cases, interviewees indicated that the main problems associated with their ISBs were time delays, IO, and exposure to numerous information sources and channels. In general, responses from interviewees reinforce literature review findings.

Hence the thematic analysis and comparisons of literature review and semi-structured interview data resulted in the classification of actors' ISBs into five main types. Figure 1 presents the five key types of ISBs exhibited by project actors during their information seeking process in the project environment.

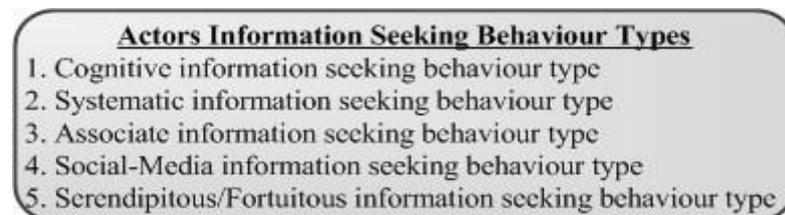


Figure 1: Types of project actors' information seeking behaviour

The five types of actors' information seeking behaviour

Cognitive information seeking behaviour

This is defined as the active thinking or mental process of seeking information to develop knowledge and understanding through a person's senses, intuition, knowledge, skills, and experiences for specific needs/tasks. According to some interviewees, cognitive information seekers exhibit tendencies of relying on their experiences, skills, knowledge, pride and mental strength to generate new knowledge and new information. Some of the channels through which they seek information

include intuition, personal folders/ libraries, search engines, database catalogues, print/electronic materials, and others.

Other dimensions of cognitive information processing styles identified in literature have focused on people's learning approaches and decision making process (Ford *et al.* 2002, Ford 2004). According to Pask (1988), people use two basic approaches in their learning process. The "*holist*" tends to adopt a comprehensive approach to learning, by investigating interrelationships between different themes at the beginning of the learning process to develop a general concept and then narrow the concept down into specific detail. The "*serialist*" uses their local learning approach to adopt a step-by-step investigation process to examine one thing at a time whilst concentrating on separate topics and the sequences linking them. Wilson (1983) posits that people generate knowledge in two different ways during the cognitive authority process; based on their "*first-hand experience*", and on "*what they have learned*" from others (second-hand experience). People's first hand-experience is interpreted to be knowledge conceived intuitively to include their interpretation and understanding of what is around them; whilst second-hand experiences relate to knowledge gained through studies, experience, and others. Interviewees agreed that their "*first-hand experience*" to information creation is through intuition/memory. Hence cognitive ISB is a person centred process that relies on mental activities to seek information for use.

Systematic information seeking behaviour

This is a process where actors' follow a structured and/or a step-by-step approach to acquire information by employing keyword and/or bibliographic search methods through library catalogues, databases, search engines, archives, personal folders, and others. The general consensus from interviewees was that this approach to information seeking is influenced by the kind of information required at a certain stage of a task/project. Thus, they choose to design systematic and thematic search plans, information pull/push systems or alert prompts to stay abreast with new information.

Witkin *et al.* (1977) in their investigations coined the terms "*field dependence*" and "*field independence*" styles. The field independence style can be related to the "*serialist*" approach which follows a structured approach to learning; whereas the field dependence style relies on direction and guidance from others in order to achieve the learning process. This is an affirmation of response from interviewees.

Ellis (1989) indicated that the IB of scientists/researchers follows a structured approach where the information seeker identifies relevant document(s) either through a keyword search or a paper already known or recommended within the context of the study; this he termed "*starting*". The seeker then goes through the "*chaining*" process by identifying references through the citation index. Thirdly, the seeker narrows the search down by "*browsing*" relevant sources, and further works through the most relevant documents to "*extract*" context specific information. These four stages were enhanced to include "*differentiation*", where the source material is filtered out to capture the most relevant information, and "*monitoring*" by creating information alert or pull system to help maintain awareness of new developments in the area of study. Thus systematic information seekers tend to apply the six stages of Ellis's 1989 model.

Associate information seeking behaviour

This term is coined on the basis that project actors in certain organisation settings predominantly prefer to seek information from colleagues or friends both internal and/or external to their environment. Interviewees indicated that factors such as trust, quality, accessibility, and others are vital to the information sources and channels

used; hence their preference to interact with friends, and experienced or specialist colleagues rather than information systems. Interviewees indicated that they tend to be selective with their contacts and the kind of interactions they have. The notion of these interactions according to interviewees is to seek specific information based on some demographic characteristics including qualifications, skills and experience levels of their contacts. Often, these characteristics are influenced by the circumstance in which the association was formed. Hence organisational confidentiality and information sharing restrictions tends to enforce internal knowledge retention in contrast to external sharing and acquisition. According to Mackenzie (2005), people in positions of authority tend to employ a range of information seeking/sharing activities regardless of their speciality or responsibility. Thus organisational settings/structures encourage associate ISB.

It is widely acknowledged that engineers prefer face-to-face information seeking or sharing with colleagues inside the same organisations than others outside (Hertzum 2002, Robinson 2010). This can be linked to the nature and composition of organisational structures, team compositions, and project delivery process. Pinelli (1991) showed that engineers perceive accessibility to be the most important determinant of their information source selection. Chakrabarti *et al.* (1983) on the other hand, concludes that managers, scientists and engineers prefer availability and ease of use as the main driving factors behind their information sources.

Social media information seeking behaviour

This is the process of project actors' interacting, discussing, seeking and sharing information on the internet through social network sites including social media communities, such as YouTube, LinkedIn, blogs, and other social media platforms. Social media ISB is characterised by close relationships of actors from different organisations or industry sectors with a common goal to discuss ideas, seek and share information on similar subjects (Meho and Tibbo 2003). The ubiquitous nature of the internet is such that information seeking and sharing occur rapidly and with ease, to the extent that its influence on individuals and organisations cannot be ignored.

According to Önder and Gümüşkaya (2011), the object of social media is to formulate online communities and provide a platform for interaction and user-created content shared among the members of these communities. Thomsen (1995) posits that actors can increase their knowledge and experience by using the web to gain information. Interviewees agreed that, three decades ago, organisations prevented their employees from accessing social network sites or transferring information via such media for various reasons. However, there has since been a transformational change at the workplace requiring a paradigm shift in organisational strategies and practices to promote information seeking and sharing and other forms of interactions via social media. Thus social networks have turned into a beneficial investment which can be used in organisations for speedy, easy transfer and access to real time information. However; interviewees were quick to assert that IO and information quality are major challenges to deal with in this type of information seeking process.

Serendipitous/Fortuitous information seeking behaviour

There was a clear indication from interviewees that they tend to seek information for different reasons. They may actively and/or passively seek information for reasons such as for pleasure or stimulations, other times; information is encountered without being sought. This form of information encountering is considered as serendipitous and/or fortuitous information seeking depending on the circumstance in which the

information was encountered. Many researchers consider information seeking to be a planned/intentional activity where the seeker consciously and actively look for information (Wilson 2000). However, there are clear indications that information can be encountered by chance. According to Case (2012), unintentional information encountering often triggers pre-existing or new interest to develop by opening new avenues for further exploration. This exploration is often referred to as “*browsing*” and/or “*scanning*” (Bates 2007). Case (2006) considers serendipity to be “*the action of or aptitude for encountering relevant information by accident*”. Erdelez (2005) identified six functional components of information encountering to include noticing, stopping, examining, storing, using, and returning. However, the connotations associated with the definition of serendipity raises questions about the affective state of the information seeker. Hence, fortuitous is used in this study in conjunction with serendipity. Fortuitous information seeking in this context is the act of discovering or encountering information by chance, either planned or unplanned, without any connotation. Hence interviewees indicated that they can either be happy or sad and still benefit or not benefit from this type of information seeking process.

Organisational behaviour is such that information encountered by chance cannot be avoided. In some situations, actors deliberately create opportunities to facilitate serendipitous/fortuitous information. Some interviewees indicated that they sometimes attend events mainly for browsing or environmental scanning opportunities. In such events, they purposely place themselves in situations (for example, coffee/tea breaks, network sessions, conferences, and others) to wait for the right opportunity in order to capture the needed information. According to Bawden (1986), browsing occurs in three different kinds: “*purposive*” as a deliberate seeking of new information in context; “*capricious*” as a random examination or exploration of information materials without any definite goal; and “*exploratory*” or “*semi-purposive*” as the result of some form of inspiration. These browsing activities range from reading or scanning of print/electronic materials through networking with friends/colleagues to laboratory experiments. In all these activities, new information is discovered.

CONCEPT DEVELOPMENT AND FUTURE WORK

As indicated in the above sections, it is obvious that project actors demonstrate distinct ISBs during their information seeking activities in the project environment however, these ISBs are undefined. It was also discovered that actors tend to demonstrate different behaviour patterns by adopting spontaneous strategies to seek and share information without any direction/structure. Other issues discovered include the challenges in the variations in the level and quality of information capture at the different phases of the PLC. Whereas actors may have distinct ISB type or preference, it may also be possible for actors to demonstrate other ISBs through the PLC stages to help maintain a certain level of consistency in order to capture the appropriate information for use. However, the significance of actors' ISB can only be realised if its relationship with performance is established. The output of actors' effective IB in information intensive processes such as construction activities can be considered to be directly dependent on their ability to seek appropriate information. However, this can only be achieved if actors are able to identify their ISB type(s) and information requirements. This can facilitate easy capture of appropriate information through appropriate channels and sources at the right quality and quantity just-in-time for use. Hence the questions posed are; (1) to what extent do construction project actors exhibit any of the five ISB types? (2) To what extent do any of the identified ISB types influence actors' performance in the project delivery process? Therefore this

research conceptualises actors' ISB types to establish its relationship to performance in the project design process. Figure 2 shows a conceptual framework of actors' ISB types. The object is to investigate and measure project actors (particularly, designers/architects) ISB activities during the design development process through to construction as indicated with the red arrow in figure 2. The bidirectional arrow signifies the input/output influencing factors such as quality, quantity, accessibility, time, and others that may have impact on performance level.

This forms the bases of a wider PhD study where the next stage of the research will employ quantitative methodology to undertake a detail investigation of the five ISB types of project actors identified in this paper, and test the framework with actors involved in the project design development process in construction organisations. This will help measure the relationship between designers ISB types and how this relate to their performance in problem solving or task delivery with the view to define and recommend strategies to improve construction project actors' information seeking and information sharing behaviours in the PLC.

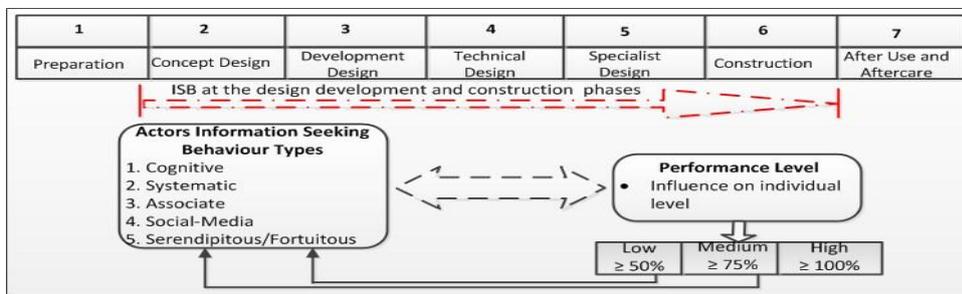


Figure 2: Conceptual framework of actors' information seeking behaviour

CONCLUSION

The ambiguous and fragmented nature of the construction process is such that the problem of IO, high amounts of time spent seeking information, and actors' exposure to different information sources and channels cannot be avoided. This is reflected in the spontaneous and dynamic nature of actors' ISBs. However, literature discoveries and exploratory studies demonstrate the need to further investigate the ISB types identified in order to examine their links to performance in the PLC. Innovative approaches to understand actors' ISBs are needed to meet the radical changes that are transforming the construction industry.

The investigations show that there is considerable need to improve the ISBs of actors' involved in the project design development process in order to reduce the amount of time spent seeking information. There is also mounting pressure on actors' to reduce process duplications, over dependence on other sources and channels, and the need to follow effective processes to meet their information needs. This research used literature review and interviews to classify actors' ISB types to set the scene for future field study. A major area to focus is to understand the dynamics of actors' ISB types and their links to performance, in order to develop strategies and systems to help improve project actors' ISBs to meet the demands of information intensive processes.

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USING ACTOR-NETWORK THEORY TO UNDERSTAND KNOWLEDGE SHARING IN AN ARCHITECTURE FIRM

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This study investigates knowledge sharing in a large Scandinavian architectural firm, ArchFirm. In particular, a knowledge management initiative called the Knowledge Building (KB) is examined. The study is based on a case study consisting of a document review and 12 interviews. Drawing on Actor-Network Theory (ANT) as an analytical lens, KB is conceptualized as a heterogeneous network consisting of several actants, human and non-human. Key aspects of ANT used when analyzing data is; translation, semiotic rationality, punctualization and black-boxing, focal actants and obligatory passage point (OPP). ANT as a theoretical approach created an opportunity to view the intricate nature of knowledge sharing in an architecture firm from a different perspective compared to previous research. This work also opens a window for further research in the area of knowledge sharing as it relates to architectural practice.

Keywords: actor network theory (ANT), knowledge sharing, professional networks, architecture firm, case study.

INTRODUCTION

In their search for competitive advantages the construction industry has adopted a 'rationalization movement' manner from the manufacturing industry meaning that they over the last decade, and in a rather unison way, have searched for and implemented more standardized routines and practices. This has included adaptation, adoption and implementation of various KM tools and methods. Together with the massive entrance of ICT this has led to a concentration of key knowledge and expertise into specific knowledge networks and artifacts, such as ICT models and virtual knowledge networks (Bosch-Sijtsema, 2013; Jaradat *et al*, 2013). This change has led to a reallocation of knowledge, as well as power, from the project settings to centrally organized functions, specialist consultancies and knowledge networks.

Thus, the change towards a knowledge economy has affected traditional logics within the built environment sector; a sector that consists of a wide range of professional actors interconnected in a fragmented and project based production process (Dainty *et al*. 2001). One of the actors that take part in the construction process is the architect, a profession subject to continuous change during the course of its age-old history (Blau 1984; Styhre 2009). In Sweden the architect profession has regressed from having a role of master builder in the 18th century to having a much more limited role in the

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current era (Gustafsson 2007) as contractors have successively overtaken the role of master builder in Sweden. It has been suggested that the establishment of a strong knowledge base is crucial for architecture firms' survival and to the very idea of the architect profession (Holm 2007). Thus, it is necessary that architecture firms have a strong basis rooted in knowledge and expertise of their domain. It is in this context we find the contemporary Swedish architect; in a dynamic environment where the use of specialist professions is of increased importance in practice, where the creation and diffusion of knowledge is essential to sustaining a competitive advantage, but also where contractors have overtaken more of the traditional architecture tasks.

A great deal of research has been conducted on the topic of architects' professional role and practice. Styhre (2009) has for example studied architects' work. He suggests that architecture work is a complex social practice conducted in the intersection between the symbolic and the material. He concludes that architectural work is based on the ability to talk, both within and outside the work, it is also built on peer recognition and credibility on the basis of individual and collective performance. In a related vein of research, Ewenstein and Whyte (2009), in their study of knowledge work in architectural design, highlight the epistemic role of technology objects and show how these roles are in constant flux, changing throughout the project. Blau (1984) explored the inherent contradictions in architecture practice and poked a hole in the romanticised myth of the strong and independent architect while arguing that the participatory office with shared responsibilities creates the best designs. Gluch (2011) has also examined inherent paradoxes and tensions but in her case in relation to the creation of specific 'knowledge'-leaders in an architecture firm. She concluded that standardization of knowledge into expertise areas lead by knowledge leaders conflicts with the social perception of the architect profession itself and that the need to standardize knowledge is a construct driven by self-interest of the knowledge leaders.

Architects are a professional group with a strong focus on creative and aesthetic tasks, combined with strong professional norms, values and identities (Styhre and Gluch 2009). However, although architectural firms are fuelled by creativity, they are also constrained in the boundaries created by their clients. The friction that emerges inbetween is termed the Daedalean risk by Blau (1984: 17); a contradiction which is embodied by the notion that architecture firms strive towards novel solutions in the fulfilment of the profession's ethos whilst pursuing pragmatic solutions more in line with their clients requirements.

At its core, ANT is an application of semiotics, presenting an idea that entities take their form and acquire attributes by their interaction with other entities (Law and Hassard 2005). The theory questions commonly held assumptions about causality and agency. In particular, it stresses the notion of non-human agency in which processes, technological tools and other similar concepts can be viewed as actants (non-human actors) that acquire an identity of their own. Essentially, this implies that the network is not composed of humans alone but also embodies machines, tools, architecture and so forth. As such, ANT emphasizes the role of artifacts in social structures, such as Knowledge Management, and goes as far as claiming that they not only mediate meaningful communication but also help in shaping it. The social interactions that occur in the production and dissemination of knowledge can therefore be seen as a patterned network consisting of heterogeneous material, i.e. various types of actors/actants (human and nonhuman).

By applying the theoretical lens of Actor-Network Theory (ANT) this paper investigates knowledge sharing in a large Scandinavian architectural firm, *ArchFirm*. In particular, a knowledge management initiative, called the *Knowledge Building* (KB), is examined.

ACTOR-NETWORK THEORY

Actor-Network Theory (ANT) as a concept emerged in the 1980's as a way to explain the differences in how something is and how it is perceived (Law 2009). Initially, the focus was on explaining the origins and the inner workings of scientific and technological breakthroughs. Subsequently, ANT has developed into a much wider framework (Law 2009) which has been applied in different contexts. However, few studies have applied ANT into an architectural context. Although not focusing on knowledge sharing, Kjetil (2011) and Stickels (2011) are two exceptions. ANT, contrary to its name, is not a theory (Law 2009) but rather an approach or a method of analysis, a way to view the world, which does so in a descriptive way (Latour 1996).

The heart of ANT is the concept of a heterogeneous network, which illustrates that society, organization, agents and machines are effects generated in patterned networks of both human and nonhuman actors (Law 1992). The word network is not to be confused with the technical use of the word in engineering contexts, such as a train or telephone network. In fact, the actor-network can lack all the characteristics of a technical network. Further, ANT have very little to do with the study of social networks (Latour 1996). As Law (2009) argues, it is possible to describe ANT in a somewhat abstract way however in its essence ANT is grounded in empirical case studies.

KEY ASPECTS OF ANT

A central concept in ANT is that of *translations* which is defined as the processes that generates ordering effects, i.e. forms the actor-network, such as devices, agents, institutions or organizations (Law 1992). Seen as a continuous process, it describes the movement of different forms of knowledge, cultural practices, technology and artefacts (Czarniawska and Hernes 2005). In ANT, a translation process is never completed and is bound to fail. Translation involves transformation (Law, 2009), for example, translating two words means making two words equivalent. An interesting example on translation comes from the work of Gherardi and Nicolini (2000). Drawing on a case study of safety knowledge in construction they used ANT to describe how safety knowledge was circulated on a construction site through a process of translation in an actor-network consisting of individual, communities, organizations and institutions. The use of ANT helped them show how nonhuman actors also influence the circulation of knowledge creation and the circulation of safety knowledge. Instead of perceiving the network as a solitary 'thing', it is in ANT rather viewed as a composition of different elements that shape one another. Closely related to translations this principle is termed *semiotic relationality*, which refers to the notion that different elements (e.g. signs and symbols) in an actor-network help define and shape each other (Law 1992). For example, Bruno Latour uses ANT to theorize the discovery of the vaccine for anthrax by Louis Pasteur. Applying ANT he argues that the vaccine, unlike what most people seem to think, was not the result of one great man's intellect (Law 2009). When Latour applies ANT on the event a new picture starts to emerge; because in the world of ANT, characterized by semiotic relationality, all actions are relational effects including actions by researchers. The actor-network in this case consisted of domesticated farms, technicians, laboratories, veterinarians,

statistics and bacilli. Subsequently the vaccine for anthrax was the generative result of the actor-network and not the result of one great man's intellect, from an ANT perspective.

As mentioned before the term actant is used in ANT to emphasise that an actor in the network can be both human and non-human. The actant that initiates the process of structuring the actor-network can be termed *focal actant* (Onsrud, 2007). The focal actant, in a sense, defines both the identities and the interests of other actants in the network. This idea is also tightly connected with translation, since the focal actant also initiates the process of translation. Callon (1986) offers an example of this. Based on an empirical study of the domestication of scallops, Callon explains that all actants are involved in a process of translation. He uses the example to illustrate how the process of translation is a mechanism of how the social and natural world progressively takes form. The researchers in that study were viewed as the focal actant by initiating the entire process and thereby defining the identities of the remaining actants.

An *Obligatory Passage Point* (OPP) is a concept that is used to denote a single node in an actor-network through which all the actants have to pass at some point (Callon 1986). As an illustrative example, Law (2009) uses an ANT perspective to analyze Portugal's success in reaching India and controlling half of the world by combining conventional accounts of military power, trade, spices etc. and the technological infrastructure making it possible to create ships and navigation. All these components are translated into a web giving each component a particular shape, which held together for 150 years with Lisbon as the OPP. Another example given by Porsander (2005) is public tendering. She studied how a city could be developed into a cultural capital and found that public tendering was the single passage that needed to be crossed if an actor should become part of this development.

When the translation process results in a single-point actant, those are said to be punctualized or black-boxed. *Punctualization* refers to the event when a network acts like a singular unit, thereby allowing it to 'disappear' and be replaced by the action itself and the seemingly simple creator of that action (Law 1992). Punctualization thus refers to the concept that the whole network is greater than the sum of its constituent parts. For example when a person drives a car or uses a computer, as long as the car or computer runs smoothly, both are perceived as a unity, or a single block as Law (1992) puts it, but when the car or computer breaks down the user will be exposed to all the complex systems that must interact in order for the block or unity to work; consequently something relatively simple is hiding the networks that make the unity work. The actors in an ANT-network are themselves made up of networks and this is how simplification works. So if we find a stable network we can punctualize it and consider it a single actor. When we change an actor we also change the network that this actor simplifies. To simplify a network can also be called to *black box* the network. Black boxes may always be reopened. Since networks are consistently unreliable and can become unstable, the contents and the complexity of the black box may become visible (Tatnall and Gilding 1999). Moreover, according to Callon, a simplified network is a black box, which in turn may consist of a network of other black boxes (Tatnall and Gilding 1999).

Research implications

These central concepts give rise to a number of interesting aspects of the world when looked through an ANT perspective. First what may seem on the surface to be purely social is partly technical and vice versa. According to ANT, nothing is purely social or

technical and consequently a relation that is either purely social or purely technical is impossible (Tatnall and Gilding 1999). ANT treats social relations, including power and organization, as network effects; networks that are materially heterogeneous and where all parts of the networks, humans and non-humans are treated equally. Tatnall and Gilding (1999) compare ANT with ethnography since it handles complexity without simply filtering it out. It extends ethnography because it allows for an analysis of both humans and nonhumans in a single register, hence not forcing one to be the context of the other. As such it helps researchers to develop a holistic narrative that builds on this common register (for humans and nonhumans) which provides the analytical inputs from all aspects of the common register, social, technological as well as political (Tatnall and Gilding 1999).

RESEARCH SETTING

ArchFirm is one of the largest architecture firms in Scandinavia and works in a wide variety of areas, including housing, health care buildings, schools, landscape design and architecture, furniture design, and interior design.

ArchFirm has established a systematic knowledge-sharing initiative, which they refer to as the *Knowledge Building* (KB). The KB is, in the words of top management, a strategic R&D investment and consists of extensive knowledge management areas and affiliated social networks active throughout the whole company. It is described as “*a network based academy*” intended to be an important meeting place with no geographic boundaries. KB is divided into 11 expertise (knowledge) areas. An expertise area is either related to a specific market segment, eg hospital buildings, or a core competence, eg project management.

Although its utilization varies, there is a standardized set of activities that should be carried out within each field of expertise. These activities can be conducted internally or together with clients and partners in order to highlight relevant topics. A core activity of the KB is the social network events in which every sub-group arranges at least one a year. In addition, activities, such as education, seminars, workshops, network meetings and study visits are arranged within the frame of KB as well as providing an online discussion forum.

Although open for all employees, each expertise area is managed by a *knowledge leader* (KL). The KLs primary task is to act as facilitators of knowledge, within the firm but also with external stakeholders. KLs’ tasks include an overall responsibility for coordinating and arranging the annual social network meetings as well as establishing contacts with internal and external experts within and related to the expertise area. Besides leading an assigned field of expertise within KB, they are also responsible for maintaining the corporate intranet. Thus, they are intended to constitute a central connection point in each knowledge area. As such they are in a position to establish an agenda and set the discourse for what is to be considered as most emergent within a specific knowledge area, for example they decide what type of information is published on the intranet. A common perception of the role as KL was that it had large degrees of freedom and flexibility where each KL could construct their network in a manner of their choice. Therefore KLs were expected to have great networking skills but they were also expected to be good at sensing and analysing industrial trends, have an established reputation as highly competent among the employees, be ambitious but most of all they were expected to show a strong commitment to the knowledge area in hand.

METHOD

Focusing on KB, a study was conducted in 2013. In order to investigate knowledge sharing in an architectural context, an interpretive case study strategy was adopted due to its argued ability to accommodate the complexity of social phenomenon (Remenyi *et al.* 1998). By adopting a case study strategy, the research offers a more in-depth perspective on the topic of knowledge sharing in an architecture firm. Twelve interviews were conducted. Initially, the interviewees were selected based on a list of recommendations from the director of KB. The list consisted of the names of six current KLS, two former KLS, two senior architects and two specialists. The one-hour interviews were held in the interviewees' offices. The interviews were structured around a set of 30 questions encompassing; the purpose of the KB; its relation vis-à-vis their professional role in ArchFirm; the use of the KB including the intranet; how they perceived the various activities; and their opinions on experts and knowledge. The interviews were recorded and transcribed in verbatim. The analysis consisted of reviewing and examining official documents provided by ArchFirm as well as interview transcripts and field notes. Using ANT as an analytical lens the data was further interpreted and coded.

The results presented in this paper are to large degree context dependent and are therefore not suitable as a basis for broad generalizations. However, the results may have applicability in cases similar to the one studied and they may also serve as a foundation for a quantitative study comprising a larger sample size of architecture firms. Moreover the discussion on ANT's applicability in similar contexts is of interest for a broader audience.

FINDINGS AND DISCUSSION

Drawing on ANT, the KB was in this study conceptualized as a heterogeneous network consisting of several actants, both human and nonhuman. This suggests that also nonhuman actors were considered as part of the social environment that creates and shapes knowledge. It also implies that in the case of ArchFirm, architecture knowledge does not only reside in the mind of individuals, neither is it exclusive to the social relations between individuals, rather it exists in the heterogeneous network made up of various employees with different backgrounds and identities, the intranet, the KB and the sub-networks etc. Hence, KB as a nonhuman actant serve as a bridge between identified gaps made of the two epistemologies of possessional knowledge and practice (cf. Newell *et al.*, 2009).

OPPs and translation processes of 'good architecture knowledge'

In the case of ArchFirm and knowledge sharing the concept of obligatory passage point (OPP) could be viewed through different levels.

In the broadest sense, the management of KB constitutes an OPP in that the management of KB is the centre point upon which the entire system is founded. KB in the perspective of providing a process that generates ordering may be seen as an effect of several processes of translations, transforming heterogeneous elements, such as the employees, the intranet and other components of ArchFirm, into a punctualized actor, the KB. Once stable the punctualized actor will be challenged by various other alternative translations because there is no such thing as "*the social order*" (Law 1992: 386). Rather there are different translations of how a social order can be constructed. In line with the idea of semiotic relationality (Law 1992), the network is not viewed as a solitary 'thing' but rather as a composition of different elements that

shape one another. This viewpoint when applied in the case of ArchFirm might suggest that KB could be viewed as a circulating entity in which each element, made up of actants, mutually interact to shape and create meaning. Although we sensed that the identity of KB differ between employees, from being that of a databank to being more like a living organism that changes over time, the KB served a unifying role regarding what good architecture knowledge is, thereby providing a reference point for the employees. For example, one of the interviewees said that within the KB: *“we become conscious about what we do and what we see, placing wordings on our aesthetic preferences.”* Another said that; that taking part in KB forces her to *“step outside my regular role and think: ‘What do we want to do?’ Where are we going?’ ”* Thus, seen in a material semiotic view good architecture and successful architectural design is not the result of one great architect but the result of relational effects.

On an operational level, however, the assigned knowledge leaders (KLs) play an influential role in facilitating knowledge sharing through the means of organizing the network gatherings and similar activities. In addition, being editors of the intranet they controls the flow of information through the intranet and are in position to choose what is relevant information and what is not. As a consequence the shaping of the actor-network becomes asymmetrical. On this level, the OPP is reflected by the individual KL whose prime function is to coordinate a specific area of knowledge, which implies that they are placed as the central node of the network. Considering that personal commitment was described as inherently embedded in the role as KL, one might also argue that personal commitment could be considered an OPP.

Although the interviewees present a rather unified view of KB's primary goal, that of facilitating shared knowledge between individuals and groupings, their perception of its role varies. Some say it primary have a social role connecting people, although some perceive it as closed social clubs of people that know each other and other as open social spaces that invites for new co-operations. Others forward KB as a confidence provider in discussions with clients, others talk of its role in recruitment and when introducing new employees, additionally others talk of KB as symbolic, showing the rest of the world that ArchFirm take seriously on knowledge sharing issues. Thus, KB could be seen as a manifestation of the conceptualized picture of ArchFirm as a knowledge company. As such it was rooted in a general idea of an interrelation between knowledge and creativity.

The KB as black boxed expertise knowledge

A central idea in ANT is the notion of the punctualization and black-box. As long as a black-box works, little to no attention is given to how it works. It is only when the actor-network either degrades in its functions or when it ceases to function entirely whereby one notices the intricate complexities underlying it. A possible example of such an occurrence in KB is the relationship between internal ArchFirm experts and staff. Most interviewees were unaware of the complexity of the work behind expert advice, e.g. the mathematical modelling or the software tools used. Instead, the process was simplified in terms of inputs (e.g. sending drawings to an environmental expert) and outputs (receiving recommendations). The process seemed therefore akin to that of a black box. The consequence of viewing expert knowledge as a

punctualized actant is that experts are constantly interrupted with sometimes trivial questions, i.e. lack of respect for their limited time. From the expert's point of view, the actor-network has broken down and the different parts of the black box have been revealed. With each new request, the expert visualises various parts of the black box

and the necessary interactions needed to answer that request; the models that need to be created, the algorithms that need to be tweaked, the background research that need to be undertaken, the strains that the request will put on other work and how it will affect the mood for the rest of the day. All of these interconnected parts are apparent to the expert but hidden to the individuals seeking his or her assistance. It seems therefore that the expert functions like a black box in ArchFirm when viewed from the perspective of the individual members of ArchFirm but not when viewed from the experts' own perception. The notion that an actor-network can be perceived as different things depending on how it is viewed is supported by ANT (Dolwick 2009). An actor-network may be viewed as an actor from one perspective but as a network from another.

KB as a black boxed place and space for creativity

One of the interviewees said: *"KB creates room for knowledge creation and dissemination of knowledge... Existing knowledge is a prerequisite for creativity..."* Here KB, in an ideal world, is expected to provide space, place and time for framing, as well as challenging, reference objects, and as the above quote exemplifies, KB is seen as a base for creativity. An idea very much rooted in architecture practice. However, the interpretation of creativity varies within the different areas in the KB. One KL claimed that architectural creativity was framed by intelligent solutions. In another area, creativity was deeply rooted in gaining recognition from others through winning design contests whereas the area of Healthcare Buildings adopted an empirical approach towards the creative by studying causal relationships between design and wellbeing. In each of these cases, creativity was reinterpreted in a way that suited the area in question. The focal actant in ArchFirm is thus that of creativity. Through each of the interactions between the different actants within the firm lies this central idea that all work should embody a creative architecture practice. In clarifying the position of ANT with respect to focal actants, Latour (1996) stresses that focal actants have the ability to transform the actants they interact with. Moving from one actant to the other, the focal actant is always translated, always moving. With creativity as a focal actant, it becomes evident that its interpretation varies widely within the different networks represented in the KB.

Opening the black box – revealing knowledge (and power) asymmetry

Based on personal and/or professional interest the employees were free to choose area(s) to join. They could also decide to not participate. The size of each area in terms of members therefore differ, some very large and other, often within a specific niche eg interior design, being smaller. In addition, although a mix of professional backgrounds was said to be preferred, some areas seem to attract more architects and others more engineers. This creates knowledge asymmetry within KB. It also separates professional discourses rather than uniting them. Moreover, as top management of ArchFirm assigned higher priority to some areas perceived as important market segments, those areas got higher priority in terms of allocated resources leading to increased attraction by employees. These prioritized areas had in common that they were dominated by an architectural logic and discourse, which indirectly side-lined areas with a more engineering perspective, thus creating a knowledge (as well as power) asymmetry within ArchFirm.

Important in relation to KB is that it discards the idea of forming the ideal knowledge arena. Instead, there are various alternatives to social formations, some of which may be more close to top management's 'official' objective of the KB. Thus, social order is

continuously contested and there are numerous sources of resistance through the various perception of KB's role. Considering the different professional groupings, opposing professional discourses and epistemological views represented in the firm, the resistance toward social orders may be greater in the case of ArchFirm. Another way in which resistance could be manifested may be through the seemingly dominating position of the architects in ArchFirm. That the architecture logics and discourse has become dominating is not necessarily because of a high proportion of architect (about half of the employees are architects) but more due to the architecture identity becoming the dominant translation.

CONCLUDING REMARKS

An attempt has been made to use ANT as an analytical lens to investigate knowledge sharing in an architectural context. This approach is intended to shed light on the intricate complexities that seems to exist in a knowledge-sharing arena consisting of many different elements. Through its methodological approach and focus on sociotechnical processes, ANT has been useful in mapping different interrelated factors that either facilitate or hamper knowledge sharing in ArchFirm, factors which may have gone unnoticed using a more conventional analytical frame. This is at the heart of the argument made by Doolin and Lowe (2002) stating that the detailed descriptions provided by applying the ANT perspective enables for an analysis of the interrelationship that comprise the actor-network. Though the ANT approach might be perceived as esoteric, it nonetheless provides a framework to better understand the complex interactions that occur between both human and non-human actors. In that sense, its applicability with regards to construction in general and architecture in particular becomes evident. The long range of intricacies embodied in architectural work necessitates an explanatory model capable of capturing complex interactions and conveying them in a coherent manner. This study has attempted to show that ANT could constitute one such explanatory model with both the scope and the depth to adequately portray the inner workings of knowledge sharing in architecture firms.

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TACIT AND EXPLICIT KNOWLEDGE IN CONSTRUCTION MANAGEMENT

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In construction better practice has been sought through the employment of knowledge management. Interest in tacit knowledge has grown due to its importance for raising performance at all organisational levels. Aspects of the limits which tacit knowledge places on knowledge management approaches in construction are considered with the focus being upon broad knowledge management categories rather than the details of particular methods. The distinction between knowing how and knowing that coupled with examination of whether the main mode of knowing is tacit or explicit is used to analyse the relationship between tacit and explicit knowledge in construction. There are significant general theoretical difficulties with incorporating tacit knowledge into the objectivist knowledge management approaches which predominate in construction particularly since methods for converting tacit to explicit knowledge are problematic. Improving performance requires appreciating the limitations of objectivist and practice based knowledge management within the context of construction projects as consideration of performance management measures illustrates.

Keywords: information management, measurement, tacit knowledge.

INTRODUCTION

Performance in the UK construction industry has long been regarded as unsatisfactory (Latham 1994, Egan 1998 and Wolstenholme 2009). Despite a number of reviews and policy initiatives to produce productivity, quality and competitiveness gains the industry has failed to meet improvement targets in a range of areas. A significant way in which better practice has been sought is through the employment of knowledge management due to increasing recognition that it can bring about competitive advantage through innovation and improved performance (Egbu 2004). Knowledge management is utilised to facilitate a structured approach to learning from construction projects and to find ways to share and reuse this knowledge. For knowledge management to deliver the greatest benefits an appropriate method must be used in an appropriate way so recognising theoretical limitations which are practically important is essential.

The relatively low-tech labour intensive nature of construction means that people are the most valuable asset an organisation has. Despite this the worth of the knowledge and skills which people have continues to be under appreciated. As Egan (1998 p.14) put it:

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“... much of construction does not yet recognise that its people are its greatest asset and treat them as such. Too much talent is simply wasted, particularly through failure to recognise the significant contribution ...”.

Interest in tacit knowledge in construction has grown in the last few decades as its importance for raising performance and competitiveness at all organisational levels has become apparent. Its value for construction is demonstrated by the extent to which the industry relies on skills and the capacity to bring different ones together effectively (Druker and White 1996).

This paper particularly focuses on aspects of the limits which tacit knowledge places on knowledge management approaches in construction. As result of this the concern is largely with broad knowledge management categories rather than the details of particular methods. It is argued that the very nature of tacit knowledge means that there are significant general theoretical problems with incorporating into it the objectivist knowledge management approaches which predominate in construction. These theoretical problems impose substantial practical constraints upon the incorporation of tacit knowledge which cannot be dealt with by improved work flow documentation, better use of technology, and other similar strategies. Fully appreciating this difficulty involves recognising that theoretical representations of knowledge management can serve both descriptive and normative functions. Such representations can be normative in that a representation acts as a standard for judging facets of practice. Insufficient understanding of how and why variance between normative representations of practice and practice itself occurs can be a barrier to its improvement. Attempts to make knowledge in practice conform to inappropriate theoretical representations of knowledge management may well confer no benefit at all.

OBJECTIVIST KNOWLEDGE MANAGEMENT

Types of knowledge management can be broadly classified as either objectivist or practice based (Burrell and Morgan 1979 and Schultze and Stabell 2004). Objectivist knowledge management predominates in construction with most improvement initiatives seeking to enhance practitioner knowledge through this approach (Anumba *et al.* 2005 and Tan *et. al* 2010). This type of knowledge management belongs to the category of cognitive models which are based on the value of using and develop knowledge (Kakabadse *et al.* 2003). In objectivist knowledge management knowledge is primarily regarded as a cognitive entity rather than comprising part of a social practice (Cook and Brown 1999). Knowledge is deemed to be objective facts which are free from individual subjectivity with much organisational knowledge typically being of this character. It is possible to separate knowledge from the individuals or groups which possess it. Analysing knowledge focuses upon the identification of component elements as this is a prerequisite for the codification of knowledge. The individual elements of knowledge identified in analysis have at the very least an independent meaning. The process of managing knowledge is regarded as the extraction of knowledge from individuals or groups so that it can be codified thereby enabling control and application thereby raising organisational performance. Knowledge is represented, collected and stored in a systematic, generalised and codified way (Hislop 2009). Through this knowledge generated during the course of construction projects is captured, shared and reused with the newly assimilated knowledge being codified and used to update artefacts such as check lists and databases. The central role which codification and control has in objectivist

knowledge management naturally leads to a strong emphasis upon the importance of logical rationality particularly with regard to evaluation and causation. Knowledge is embedded into rules which have a logical causative rationale and which the practitioner is then meant to follow. There is an emphasis on predictability and a diminished role for the management of uncertainty. The increased focus on the role of information technology in construction over the last decade or so has resulted in objectivist knowledge management concentrating heavily upon the delivery of technological solutions (Anumba *et al.* 2005 and Tan 2010).

TACIT AND EXPLICIT KNOWLEDGE

The nature of tacit knowledge in construction imposes limitations on the effectiveness of objectivist knowledge management. It has difficulty dealing with tacit knowledge and this matters because explicit knowledge is only a small part of relevant construction practice knowledge. In order to appreciate the problem it is important to recognise that tacit knowledge is not problematic in itself, as such knowledge clearly exists, but precisely articulating the nature of tacit knowledge is. This is because tacit knowledge is knowledge that an individual has but which cannot be articulated (Polanyi 1958 and 1966). Definitions of tacit knowledge in the literature vary in their details but there is general agreement that tacit knowledge is personal know how primarily acquired through education, training and experience. As a result of this tacit knowledge is a complex content dependent notion which covers a wide range of diverse cases with examples of it including intuition and interpersonal skills. There is no common property or attribute which all cases of tacit knowledge share and its coherence is of a family resemblance kind (Wittgenstein 2009). In construction instances of tacit knowledge could range from the ability to plaster to interaction with the supply chain (Egbu and Robinson 2005). A complication in the literature on tacit knowledge is that it is expressed as both being knowledge which cannot be explicated (Polanyi 1958 and 1966) and knowledge which is not explicated (Collins 2010). The difference between 'cannot' and 'is' is both theoretically important and practically relevant since tacit knowledge which could be explicated but has not been is the kind which could potentially be codified. In what follows the concern will be with tacit knowledge which cannot be explicated.

Construction knowledge is multidimensional and multivalent involving propositional, experiential, performative and epistemological kinds all of which engage with truth in different ways. These sorts of knowledge act together and it is only a small amount of mainly the explicit kind that can be easily codified and represented (Mingers 2008) with one estimate claiming that 80% of useful construction knowledge is tacit (Sheehan *et al.* 2005). The extensive reliance on tacit knowledge is partly a result of much construction knowledge being in minds of those working on a project, an absence of documentation about the motivations for decisions, and people leaving the project for another once construction is completed. Research on objectivist knowledge management in construction recognises that explicit knowledge only identifies a limited aspect of the thinking and acting in practice. It attempts to account for the heavy dependence on tacit knowledge in construction practice by codification methods for converting tacit to explicit knowledge. For example, Anumba *et al.* (2005) suggest that experiences of construction professionals are based on a balance between explicit and tacit knowledge in different phases of a project and they are interchangeable by different codification methods. The principal codification method is the SECI conversion model which involves socialisation, externalisation, combination and internalisation (Nonaka and Takeuchi 1995 and Nonaka *et al.* 2000).

However, as Baumard (1999 p.4) observes this method contains an unavoidable paradox as knowledge which cannot be codified is analysed by a codification method.

The problem of the substantial amount of tacit knowledge in construction cannot be wholly satisfactorily addressed by the methods used for codifying tacit knowledge so it can be converted into explicit knowledge. The significant general theoretical problems which these conversion methods have can be demonstrated by considering how tacit and explicit knowledge relate to the distinction between knowing how and knowing that. Ryle (1946 and 1949) influentially argued that the kinds of knowledge involved in knowing that and knowing how are distinct. (For a long time this view was widely accepted and despite some criticism from analytic philosophers in the last decade or so it is still considered by many to be a viable position (Winch 2010).) Knowing that is propositional knowledge whilst knowing how is non-propositional knowledge. For example, knowledge of the chemical composition of plaster is knowledge that but the ability to plaster is knowledge how. The difference between these types of knowledge is less apparent in English than French or German both of which have distinct verbs for these kinds of knowledge.

Ryle's (1946 and 1949) central argument for claiming that knowing how is irreducible to knowing that appeals to regress. He claimed that if knowing how is a kind of knowing that then to engage in action a person would have to contemplate a proposition (because knowing that is propositional knowledge). However, the contemplation of a proposition is itself an action which would have to be accompanied by the separate and distinct contemplation of a proposition. It follows that there would be a never ending regress of contemplating propositions with the consequence that knowing how could never be manifested. This argument provides justification for taking knowledge to consist of knowing how and knowing that where these are distinct kinds of knowledge. There has been criticism of Ryle's view that the two kinds of knowledge operate in wholly distinct ways on the grounds that a satisfactory account of expertise in an occupational capacity should explain how these kinds of knowledge interact. The difficulty with Ryle's view is that a great deal of knowing how requires the possession of knowledge that such as in the case of the ability to plaster partly being dependent on knowing facts about plastering. This objection can be fairly easily dealt with in a way which leaves Ryle's main claims intact by modifying his account to take proper account of the interaction between knowing how and knowing that in the performance and justification of action (Winch 2009). It is worth observing these theoretical arguments in favour of expertise requiring an integration of knowing how and knowing that are corroborated by a chunking model of expertise from psychology. This model is strongly supported by experimental evidence and provides a powerful explanation of learning and expert behaviour through the idea that expertise gradually builds up through the incremental and implicit learning of both knowing how and knowing that (Gobet 2005).

Given that Ryle's distinction between knowing how and knowing that is sustainable it is time to consider how tacit and explicit knowledge relate to knowing how and knowing that. Explicit knowledge is straightforwardly equivalent to knowing that. However, characterising the relationship between knowing how and tacit knowledge is more difficult since the equivalence does not go both ways. Not all knowing how is tacit knowledge because there is some knowing how which can be explicated, such as manual instructions explaining how to set cutting blades. Since tacit knowledge is knowledge that an individual has but which cannot be articulated it follows that it cannot be knowing that and so must be knowing how. Having established that tacit

knowledge is knowing how an application of Ryle's regress argument that knowing how is irreducible to knowing that can be used to show that the SECI model conversion of tacit to explicit knowledge is problematic in principle. For codification to be possible the SECI model has to be able to decontextualise knowledge including those elements of it which cannot be individually identified. If knowing how cannot be reduced to knowing that and tacit knowledge is knowing how then it follows that tacit knowledge cannot be reduced to knowing that. If such a reduction is not possible then the decontextualisation involved in codification is not possible.

PRACTICE BASED KNOWLEDGE MANAGEMENT

In objectivist knowledge management explicit knowledge is taken to be the main mode of knowledge and tacit knowledge must be explained in reference to it. The problem that tacit knowledge which cannot be codified poses for it is a direct consequence of regarding explicit knowledge as the primary mode. In contrast to the objectivist knowledge management perspective many in practice based knowledge management, psychology and the sociology of knowledge claim that tacit knowledge is the main mode of knowledge and explicit knowledge must be explained in reference to it. Explicit knowledge must rely on being tacitly understood and applied with the consequence that all knowledge is either tacit or rooted in tacit knowledge. An entirely explicit knowledge is inconceivable (Polanyi 1958 and 1966). Tsoukas (2003) has developed Polanyi's ideas to claim that even the most explicit knowledge is only practically applicable via the exercise of skill and judgement. He employs the distinction Polanyi makes between focal and subsidiary awareness to criticise the SECI model on the grounds that it does not actually convert tacit to explicit knowledge. Tsoukas argues that the conversion procedure extracts the know that aspects of the knowledge (that is focal awareness) without accessing the whole purposeful meaning of an activity (that is subsidiary awareness). He maintains that reflection after an activity merely extracts what can be articulated linguistically and subsidiary awareness can never be expressed explicitly. This is because attempts to articulate the subsidiary awareness of a particular activity would mean that an individual would no longer be engaged in that activity but would instead be engaged in the activity of thinking about that particular activity. Arguments like those of Polanyi and Tsoukas present are complex and controversial but they provide grounds for examining the status of the claim that explicit knowledge is the main mode of knowledge. In objectivist knowledge management it might be thought to be serving a descriptive function but the criticisms of it just noted suggest that its normative function could well be at least as significant.

The importance of irreducible tacit knowledge ensures that types of practice based knowledge management have a valuable role in construction. An approach which usefully accommodates the complex context dependent nature of tacit knowledge is sensemaking. From a sensemaking perspective practice is about observation and inquiry to understand situations by locating them within previous experiences. Sensemaking involves current positions determining what is sought, the past framing what can be seen in a situation, cues which align situations with previous experiences and plausible construal within a social situation taking preference over accuracy. Interactions result in greater understanding which reshapes the sense that is being made of the situation (Weick 1995 and 2001). Given these ideas about sensemaking expertise can be regarded as drawing on situated experience where actions are negotiated from norms of knowledge, social and organisational positions and perceptions of risk (Lave and Wenger 1991) along with involving the ability to engage

in the right kind of deliberation and actions in situations where there is incomplete information through an appropriate appreciation of context (Boyd 2006). What this and the preceding discussion suggest is that in construction objectivist and practice based knowledge management should be regarded as complementary rather than competitive. Instead of attempting to demonstrate, as quite commonly has been done, that one approach is better than the other emphasis should be placed upon recognising the limitations of each within the context of construction management.

CONCLUSIONS

The character of tacit knowledge has implications for recognising the limitations of performance management measures particularly key performance indicators. The objectivist knowledge management perspective that explicit knowledge is taken the main mode of knowledge supports the idea that measurability corresponds with value and usefulness with a notable instance of this being the reform movement in construction. In terms of reviews, policy initiatives and organisations the movement has been and remains an important driver for alterations to improve practice. These changes involve identification of best practice via heavy reliance on measurability. However, the emphasis on measurability results in insufficient recognition of what cannot be measured coupled with excessive stress on the readily measurable and codifiable aspects of performance (Ferne et al. 2006). Tacit knowledge has an essential role in explaining what is best (or conversely substandard) practice and in so doing contributing to its improvement. Explanations of practice which lack the significant context which tacit knowledge provides are likely to be uninformative in some way particularly since this knowledge cannot be replaced by explicit knowledge. Given that by its very nature tacit knowledge is resistant to measurement much more attention should be paid to the connection between what can be measured and what cannot. This should be coupled with consideration about how to best to handle the latter and recognition that not all aspects of performance are measurable (Ferne et al. 2006). The importance of tacit knowledge can also be seen in the usage of the increasingly important performance management tool of building information modelling and management systems. These systems effectively employment explicit knowledge to track and manage project information but they cannot capture the tacit knowledge which is also a crucial part of successful project delivery. For example, Jaradat et al. (2013) found that some professionals objected to certain ways in which computer systems were used such as the requirement to spend time updating files instead of just carrying on and dealing with problems as they arose. Here the resistance is to what is perceived as unnecessary explicit knowledge at the expense of problem solution best dealt with by tacit knowledge.

Improving performance requires appreciating the limitations of objectivist and practice based knowledge management within the context of construction projects. This includes understanding the extent to which tacit knowledge constrains the identification and dissemination of best practice and that as a consequence the latter should be regarded as a family resemblance concept. Taking best practice in this way enables many kinds of best practice which combine performance management measures with approaches like sensemaking in varying combinations.

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RISK MANAGEMENT AND UNCERTAINTY IN INFRASTRUCTURE PROJECTS – WHAT ROLE(S) FOR KNOWLEDGE AND CONSTRUCTION MANAGEMENT?

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The assumption that large complex projects should be managed in order to reduce uncertainty and increase predictability is not new. What is relatively new, however, is that uncertainty reduction can and should be obtained through formal risk management approaches. We question both assumptions by addressing a more fundamental question about the role of knowledge in current risk management practices. Inquiries into the predominant approaches to risk management in large infrastructure and construction projects reveal their assumptions about knowledge and we discuss the ramifications these have for project and construction management. Our argument and claim is that predominant risk management approaches tends to reinforce conventional ideas of project control whilst undermining other notions of value and relevance of built assets and project management process. These approaches fail to consider the role and potential value of knowledge production during the project process, instead seeing knowledge as an input into upfront planning and specification. We examine ways in which actual project practices approach the question of risk management for the case of large public hospital building and infrastructure projects in Denmark. These projects are characterized by long durations involving substantial materiality, high uncertainty, ambiguity, and complexity. Yet, they are also subjected to risk management that operates according to a standardized ‘best practice’ control approach – as if these hospital and infrastructure projects are quite simple, predictive and similar in nature. The cases reveal the emerging uncertainties that challenge the project plan and the risk management approach as new knowledge about the conditions are produced during the project processes. The paper concludes by proposing a more dynamic understanding of the role of knowledge, considering the practical implications of uncertain knowledge conditions as a prevailing condition for construction management rather than something to be known in advanced and reduced by risk management.

Keywords: risk, uncertainty, knowledge, infrastructure.

INTRODUCTION

“The [ideal knowledge] conditions required for it to be relevant to talk of risk are not met. We know that we do not know, but that is almost all we know: there is no better definition of uncertainty” (Callon *et al.* 2009, p. 21).

During the last two decades scholars within management and organization studies, sociology and economics have developed a renewed interest in the concept of risk,

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dealing with classical topics such as gambling, occupational and operational risks as well as more recent and encompassing topics and notions such as ‘risk society’, ‘world risk society’ (Beck 2009) ‘enterprise risk management’ and ‘the risk management of everything’ (Power 2004). According to Power (2004) ideals about more and better control are underpinning the recent expansion of risk management practices across organizations and societies. Best practice approaches to project management have long since promoted control with a corresponding role for project management: a key role and responsibility of project management is about ensuring ongoing monitoring and control so that the project can be executed efficiently and accurately and delivered according to predictions. That is, according to a set goal and plan (Turner *et al.*, 2010, Flyvbjerg 2006). The reduction of uncertainty to ensure execution according to a set goal and plan is integral to the control ideal in ‘best practice’ project management.

During the last two decades an increasing numbers of scholars in project research have addressed a number of critical issues and limitations associated with uncertainty reduction and control such as; the project’s lack of effectiveness and loss of relevance in the wider stakeholder environment (Christensen and Kreiner (1991), Kreiner (1995), the lack of a broader value-orientation (Morris, 2010), the reduction of robustness and reliability in organizational performance due a false sense of control and certainty (Weick and Sutcliffe 2001, Coutu 2003). A key argument across several contributions concerns the conditions of knowledge in temporary project settings. Knowledge about the project and task is always uncertain, especially in the beginning of the temporary project when few actions have been taken and relatively little is known. Christensen and Kreiner (1991), Kreiner (1995), Lundin and Söderholm (1995), Engwall (2002), Jönsson (2004), Atkinson *et al.* (2006) and Lindkvist (2011) have all emphasized the contextual complexity, uncertainty and ambiguity of temporary project settings. Alongside these conditions, Van Marrewijk (2007) noted the prevalence of rituals and cultural values governing mega-infrastructure projects and Winch (2002) noted the existence of wicked problems in construction projects. These are problems that are uncertain in the sense of being ill-defined and without an optimal solution. In brief then, the conventional control approach to projects and project management has been questioned for being reductionist when dealing with uncertainty, biased in favour of predictability and efficiency in execution while disregarding the project context and longer term perspective after the project is handed over and its results are put to use.

The distinction between uncertainty and risk is integral to the above discussion. As noted by Chapman and Ward (2011) uncertainty management can be better than risk management insofar as the former implies further consideration of potential favourable opportunities, benefits and outcomes, in contrast to the more limited notion of risk management which tends to deal with the unfavourable costs and outcomes. However, as also noted by Power (2004) there seems to be more to this distinction. When the economist Frank Knight (1921) introduced the distinction between uncertainty and risk it was, according to Langlois and Cosgel (1993), to address a more fundamental uncertainty that goes beyond assigning probabilities to more or less favourable outcomes. The latter presuppose that we at least have knowledge of concepts to classify outcomes, although we might not know their probability distribution. Knight reserved the notion of risk for such situations and states that are sufficiently known to be measured and calculated. “*By contrast, uncertainty as Knight understood it arises from the impossibility of exhaustive classification of states*”, that

is, when the knowledge and conceptual categories are themselves unknown. (Langlois and Cosgel, 1993, p. 459 – 460). Thus, according to a Knightian distinction, the concept of uncertainty is broader in scope and implication than the concept of risk – while the latter can be subjected to quantifications and calculations, the former cannot. Instead, when actors are confronted with uncertainty, they must rely on judgment and intuition. As noted by Winch and Maytorena (2009) the distinction between uncertainty and risk was carried into management and organization research through the work of March and Simon (1958). Simon (1983) in turn questioned the contemplative ‘cold’ cognitive bias of much previous work on decision-making in organizations, especially associated with rational choice and the so called subjective expected utility theory. Instead, Simon proposed a model based on intuition and emotion, drawing attention to ‘hot cognitions’. Hot cognitions are related to surprise and sudden discovery as well as the excitement these provoke. This notion carries further associations to March (1971) work on ‘technology of foolishness’ and the distinction between exploration (of yet unknown and hence uncertain worlds) and exploitation (within a relatively well known universe).

Some more recent contributions have also addressed possible complementary perspectives on uncertainty and risk management. Corvellec (2009) draws attention to the usefulness of silent, non-explicit non-formalized risk management practices. While Flyvbjerg (2006) points to the usefulness and importance of accuracy and the reference class forecasting method as a way to facilitate better control and predictability of large complex infrastructure projects and outcomes, Millo and MacKenzie (2009) point to the usefulness of inaccurate models and methods. According to them, the success of a forecasting method can depend on its usefulness in practice and thus be independent of the method’s more or less predictive powers and expert knowledge. For example, organizational actors might adopt a particular forecasting method because it helps them to make fast and efficient calculations and decisions, and in turn, justify those calculations and decisions, and to communicate with others about issues of mutual interest. This is a rather different utility that the classic argument about making reality and the project more certain. Millo and Mackenzie’s (2008) idea of inaccuracy, Callon and Law (2005) on qualculation as a continuum between judgment and calculation, Callon *et al.*’s (2009) emphasis on action in an uncertain world as opposed decision, choice and risk, and Latour (2002) on technical action, all point towards the active and performative role of technical devices in enacting and shaping the world they help to describe. Beck (1999) seems to allude to something similar when he comments on what an emphasis on the notion of risk and risk society implies:

“So risk is man-made hybrids [...the notion of risk...] is the way the ‘hybrid society’ watches, describes, values, criticizes its own hybridity” (Beck 1999, p. 146).

In our reading, the emphasis on risk can be for better or worse and should be examined empirically alongside a less instrumental notion of acting and preforming within uncertain knowledge conditions. Below, we present empirical material from studies of two large infrastructure projects in Denmark; the current Danish hospital building programme which represents the largest ever public infrastructure investment in the country at some 42 billion DKK (£46 billion), and the 13 year, 3.2 billion Euro Danish rail signalling infrastructure redevelopment programme. Both cases demonstrate the complex interplay of risk and uncertainty in large projects, as well as the tension between risk management producing knowledge about project conditions ‘out there’ and risk management performing and reifying those conditions. In the

context of our work we focus on risk management practices in projects, but complement this with a particular focus on the possible complex dynamics and exchanges between a more or less uncertain project condition and the risk management practices that are used to manage those uncertain conditions. More specifically we ask how risk management practices shape project conditions for large construction and infrastructure projects and with what ramifications for knowledge and project- and construction management roles.

CASES AND METHOD

Both cases are on-going in terms of data collection. The “*Kvalitetsfonden*” hospital building programme data to date consists of a combination of interviews with actors from the Danish Regions state client organisation and built environment organisations involved in the design and construction of several of the individual hospitals that constitute the programme, along with attendance at public and closed project meetings, and documentary data. The documentary data is significant given the extent of public domain reports and media coverage. The signalling programme data consists primarily of long-term participant observation within the projects from the end of 2009 when the programme received the go-ahead, combined with interviews and documentary data conducted and collected during this period also.

RISK MANAGEMENT IN THE DANISH HOSPITAL BUILDING PROGRAM

“*Kvalitetsfonden*”, the current building and renovation program for the Danish hospitals is the largest public investment in physical infrastructure ever seen in Denmark. With a total budget of 42 billion Danish crowns (DKK), the “*Kvalitetsfonden*” involves 16 hospital construction projects ranging from significant rebuild and renovations of existing hospitals, through green field projects, university hospitals to so called ‘super hospitals’ with individual project budgets between 4 and - 6.5 billion DKK. During the start-up of the program in early 2008 the client and umbrella organization for public hospital care, Danish Regions, requested help from the well-known consultancy firm KPMG to advice on how to manage the risks in such a complex building program. KPMG was at that time about to deliver their final report to the Danish state concerning a public inquiry into the new building for Danish Radio. The project became infamous for being late and for going over budget by 1.7 billion DKK. According to KPMG and Grant Thornton (2008), the deviations from the time schedule and budget were due to a lack of overall control and inadequate calibration and use of the risk management tools. The tool in use, “*successive calculation*” should have been calibrated differently in order to assess and communicating the actual risks.

With this track-record KPMG seemed well prepared to advise the Danish Regions on risk matters in large public constructions projects. The report (KPMG 2008) introduced the potential benefits of “*successive calculation*” supplemented with case scenarios such as worst, best and most likely along with the suggestion to identify the “*top-ten*” risk and uncertainty factors for the construction project (appendix, p.34). The National Audit Office (NAO) assumed a particular task and responsibility of monitoring the ways in which the different constituencies managed the execution of each of the projects as well as the overall programme. The NAO (Rigsrevisionen, 2010) urged the regions to increase the focus on risk management in each project, citing the KPMG (2008) report. In NAO (Rigsrevisionen, 2011) the focus on project risk was reinforced and extended to the Ministry of Health:

“Rigsrevisionen [NAO] notes that construction projects of such scale and complexity involve risks. It is therefore essential that the Ministry of Health specifies and meets its responsibilities as manager of the grants and supervisor to ensure that the construction projects are implemented within the total budget framework”.

The regions, as client are, however, still in NAO's focus:

“The regions should throughout the construction process be focused on risk management and ensuring robust and competent building organizations in order to achieve the objectives set for the construction projects within the budget framework.” (p. 3. English in original).

What prompted NAO to reinforce the focus on risk management and budget control among the constituencies was the disturbing news, that one of the largest projects in the program was reported to have a significant risk of going more than 1.2 billion DKK over budget.

The Ministry of Health (Ministeriet for Sundhed og Forebyggelse, 2012) took swift action, used the KPMG (2008) model for project reporting and elaborated upon it to include a traffic light model for how each of the project risks concerning budget, time and quality could be assessed and then stipulated that each project organization should use this standard format and report accordingly on a quarterly basis. During this period, there were also emerging concerns within the project organizations about how to best estimate the risks. A risk manager in one of the projects considered it to be an extraordinarily difficult and uncertain task to estimate risks on a large and complex hospital construction project with a completion time 10 years in the future.

“Frankly speaking, nobody knows if we will be on, below or even twice beyond the budget or more [!]”

Another, and perhaps more damning concern, was the certainty and the rigidity of the authorized budget frame – as if it was being *“made of stone”*. This rigidity was considered to be potentially detrimental for the resulting hospital. Given the uncertainty and complexity of the task and project it would be better to have more flexibility so that the project plan and design could adapt to new and still unknown technological solutions, and social and health trends. This would benefit the new hospital when in operation. But within the budgetary constraints, even if long term operational advantages using alternative technological solutions could be demonstrated using an impeccable investment calculus as support, it would not be possible to negotiate for the extra money. Everything had to be accounted for within the existing project budget, the risk manager explained, while adding that the current risk management set-up appeared to be more about bureaucratic control within the confined space of the project budget and less about the longer term quality, benefits and value for the hospital in use.

However, when the NAO (Rigsrevisionen, 2013) returned with a new status report for the hospitals under construction it was with a somewhat different focus. The focus was no longer primarily about the project economy and the risk of exceeding the construction budget, but rather about the longer term ‘total economy’ for the coming hospital in use. KPMG (2008) was again part of the argument, with the NAO (Rigsrevisionen, 2013) reminding the regions about total economy being an important criterion for public constructions since long before the hospital programme. Another reminder concerns the specific requirement for funding, that each project must demonstrate a certain level of increased efficiency and productivity in hospital

operations compared to a cost baseline defined at the point of project approval. NAO thus urged the regions and project owners to calculate the productivity gains and ‘total economy’. But uncertainty is at least implicitly recognised:

“In connection with kvalitetsfondsbyggerierne the possibility of using a calculus of the total economy is limited due to the fixed [budget] frame for each construction, which cannot be exceeded. This means, that the regions can only implement solutions that are possible within the allocated [budget] frame” (p. 31 Translated from Danish).

The NAO seem to express the concern that the longer term total economy of the hospitals 'in use' might have to pay for the rigidities associated with a ‘fixed’ construction budget at the commencement of the project. It further appears that the rigidities of the risk control set-up the risk manager at one of the projects warned against two years earlier, was about to return back to NAO as an emerging and quite complex issue about risks produced by the current risk management system itself. Although still framed in terms of the need for budget control and classic risk management, the issue of uncertainty and lack of flexibility over the long term has re-entered the discussion.

RISK MANAGEMENT IN THE DANISH EUR 3.2 BILLION RAILWAYS “SIGNALLING PROGRAMME”

In 2006 the Danish Ministry of Transport, encouraged by the Danish Ministry of Finance, implemented new formal requirements for dealing with uncertainty on large transportation infrastructure projects. As with the later hospital projects the Danish Ministry of Finance had grown tired of repeatedly having to deal with cost overruns on large infrastructure projects (Finansministeriet, 2010). In an attempt to avoid this, formal risk management was introduced to support management accounting control practices (Transportministeriet, 2006). In contrast to the hospital projects, however, successive calculation was banned as the Danish Ministry of Finance and the Danish Ministry of Transport blamed this principle for leading to inaccurate cost estimates (Finansministeriet, 2010). Instead, they emphasized that budgets had to be produced using known prices and quantities and a fixed contingency reserve of 30 percent had to be added on top of that. As this was only to be granted under strict requirements, however, formal risk management was introduced so make sure that uncertain events were dealt with so that project objectives could be achieved with greater certainty.

The Danish Ministry of Finance and the Danish Ministry of Transport, however, were unfamiliar with how to approach the construction of these new practices; they needed therefore to test this somehow. At that time, the need for a total replacement of the Danish railways signalling equipment was at hand. In the years leading up to 2006, the Danish railways signalling equipment had been decaying to the point that train operation was regularly being affected (Booz Allen Hamilton, 2006). Also, the National Audit Office had been criticizing the management accounting practices of the state-owned enterprise that manages the rail infrastructure, Rail Net Denmark, for being unsatisfactory (Rigsrevisionen, 2002, 2004, 2005). As parliament decided to approve of the total replacement of the signalling systems that same year - what was later to become the Signalling Programme - the Danish Ministry of Transport and the Danish Ministry of Finance saw this as a clear business case for implementing formal risk management for the first time.

The Signalling Programme runs from 2009 until 2020/21 and has been separated into three main subprojects; the regional lines west, the regional line east and the Copenhagen mass transit system. It has been approved with a EUR 3.2 billion total

capital cost budget and employs the first holistic practice of risk management to be attempted with large transportation infrastructure projects in Denmark. It employs on average more than 120 people whereof at least two-third of these are externally hired consultants. It uses the best practice approach to risk management as defined by the Project Management Institute, which has come to be the best-practice approach to be applied across the Ministry of Transport's domain (PMBOK). This means that it draws upon a cause-and-effect based logic where actors have to define those events that have either positive or negative effects on the project's objectives; utilizes the commonly used "*traffic light assessment matrix*" where risks are assessed using the probability times consequence logic; requires risk reducing actions to be undertaken and then compared to that assessment; and for them to be monitored, controlled, and reported on throughout the lifetime of the programme. It further enforces the use of a very complex IT-based management control system so to calculate risk values and allow for a decentralized use by project managers while still maintaining a centralized control by a few actors. It builds on the logic of setting a risk appetite and then comparing the calculated risk value against this so to make sure that, at worst, this value stays below the 30 percent contingency reserve included in the budget. It has been argued by several key actors, however, that the purpose is more to show reducing values than to actually compare this against the contingency reserve as risk value estimates rarely compare with budgeted and actual cost.

The practice (the programme) has been described as very successful by the Ministry of Finance and also those involved find it very useful. The case, however, reveals that several problems exist with this practice. One of these is that even though you include risks into the control system and agree that this poses a threat against the objectives of the programme, sometimes you cannot do anything about it. This was evident when one of the very large Danish entrepreneur companies went bankrupt. This event sent ripples throughout the sector as many smaller contractors employed by this company, Pihl and Son, were brought down with them. In the Signalling Programme this had been taken into consideration but to actually reduce this risk to zero, this would have required that contracts had been prepared with other large entrepreneurs, who then would have had to sign them so to avoid delays incurring. If this had been done it would have cost millions, and since no one expected this to happen, it seemed like an extreme measure to take at that time. It did help to create awareness of the possibility, and slack had been included in the schedule to deal with such events, but it did not decrease the costs that were subsequently incurred when a new contractor had to be found. As it turned out, everything worked out as the programme did have adequate time scales to deal with such unexpected uncertainties, but it has resulted in compressed deadlines so that further uncertainties incurring could topple the house of cards and thus points the problem: did the use of risk management, and the investment in risk management tools and practices, actually reduce any costs in this case?

Another unexpected consequence refers to the fact that only those uncertainties that can be described using the before mentioned cause-and-effect oriented logic can be included as a risk – but that require a high degree of existing, validated knowledge, which rarely exists on unique projects running over long period of time. On multiple occasions this had led to frustration from the project managers as they have not always been able to produce justified explanations. As the project runs for approximately 12 years and thus could be prone to many unexpected events, removing any ability to accommodate the gut-feelings, hunches, and intuition of actors with years of experience seems in itself risky. In one example, a project manager was very sceptical

of a newly signed contract with a supplier because he knew from experience that this supplier always makes mistakes. However, this was excluded as it could not be accounted for within the risk management system. Two years later, that same supplier made a significant design mistake that made the signalling hardware too heavy, several trains were grounded and new timetables with reduced train operations almost had to be made which would have caused a major media scandal.

This relates to another situation; namely that once the initial project description has been made and the budget approved, the practice of risk management focuses on this now fixed capital budget – and not the effects of their work on the later operations budget. This means that the practice only accepts those risks into the system that can be referred back to the initial capital budget. The quality or long term suitability of the budget, the effects its design has on later maintenance and operation – and not least the effects on other entities such as train operators - are excluded as risks within the programme. As an example, at one risk management meeting, a safety manager was discussing with a head subproject manager about raising the impact assessment of a certain risk because new events, as he argued, had caused them to face even more uncertainty than before. The head subproject manager found this to be straight up ridiculous as such a high assessment just seemed unrealistic. The two participants continued to discuss this but the situations seemed deadlocked as no one was willing to agree with the other party. At that time the safety manager had not mentioned that the impact would be on later operations. As the head manager during the debate suddenly became aware that the reason for the proposed higher assessment related to this, the deadlock was broken, because now he could explain to the safety manager that because the practice focused on the objectives of the programme and not later operations this higher assessment was irrelevant for the programme. The safety manager looked surprised but as the head subproject manager's words were backed by a risk consultant participating, who explained him that that was the rules of the practice, the discussion was cut short. In short, this situation illustrates that when risks have effects on anything else but the capital budget (or the chances to meet this), such as later operations, they are excluded from the practice as risks, and ignored.

CONCLUSIONS

Three tentative conclusions spring to mind when examining these brief case descriptions. The first involves what gets lost through the enforcement of rational risk management processes. From the inability to include the ‘hunches’ of experienced engineers in the signalling case, to the threat of losing sight of the longer term value of the hospital projects as the rigidities of budget and risk control close off more ambitious future oriented thinking, relevance is lost and the hot cognitions and opportunities for foolishness are reduced. The second concerns the problem of a focus on identifying the responsibilities for specific risks, promoting a short sighted and self-interested approach to management, as seen with the dismissal of operational risks as unimportant for the delivery of the capital programme in the signalling case. Both of these conclusions suggest the partiality of existing risk management practices, and both represent in themselves potential longer term threats to the societal and economic value of the projects. Our third conclusion is that both cases involve the application of calculative practices to very uncertain contexts. We are not necessarily dismissing the utility of existing risk management practices, but it does need to be recognised that this is a practice of trying to rationally calculate under uncertain knowledge conditions, and that there might be other more inclusive ways of thinking about risk and uncertainty. We began this paper with Callon’s reminder of what

uncertainty is – something we do and cannot know. Embracing and responding to this in ways which complement more instrumental notions of risk management may have significant implications for risk management practice, but also produce significant benefits for the delivery and overall value of large infrastructure projects.

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AN ILLUSTRATION OF THE DEVELOPMENT OF A STRATEGY FOR EVALUATING THE DESIGN OF HOSPITALS WITHIN A PRACTICE ORDER NETWORK

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This paper is part of on-going research that is investigating the potential of a practice theory perspective to understanding stakeholder evaluation of hospital design. Practice theory offers numerous affordances, especially to researchers and practitioners who seek alternatives to the problematic assumed universality of other 'traditional' theoretical perspectives. However there are several disagreements left unresolved in the literature about practice theory methodology that risk compromising its full potential. Drawing on Schatzki's notion of site ontology and illustrated by an on-going ethnographic study of the practice of evaluating the design of a major UK National Health Service (NHS) hospital, this paper seeks to contribute to resolving such disagreements by developing a strategy that generates a methodology for use with practice theory. The strategy is based on the premise of ontological salience and phenomenological congruence. Arguments for the mobilisation of a pluralistic portfolio of methodologies, methods and the synthesis of a pair of analytical devices ('design evaluation as practice' and 'design evaluation in practice') that emerged from the application of the strategy are explored. Dialogical reflexivity is foregrounded as a further and essential part of the strategy. The paper elucidates and enhances both the praxis and practices stimulated by current approaches to design evaluation. It raises important implications for the future development of UK Government policy to substantively improve the design quality of NHS healthcare building sand, in turn, improve patient healthcare outcomes.

Keywords: methodology, practice theory, design evaluation, pluralism, dialogical reflexivity.

INTRODUCTION

The continuing failure of large publicly funded national building, infrastructure and IT projects has led some commentators to conclude that such projects "*never go according to plan*" (Financial Times, 1999). Critical authors from the so-called 'Scandinavian School' (Hodgson and Cicmil, 2006, p. 11) identify the lack of empirical studies and other alternative representations of 'projects' together with the assumed universality of project management theory as major deficiencies even in the improvement efforts made to address such failures.

Such deficiencies are also encountered by United Kingdom (UK) National Health Service (NHS) organisations that have experienced design quality failures in their hospital building projects.² They too have implemented important policy-based

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² For example, see Prasad in Macmillan (Macmillan, 2004, p.176).

regimes that seek strategically to improve design quality. Current UK NHS Design Quality Policies³ mandate the use of objectified and positivist design evaluation instruments to capture stakeholder views. However these policy improvement efforts have been critically analysed and weaknesses have been identified that also resonate with those identified by the Scandinavian School in relation to project management failures (O'Keeffe et. al. 2012).

This paper is part of on-going research that is being undertaken to investigate the potential of a practice theory⁴ perspective as an alternative representation and theoretical approach for improving the design quality of hospitals to the above policy-based regimes. Practice theory affords the potential to mobilise a radical alternative theoretical perspective that avoids many of the irreducible dualisms (such as actor/system, social/material, body/mind, and theory/action) used to describe the social world that remain unresolved in other traditional perspectives (Nicolini, 2013, p.2). Since the 1990's its use is increasing across many organised activities⁵(Reckwitz, 2002; Schatzki, 2002; Schatzki *et al.*, 2001).

Because practice theory can grant these affordances, it may hold promise and is likely be of particular interest to those researchers and practitioners who take a critical perspective, drawing on critical management studies within a wider organisational and societal context (Hodgson and Cicmil, 2006) and others who continue to find themselves dissatisfied with traditional theoretical perspectives. However, despite these affordances, the literature on methodology⁶ for use with practice theory remains nascent and contested (Schatzki, 2002; Hirschauer, 2005; Halkier *et al.*, 2011, p.6 ; Nicolini 2013). This is a matter of concern; left unresolved such uncertainties might affect the potential of practice theory as an alternative theoretical perspective.

Specifically, this paper seeks to contribute by addressing this concern. At its core, the paper provides an argument for a strategy that oversees the reasoning and process used to generate methodology for use with a practice theory. Because it is regarded as a pre-requisite for any qualitative enquiry, the strategy is based on notions of congruence and salience. Salience is defined as the need to ensure that the methodology fits with the assumed ontology and with the resultant epistemic consequences of the overarching practice theory perspective (Dainty, 2008, p.3). Adopting Richards and Morse (2002. p.34), congruence is defined as the need to ensure that the methodology fits with the research aims, questions and is sensitised (Blumer, 1969) to the characteristics of the phenomenon being studied. The paper illustrates the development of such a strategy of salience and congruence (hereafter 'the Strategy') and its consequences by reference to empirical findings that have emerged from the study of the practice of evaluating design for a major new NHS hospital.

3 Typified by NHS Scotland's Design Quality Policy CEL (19) 2010, available at http://www.sehd.scot.nhs.uk/mels/ce12010_19.pdf [Accessed 26th September, 2013].

4 Also variably referred to in the literature as practice standpoint, practice lens, practice idiom, practice order and practice based approaches (Corradi *et al.*, 2010).

5 For example published studies in cooking, telemedicine, teaching, business strategy, hiking, family photography, consumer studies, information transfer studies, herb production, and on-line trading to mention but a few.

6 For the purposes of this paper a methodology is defined as coherent research study framework that sits above and governs specific methods proposed to collect data.

THE HETEROGENEITY OF PRACTICE THEORIES

A distinguishing feature of all practice theories is that they are all, to some extent at least heterogeneous: there is no such thing as 'a' unified, single corpus of practice theory (Schatzki *et al.*, 2001, p. 11) which is not without contested views (see Turner, 1994). This fact has at least two important methodological implications in relation to the Strategy. First is that a single 'one size fits all' methodology, or even a set of methodologies, cannot be used generically with practice theory. Second is that the heterogeneity of practice theory creates the opportunity for a 'programmatically' (Nicolini, 2013, p. 215) methodological approach; in that an eclectic portfolio of different methodologies can be applied in combination in the field in response to a reflexive understanding.

METHODOLOGICAL CONSIDERATIONS IN RELATION TO SALIENCE

Building on insights from Wittgenstein and Heidegger, Schatzki has "*offered one of the more explicit and clear illustrations of the implications of a practice-based approach*" (Nicolini, 2013, p.163). He provides two clearly expressed notions of practice: first that practice is "*temporally unfolding and spatially dispersed nexus of doings and sayings*" and secondly the notion of "*practice is that of a performing an action..*" (Schatzki, 1996, p. 89-90). It is for this reason of clarity (i.e. about what a practice is and what it is not (Cox, 2012, p. 2) that Schatzki's assumed ontology⁷ (hereafter ontology) - as carefully explicated in his book 'The Site of the Social' (Schatzki, 2002) - is used. According to his ontology the understanding of design held by the stakeholders involved in design evaluation is co-created and transpires amid an elaborate, constantly evolving, (both temporally and spatially), nexus of arranged things and organised activities. The scope of Schatzki's ontology can therefore be seen as radically different to the much narrower view of design evaluation implicit in NHS policies. This consideration of site ontology has at least three significant epistemological consequences for evaluating design: first, it means that we can, within the site (e.g. in the context of evaluating design), scrutinise the knowing and the lived experience of the knowing (its phenomenology) as a series of distinct moments of the practicing without assuming them as separate. In other words, knowing and practice can be seen as ontologically equivalent, inextricably linked as constituting one another but also as analytically different: the practice being the backdrop against which the other - the knowing - emerges.

Second is the role of individualism. In Schatzki's words "*this [i.e. his ontology] contravenes individualism in holding that actions, groups, and constellations of individuals exist in the social*" (Schatzki, 2002, p.141; emphasis in original text). As such, the unit of analysis for researchers who want to use practice theory for evaluating design should not be individual design skills or knowledge but the practice under consideration.

The third, and indeed distinguishing, feature of Schatzki's site ontology from other contemporary practice theories (and a feature in common with Heidegger and Wittgenstein) is the centrality granted to intelligibility in human affairs. All of these authors subscribe to the fundamental view that, at all times and always, and manifest

⁷ Schatzki is careful to point out that ontologies only describe "basic characters, compositions and structures" as an assumption of reality and that ontologies do not explain social phenomena - but they may act as an explanatory resource and can ground pronouncements (ibid. p. xvi): hence the use of the term 'assumed ontology.'

as part of an on-going practical activity, people mostly do and say whatever it makes sense for them to do (and say). Schatzki's precise term for this essentially anthropological trait of humans is 'action intelligibility' or 'practical intelligibility' (used interchangeably): "*the articulation of action intelligibility is the specification of what makes sense to people to do*" (Schatzki, 1996, p.118). Schatzki further adds that practical intelligibility is not the same phenomenon as normativity. "*What makes sense to someone to do is not the same as what is, or seems to the actor to be, appropriate, right or correct*" (Schatzki, 2002, p.75). This distinguishing feature of Schatzki's ontology is reflected upon in the observed behaviour of the participants as set out in the early empirical findings below.

According to Schatzki's ontology, to say that the doings and sayings that comprise a practice constitute a nexus is to say that they are linked according to four "*avenues*" (Schatzki, 1996, p. 89) of linkages: practical understandings,⁸ rules,⁹ teleoaffective structures¹⁰ and general understandings¹¹ all of which characterise the social site through which the practice emerges. All of these avenues provide a basis for analysis, and the avenue of teleoaffective structure has a significant methodological implication. Its temporal and spatial implications for reflexivity require any exploration of evaluating design inevitably¹² to take into account other social phenomena (e.g. other practices and actions at different times and settings) that influence and arrange its manifestation and the outcomes this practice of evaluating design produces. Referring back to the heterogeneity of practices, this observation also has further epistemological significance: it means that a pluralistic methodology will almost always be necessary when undertaking an empirical study of a practice. Furthermore, and as pointed out by Nicolini, this has another "*far-reaching implication [....]. To understand social life as it happens, it is not enough to grasp its real-time happening. One has to grasp what is not happening*" (Nicolini, 2013, p.167). Consistent with its Heideggerian traditions of coping with present circumstances, this implies that, to understand what is actually going on, also requires, to some extent, an understanding of what else could have happened. The epistemological considerations of spatiality, temporality and reflection upon the methodology will be revisited in further discussion below.

Introducing new analytical devices: design evaluation as practice and design evaluation in practice

The above epistemological consequences of adopting Schatzki's ontology are now synthesised into a pair of analytical devices: 'design evaluation as practice' and 'design evaluation in practice;' both of which occur within the practice of evaluating design as part of a wider network, or practice order of practices. The epistemological concern of design evaluation as practice is: what and how can we know what goes on during the actual practice of evaluation? It refers to '*the here and now*' of it as it happens. The epistemological concern of design evaluation in practice is: what and how can we know about the connections between the practice of evaluating design and other related practices? It refers to '*the elsewhere and when*' as part of, to use Schatzki's

8 For example knowing how to do things like reviewing design drawings and proposals.

9 For example explicit formulations that direct how evaluating design is done.

10 For example the overarching purpose, mood or feelings that are linked to the tasks that comprise evaluating design.

11 These are reflexive understandings of the overall project in which the people are involved and contribute to practical intelligibility hence action - for example in the design evaluation of a hospital the general understanding that the design of the hospital will impact on how the hospital can be used to treat patients.

12 On the premise that no single practice can operate entirely in isolation.

terminology, a 'network' of practices taking place in other spaces at the same or at other times during the course of the design development thus emphasising the spatiotemporal dimension of practice.

METHODOLOGICAL CONSIDERATIONS IN RELATION TO CONGRUENCE

Relating the Strategy to congruence requires consideration of the compatibility of the methodology with the research aims and the research questions, as well as the prominent characteristics of the phenomenon being investigated, as the awareness of them improves. This position has been informed by three principal assumptions briefly outlined as follows.

First is an assumption that the practice of evaluating a design within a large NHS project is, by definition, a complex affair subject to numerous external constraints. As a public-sector project, the Project's principal constraints manifest themselves as matters of affordability, value for money, compliance with established technical and health and safety standards and regulations and overall delivery timescales.

Second is the assumption that practice cannot be simply regarded as "*just what people do*" in some unmediated way: such a notion is a merely a return to a naive form of empiricism (Schatzki *et al.*, 2001). Careful consideration, therefore, of matters that are suspected of mediating the practice of evaluating design is required. Such matters considered in the study to date include:

The architectural motto of 'form follows function' requires the clinical adjacencies of distinct departments to be considered and how, the flow of patients, visitors, staff, supplies and waste are separated.

The issue and implications of the public accountability that impose strict budgetary, value for money, affordability and business case considerations. These frame the project team to "*qualculate*" (Tryggestad and Georg 2009, pp. 970-971) the concept design by actively managing the social relations and expectations of stakeholders when evaluating the design.

Against a background of NHS hospital design being dominated by functionality (Francis *et al.*, 1999) is the body of literature advocating 'evidenced based' design (Ulrich, 1984; Ulrich, 2000; Ulrich, 2005).

The increasingly influential role that visual representations (enabled by BIM, modelling simulation and visualisation technique is such as CAD and CGI. This democratisation is transcending historical boundaries, permitting individual designers to position design evaluation as a continual spatiotemporal social activity distributed amongst the participants and artifacts generated by computers (c.f. Ewenstein, B. and Whyte, J. (2009)).

Finally, the authority and deference granted to senior clinical and medical stakeholders included in the design evaluation team alongside highly experienced design, legal, financial and project management professionals. This observation 'matters' because, in a mutually deficient way, clinicians are for the most part novices in architectural design and, to the contrary, architects are novices in clinical procedures: this can incite demanding requirements for sense-making.

Third is the assumption that praxiographic research has at its centre an observed materiality interlinked with supra-individual social practices. If practices are understood as a 'nexus of doings and sayings' in Schatzki's sense (2002), then

firsthand reports from participants engaged in the practice (e.g. interviews, diaries, fieldnotes, other remarks and personal documents) at different times and settings provide important methodological access in the quest for the meaning that they attribute to their experiences and their developing understanding of evaluating design. In other words, articulating and foregrounding practice requires a material activity and surrounding discursive work that is of itself, another practice. As Nicolini (2009, p. 4) points out, studying practice always requires the scrutiny of two practices at the same time: epistemic practice and the what we are concerned with.

SOME EARLY EMPIRICAL FINDINGS

By way of illustrating the development of the Strategy the paper draws upon the research work undertaken by the authors for an on-going ethnographic study of a large (£250 million / €298 million) new NHS acute hospital project (hereafter 'the Project') in Dumfries, Scotland.¹³ The project is currently in its procurement phase.¹⁴

The following two examples represent some of the thematic content emerging at this point in the ongoing study. It is submitted that they provide instances of what Schatzki calls 'integrative'¹⁵ practices, to illustrate the unfolding complexity of evaluating design.

Role of stakeholder power relations in the practice of design evaluation

Stakeholder power relations have been exercised most notably to date by the more senior hospital consultants. These have manifested initially as verbal exchanges in promoting or presenting their cases for proposed changes in the Model of Care (e.g. the Clinical lead for Women and Children's service announcing in a presentation made directly to the members of a full and specially convened meeting of the Board that "*we are special*"; other examples include 'championing' particular departmental spaces such as Executives promoting the particular needs of a spiritual care centre and well-rehearsed arguments for "*special considerations of office and seminar spaces*".

These displays of power by senior clinicians also indicate that space, and in particular clinical space, is regarded protectively as a territory and marker of professional boundaries and not as merely a resource. As such these findings resonate with the recent accounts of such matters (Wagner *et al.*, 2002; Wagner, 2006; Marcum, 2013) and also those accounts of both the oft-strained relationships between doctors and managers and those of the identity of doctors working within hospitals (Konteh *et al.*, 2011; Davies and Harrison, 2003).

It is suggested that these micro-struggles and displays of power relations serve as a reminder that evaluating design cannot be regarded conclusive at any given point and that design evaluation in practice continues to be an "*unfolding ontology*" (Knorr Cetina, 2001, p. 190).

Manifestations of practical intelligibility and 'arresting moments'

Relations between the design evaluation practitioners have been observed generally as episodic enacted dialogically through generative encounters. However on numerous occasions these have been disputed by 'arresting moments' (Cunliffe 2001, p. 358;

¹³ The Acute Services Redevelopment Project, the largest hospital project within the Scottish Government's innovative Non-Profit Distribution (NPD) Programme, see <http://www.scottishfuturestrust.org.uk/our-work/funding-and-finance/non-profit-distributing/> [Accessed 26th September, 2013].

¹⁴ See <http://www.bbc.co.uk/news/uk-scotland-south-scotland-24110838> [Accessed 26th September, 2013].

¹⁵ Schatzki categories practices as 'dispersed' or 'integrative' (Schatzki, 1996, 91). Dispersed practices include the practices of describing, following rules, explaining, questioning, examining. Integrative practices refer to those more complex practices found in and constitutive of particular domains of social life.

Beech *et al.*, 2012) in which previously taken-for-granted notions and beliefs become disrupted in the course of evaluating the design. It is suggested that these may represent a manifestation of instances of the practical intelligibility (as defined by Schatzki) of one practitioner acting in challenge to that of another: these instances suggest instances of what makes sense in a taken-for-granted way to one practitioner may not make sense for another. Several instances of such arresting moments have been observed involving design evaluation. Take for example the disruption surrounding the evaluation of the mechanical and electrical (M&E) engineering design.

*...."all M&E engineers designing new NHS hospitals 'over-engineer' their designs"
(Brian- a pseudonym - Head of Estates and Engineering for the Health Board)*

This strident viewpoint represents the manifestation of the position power of Brian's hostile reaction to the use of output specifications and cynicism of design risk transfer: matters that are actually enshrined in the contract documents. As the discussions ensued he was increasingly convinced that the Bidder's M&E designers 'over-engineer' and are complacent and profligate - with notions of "fat-cat" engineers and wasteful duplication being articulated. Observed emotions included distrust of the Bidder's M&E engineers coupled with a tangible resentment of being divested of design responsibility; being highly defensive and ultimately displaying a stubbornness and reluctance to accept the proven expertise of Bidder's M&E designers. Tactics used to press his viewpoints included the use of isolated incidents of over design from earlier entirely different projects procured by the Health Board based on entirely different procurement routes. Furthermore these 'concerns' were articulated to non-technically qualified but highly influential stakeholders such as the Project Sponsor.

Another example relates to strongly entrenched views held a key member of the Board's maintenance staff evaluating the design in relation to flat roofs and external drainpipes.

...." I don't care what the bidder's want or how good they think they are at building flat roofs - we don't want them - it's not them that has to face the Chief Executive later on"

Tactics included again the use of position power to influence others and again citing examples of problems with older projects coupled with an outright rejection of modern construction methods or the acceptance of design risk transfer. In both of these instances of 'arresting moments' further reflection and discussion ensued that eventually ameliorated these polarised positions - in summary what was observed is conflict and emotional tension between practitioners may serve as a catalyst for new insights and potential for new knowledge.

REPRESENTING THE DATA: EPISTEMIC CHALLENGES ENCOUNTERED

A challenging ethnographic consequence of the Strategy is the task of analysis and the subsequent representation of the data. Since October 2012, in terms of data gathering, a total of 60 such events and meetings ranging in duration from about 30 minutes to four hours have in aggregate been collected by the researcher together with eight interviews and review of numerous artefacts and documents and a research diary. To date, Czarniawska's (2007) narrative approach has been adopted to produce a succession of short vignettes to illustrate themes that have emerged recursively from the data. These vignettes are framed by a prologue: the objective being to provide, not

only a rich-picture and insight into the 'world of evaluating NHS hospital design' but also a nuanced view of the dynamics of evaluating design represented by observations of decision making and how decisions are shaped and reshaped as the relationships between the stakeholders unfold.

DISCUSSION

At its core, the Strategy foregrounds notions of congruence and salience to generate the reasoning and process by which methodologies and methods are developed to enact the particular practice theory perspective. The Strategy leads a reflexive multi-dialogical approach, not as detachment from, but as engagement in the means of acquiring knowledge. Early empirical findings from the Project are contributing to the research aims by revealing insights through these dialogues in terms of (amongst others) power relations between stakeholders and instances of arresting moments. To date the settings have been grounded in and constrained by the procurement phase with both bidders. As the study progresses the prospect of working with a single-bidder, in contract, to finalise design evaluation will afford another empirical opportunity to compare and understand the influence that a different teleoaffective structure and spatial setting may have on the practice of design evaluation.

As analytical devices, design evaluation as practice and design evaluation in practice transcend some of the deterministic and reductionist shortcomings of the current NHS design evaluation. Conceptually, this analytical approach represents an application of Schatzki's practice theory to evaluating design. Empirically, they let the researcher see how evaluating design is practically and relationally done, re-done and perhaps slightly re-done again as it is situated, at different times and settings; capturing a multiplicity and variety of ways and performances of the participants during the development of the hospital design.

Moving to consider the implications of this work for wider practice, at least two questions emerge. First, could the Strategy be extended beyond the confines of the observed NHS hospital project? As the unit of analysis is the practice of evaluating design the answer is arguably yes if the researcher remains attentive and sensitive to potentially different spatiotemporal characteristics the phenomenon and concurrent practices (e.g. the type of hospital project; the procurement route, the constituency of the participants). Second, what research implications does the Strategy have for those considering its use? Certainly the likely period of time required for access to and immersion in the field may present challenges for researcher-practitioners. The researcher-practitioner’s pre-understanding and ‘insider’ status and their ability to influence organisational politics may warrant debate through which the researcher-practitioner resolves the political framing of practice-theory research project within the host organisation, including balancing that organisation’s justification for granting access, with the researcher-practitioner’s personal research ambitions.

CONCLUSION

Qualitative forms of inquiry are considered by many to offer as much a perspective on how to investigate a particular research problem as it is as of a particular research protocol. As illustrated by the Project, empirical investigations that mobilise practice theory ontologies are likely to be emergent. As understanding deepens and situations unfold the researcher may wish to avoid rigid designs that eliminate responsiveness so that they can pursue new paths of discovery as they emerge: the Strategy as presented has this flexibility.

The works extends approaches that advocate methodological pluralism in forms advocated by the likes of Nicolini (2013) beyond theoretical considerations. The Strategy suggests that a form of methodological pluralism structured around multiple reflexive dialogues is required in addition to methodological pluralism.

Further implications and potential limitations of the Strategy in relation to the challenges such a Strategy presents to a researcher- practitioner have been highlighted. The Strategy has the potential to mobilise new insights and sense-making to the participants involved in evaluating design not afforded by the sole use of the current NHS design evaluation policy. The Strategy has the potential to be used in other areas of empirical investigation and this may encourage the wider use of a practice-theory based empirical research as an alternative theoretical approach. Perhaps in the future the reasons why large publicly funded national building, infrastructure and IT projects fail can be better understood by the mobilisation of such a practice theory methodology; thereby reducing the current trend of commentators to conclude that such projects "never go according to plan".

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CHANGING PARADIGMS IN CONSTRUCTION COMPETITIVENESS RESEARCH

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In the construction industry, every company has to apply some kind of strategic solutions in order to maintain their competitiveness. Although there are variety of discussions of what is the meaning of ‘competitiveness’ and ‘strategy’ keywords, in generic terms while the competitiveness means gaining advantage against rivals, strategy refers the actions that provide competitiveness. Construction management literature is abundant in researches, which evaluate the competitiveness strategies of construction industry organizations, however, they approach the “competitiveness” concept from variety of theoretical backgrounds and methodological perspectives. There is a requirement for a systematic summary of the literature in order to demonstrate the changing paradigms in competitiveness research. Therefore, the aim of this paper is to analyse and identify the changing paradigms in construction competitiveness research by utilizing meta-analysis methodology to six leading construction management journals from 2000 to 2014. Findings of the research will clarify how the research focus, level of analysis, sources of information, contribution of papers, author orientation and utilization of different schools of thoughts have changed in time and how future directions could be designed in construction competitiveness research.

Keywords: competitiveness, corporate strategy, meta-analysis.

INTRODUCTION

Construction management literature is abundant in researches, which evaluate the competitiveness strategies of construction companies from variety of perspectives. However, recent discussions call for a fresh perspective in competitiveness strategy research (Green *et al*, 2008a; 2008b). Most authors have not only discussed the ‘competitiveness’, ‘strategy’ and ‘performance’ keywords with referring to generic competitiveness strategy theories but also utilized them in their research without discussing the reasons why they have based their research on this particular theory. Although there are different theoretical perspectives in ‘competitiveness’ and ‘strategic management’ literature, most papers have analysed the research question from the perspective of a single theory, applied positivist methods, and suggested generic competitiveness indicators or indexes for company competitiveness. However, some recent studies indicate the benefits of holistic research approaches in which data is gathered by in depth analyses and analysed within the light of multiple research theories and techniques (Green *et al*, 2008b). Since, the competitiveness strategy theories are developing in line with the changing trends of today’s business and management systems, construction management scholars should study these changing

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paradigms and develop new competitive agendas. Therefore, a systematic analysis of the articles in referred academic journals could help the researchers to gain a wider perspective of the field quickly and make further advancement in the chosen topic.

Academic journals are the key sources where the academic debates take place and the knowledge development process of a specific research subject could be observed (Betts and Lansley, 1993). For this reasons, it would be valuable to use meta-analysis as a research methodology in order to examine academic studies on competitiveness research in construction management literature. Meta-analysis, by providing ways to examine published studies on the chosen topic, will be used to integrate results from individual studies for the purpose of integrating the research findings (Betts and Lansley, 1993). As far as the scope of this paper is concerned, it intends to analyse research inclination and identify the potential research gaps on the subject of competitiveness in the construction industry.

RESEARCH METHODOLOGY

As a sizable body of research results on competitiveness in construction has accumulated, it becomes increasingly difficult to find which research direction is most important and whether a definite conclusion can be reached. For this reason, inspired by the meta-analysis concept, we employed a structured approach to review the competitiveness studies in construction management literature from six leading construction-related journals. The approach employed in this study is composed of the following steps:

1. Defining the research question: Where is the pattern in current competitiveness research in the construction industry? On what common structure are those consigned with understanding construction competitiveness?
2. Conducting the literature review: The articles related to competitiveness from 2000 to 2014 were analysed in terms of countries of origin, content (research focus, level of analysis), style (sources of information, contribution of papers) (Betts and Lansley, 1993), and school of thoughts introduced in the studies.
3. Research Trend Analysis: This step consists of identifying trends for the research topic chosen (tendency in theoretical background selection).
4. Interpretation of results: The results of the literature review are evaluated with respect to research thrust.

DATA ANALYSIS AND RESULTS

After defining the research question, a set of inclusion and exclusion criteria was drawn up to undertake a literature review. A search with the keywords derived from "*compete*" was conducted at the search engines of selected journals (Journal of Construction Engineering and Management (JCEM), Construction Management and Economics (CME), International Journal of Project Management (IJPM), Building Resource and Information (BRI), Journal of Engineering in Management (JME) and Engineering, Construction and Architectural Management (ECAM) in a fourteen years' time period (2000-2014). Following this, an abstract review of the papers was conducted in order to see whether they are directly relevant to the topic of the meta-analysis or not. After the grey literature papers were excluded, a total of 122 papers were identified as being published in the selected eight construction journals. The meta-analysis started with presenting the number of articles from each journal publisher by their publication years. Clearly, as Table 1 shows, within the studied period, the journals CME, JCEM and IJPM have published the highest number of

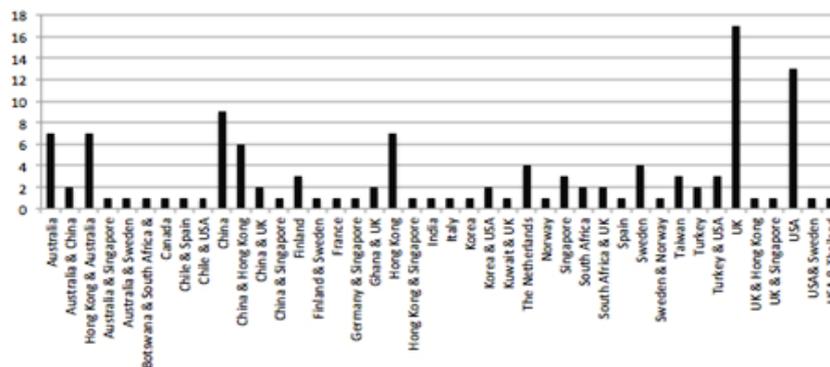
competitiveness papers, respectively 39, 26, and 26. The number of competitiveness papers published in CME is much higher than any of the other selected journals, providing the greatest contribution to competitiveness studies in construction. Besides, the statistics in Table 1 show that the selected journals published 18 papers in 2013; the highest point during the studied period and competitiveness has received attention in construction management literature throughout the selected time period.

Table 1: Chronological Distribution of Articles by Journals

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014 1 st Quarter	Total
JCEM	0	0	1	1	2	2	1	0	2	2	6	2	3	3	1	26
CME	3	3	2	1	2	1	2	3	5	6	5	0	2	4	0	39
JME	1	1	1	0	0	1	0	1	2	0	0	2	1	3	0	13
IJPM	1	2	1	1	2	0	2	1	2	2	1	1	1	7	2	26
ECAM	1	0	0	2	0	0	2	0	0	1	1	1	1	1	1	11
BRI	1	0	1	0	2	0	0	0	2	1	0	0	0	0	0	7
Total	7	6	6	5	8	4	7	5	13	12	13	6	8	18	4	122

Country of origin analysis shows that authors from 27 different countries were involved in competitiveness research. The countries that dominate competitiveness research in construction management are UK, USA, China, Hong Kong, and Australia. Results revealed that 41 papers (%34) involve a collaborative study of the authors from different countries. Among them, Australia & China and Hong Kong & China realized the highest number of collaborative study. The reason could be attributed to their geographical proximity, emerging economic developments in these areas and their active role in international construction sector. Increasing volume of collaborative studies could provide comprehensive analysis with introduction of different local parameters and interpretations from fresh perspectives. Figure 1 indicates that although some countries have dominated the competitiveness research, it has also gained attention from the countries in Europe, South Africa and Asia as well as Canada.

Figure 1: Country of Origin Analysis of Competitiveness Research

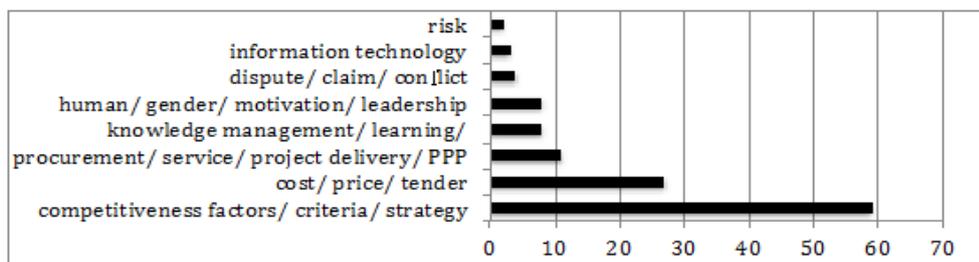


Content

Content analysis focused on two main sub-categories as research focus (subject) (Figure 2) and level of analysis (Figure 3). Distribution of articles by *research focus* revealed that the articles could be classified under eight main research area as (i) competitiveness factors/ criteria/ strategy, (ii) cost/ price/ tender, (iii) procurement/ service/ project delivery/ PPP, (iv) knowledge management/ learning/ education, (v) human/ gender/ motivation/ leadership, (vi) dispute/ claim/ conflict, (vii) information technology, and (viii) risk. Figure 2 portrays that the majority of the articles focus on

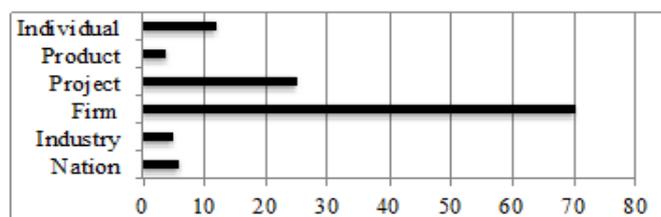
the *Competitiveness factors/ Criteria/ Strategies* with the number of 59 studies (%48 of total articles). Most of the articles within this group intend to explore how competitiveness is gained in construction market and explain according to what factors a specific geography/ country or sub-sector could gain competitive advantage over its rivals (i.e: Zhao & Shen, 2008; Deng *et al*, 2013). 27 articles (%20 of total articles) examine the competitiveness from *Cost/ Price/ Bid/ Tender* perspective, and most of them discuss the competition of contractors on the tendering phase (i.e: Fu *et al*, 2002; Yuan, 2012). Next, *Procurement/ Service/ Project Delivery/ PPP* subject involves 11 articles and the papers within this category mostly deal with the competitiveness in procurement phase. 8 articles focus on *Human/ Gender/ Motivation/ Leadership* subject and they discuss the competitiveness from the perspective of psychological capital, women, discrimination, coordination, and project management. 8 articles in the *Knowledge Management/ Learning/ Education* section deal with the issues related to innovation, education, learning, knowledge management and networks. There are 4 articles in *Dispute/ Claim/ Conflict* subject area and the papers focus on contract laws, penalty, disputes in partnerships, and change orders. *Information Technology* subject involves 3 papers, which discusses the software and web technologies in relation with competitiveness. Finally, 2 papers fall into the research category involving *Risk* related issues such as risk attitudes and risk allocation of contractors.

Figure 2: Distribution of Articles by Research Focus



The second part of the content analysis focuses on *level of analysis*. A four level of analysis, involving nation, industry, firm and project were adopted from Flanagan *et al.*'s research on competitiveness (2007). After the review of selected papers this four-level analysis was extended to a six-level analysis with the addition of individual and product levels. Figure 3 reveals that the most common level of analysis on which the competitiveness papers focused is firm level (57%), followed by project (20%), individual (9%), nation (4.9%), industry (4.1%), and then product levels (3.28%). This tendency for the levels of analysis contradicts with the view that competitiveness can be considered a multidimensional construct and requires multiple levels of analysis, which complement each other (Osarenkhoe, 2010). Yet, it may be argued that the use of multi-level analysis may provide more valuable results than single level analysis due the embedded relationship between individual and society.

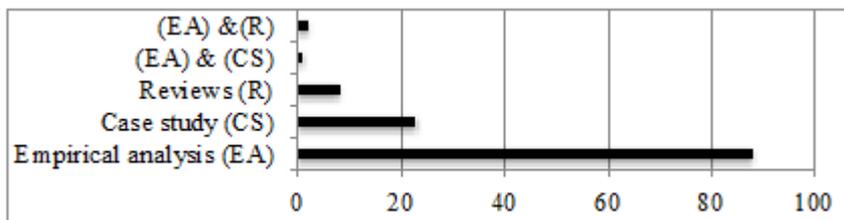
Figure 3: Distribution of Articles by Level of Analysis



Style

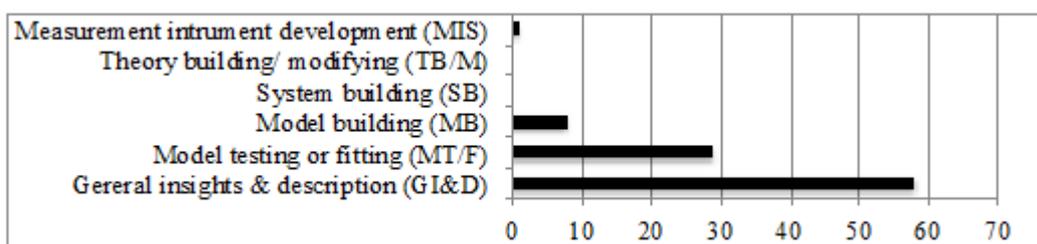
The second part of the meta-analysis focuses on the sources of information (*Figure 4*) and contribution of the papers (*Figure 5*). Initially, studies were analysed in terms of the *sources of information* including empirical analysis (EA), case studies (CS), reviews (R) and combination of them. As seen in *Figure 4*, all sources of information were used in construction competitiveness research. Among them, empirical analysis is the most frequently used method with 88 articles (%72 of total articles). This is followed by case studies with 23 articles (%19 of total articles). While only 8 articles base their research on review method, 2 of them comprise both empirical analysis and review and only 1 of them makes room for both empirical analysis and case studies. The results show that most researchers in construction competitiveness studies do not equally adopt a quantitative or a qualitative approach and that they tend to choose the quantitative approach. Conversely, the qualitative approach increases the researcher's ability to describe a complex social system, and gives a greater guarantee of internal validity of results (Marshall and Rossman, 1989). As such, it would be ideal to assure the greatest validity in results by employing both of these approaches together by means of triangulation (Thietart et. al., 1999).

Figure 4: Distribution of Articles by Sources of Information



As for the contribution of selected papers, they were evaluated in terms of the output they produce such as (i) general insights and descriptions, (ii) model testing or fitting, (iii) model development, (iv) system building, (v) theory building/ modifying, and (vi) measurement instrument development (*Figure 5*). General insights & description comprises the majority with 58 articles (%48 of total articles). 34 articles (%28 of total articles) intend to contribute to the literature with model building and most of them intend to produce critical success factors / key performance indicators or frameworks to explain or manage the competitiveness strategies of organizations /sub-sectors or regions. 29 papers (%24 of total papers) deal with model testing of fitting which means mobilizing one or more school of thought in the research in order to explain the competitiveness. Only 1 of them, which aims to analyse the cost-estimating competencies produces a measurement instrument. None of the papers attempt to contribute by theory building / modifying or system building. This indicates that general tendency is adopting generic competitiveness theories in order to discuss the construction sector competitiveness.

Figure 5: Distribution of Articles by the Contribution of Papers



Research Trend Analysis

The major schools of thought applied in competitiveness are SWOT Analysis (Learned *et al.* 1965), The Strategic Positioning School (Porter, 1980; 1985), Core Competence View (Prahalad & Hamel, 1990), The Action School (Mintzberg, 1990), The Resource-Based view/RBV (Barney, 1991), The Process School (Pettigrew and Whipp, 1991; Pettigrew, 1997), The Dynamic Capabilities School (Teece *et al.*, 1997) and The Practice School (Jarzabkowski, 2005). Figure 6 illustrates how these theories were employed in the papers. The grey areas present the papers that utilize these theories to answer their research questions, whereas the black areas refer to the articles that give place these theories only in literature review section. Results reveal that the Strategic Positioning School is the most referred theory in construction management literature. While 20 articles bases their research on that theory, 20 of them content with referring to it. The Resource Based View is the second most popular theory and referred by 20 articles. Most of the papers referred to RBV in order to analyse endogenous resources that make the companies competitive in the market. Although the action school becomes the third most reviewed theory, only one study prefers using it as a theoretical base. On the other hand, Dynamic Capabilities View (3 of 7) and the Action School (3 of 7) find application as a theoretical base that shapes the competitiveness research design. Results indicate that the utilization of Process School and Practice School are limited in construction management literature. Future studies could mobilize those theories or other current trends (i.e.: network theory) in order to bring fresh perspective in competitiveness research.

Figure 6: School of thoughts in competitiveness research

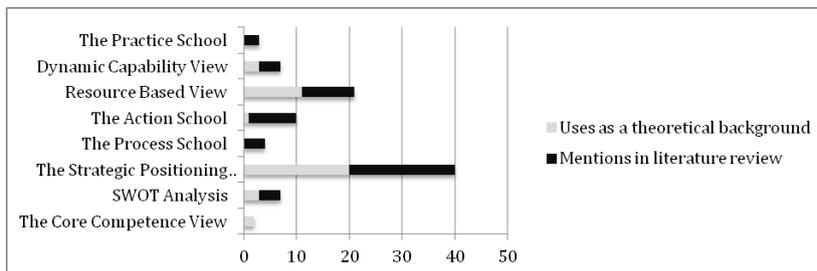
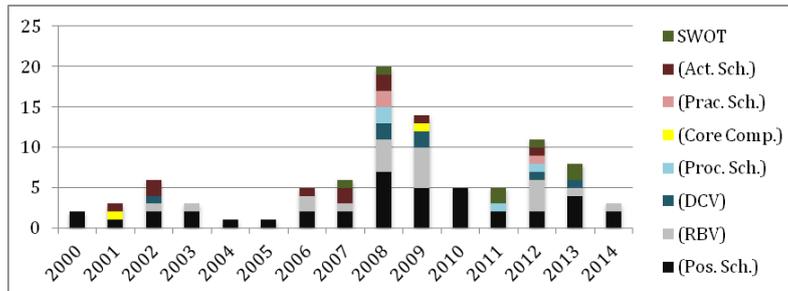


Figure 7 highlights the yearly distribution of the cited school of thoughts in construction management literature. Results show that Porter’s Positioning School is the most commonly cited theory in the given reporting period. The Resource-Based View is the second most frequently cited theory and has found application in most years since 2002. Although the first reference to the Dynamic Capabilities View occurs in 2002, it has gained wide acceptance in 2008 and the following years. It is worth indicating that the application of SWOT analysis in construction competitiveness studies appeared in 2007 despite its early utilization in general management literature since the 1960s. As seen from Figure 7 there is a proliferation in application of various schools of thought in 2008 and 2009. As level of analysis embedded within different theories (or schools of thoughts) -ranging from industry level (Strategic Positioning School) to organization (RBV and DCV) and individual (Practice School) levels- change, the focus of competitiveness research is shifting from industry level of analysis to the organizational and individual level of analysis. However, there is still a gap in individual level of analysis in competitiveness research in construction industry. Apart from the above-mentioned theories, social network theory is gaining importance in construction competitiveness research. Recent studies started to stress the importance of embedded characteristics of business relations and

the impact of social structure in which the company is embedded as well as the characteristics of relations with the external environment. For instance, Kao *et al* (2009) suggested ‘localized learning’ and ‘embeddedness’ as alternative discourses for competitiveness research in construction industry. Besides, Ling *et al* (2012) combined the social network approach with Porter’s strategic positioning school and Sun Tzu’s Art of War in order to analyse the competitiveness components in the Chinese construction industry.

Figure 7: Distribution of thoughts in competitiveness research



With regard to the number of theories involved in the papers, 26 papers explicitly analyse a single theory, whereas the other articles include multi-theory. 11 out of 26 explicitly refer to the theories as a foundation of their concepts and models whereas the remaining articles only refer to the theories in the theoretical literature review. As for the papers employing multiple theories, 10 articles refer to two different theories in their study, however, only 3 of them use both theories as a theoretical background for the empirical study. 7 articles refer to three different schools of thoughts in their study. While one of them mobilized all three theories in their empirical analysis, 3 of them prefer utilizing two theories as a theoretical base for their study and use the third one in literature review section. In short, only a limited number of papers give place several schools of thought in their studies, and few pay attention to a critical discussion of competitiveness theories. For instance, Green *et al* (2008) proposed a comprehensive discussion about the theories that are mobilized in construction management research and suggested ‘indicating the importance of the –context- in which the competitiveness is questioned’ and ‘mobilizing current theories as the constitutes of a broader discourse’.

Here, the important point is that the use of multiple perspectives is more likely to lead on to the rich insights that will most benefit researchers in construction management. Rather than mentioning a specific theory, researchers should go further and carry out a critical analysis of mainstream theories of competitiveness in their methods and approaches. Besides, most researchers prefer using a single level of analysis and single source of information; however, combination of multiple level of analysis and sources of information as well as discussing the research question from the perspective of multiple theories could reveal more comprehensive results. Despite all changes in industry dynamics and business models, it is interesting to note that Porter’s positioning school dominates the competitiveness research in construction management literature. In fact, above-mentioned theories mostly accept the organizations as atomistic units and ignore the effects of interactions with other organizations on the strategy-planning phase. However, modern economics prefers analysing the companies as social entities that are embedded in different networks.

Therefore, construction companies should keep up with this trend and shape their strategies according to the social contexts in which they have been embedded.

Consequently, meta-analysis of the data gathered from 122 papers revealed that research interests in competitiveness within the construction industry have not steadily increased or decreased throughout the years, but rather been somewhat of a rollercoaster. Also, this study identified that researchers from UK, USA, China, Hong Kong and Australia published the most of the papers on the research topic, ahead of researchers from other countries. Due to the comprehensive scope of research on competitiveness, eight categories have been classified as the primary research interests, including (i) competitiveness factors/ criteria/ strategy, (ii) cost/ price/ tender, (iii) procurement/ service/ project delivery/ PPP, (iv) knowledge management/ learning/ education, (v) human/ gender/ motivation/ leadership, (vi) dispute/ claim/ conflict, (vii) information technology, and (viii) risk according to majority. Within the sample group of this study, it is also clear that the techniques adopted in the papers vary from qualitative to quantitative analyses; however, empirical analysis and quantitative approach are prevalent among others. Also, organization (firm) level of analyses gained much attention than other levels, and the dominance of application a single level of analysis indicates the requirement for multiple level of analysis in a single study. Since the schools of thoughts focuses on different level of analysis and approach the competitiveness concept from differentiated perspectives, utilization of multiple theories could bring more comprehensive findings.

CONCLUSIONS

The popularity of many management topics has been found to decline over time (Carson, Lanier, Carson, and Guidry, 2000). However, some management topics such as competitive analysis become so popular and useful that they evolve into mainstays of general management literature and construction research in particular (Gibson and Tesone, 2001). This study has uncovered the main research directions in the field of competitiveness, and has reflected what was published in the six construction related journals across a fourteen year period. It also has implications for the conduct of meta-analysis as a framework in competitiveness related studies in construction management literature. The approach used in the study goes beyond a classic meta-analysis because there are not quantitative variables to be measured, but trends to be clarified. Overall, the analysis proposes two taxonomic frameworks that constitute a useful basis for providing a systematic way to review and classify the competitiveness literature in construction. The first taxonomy may classify the papers according to the eight main research subjects find room in construction competitiveness research in construction management literature. The second taxonomic framework suggests the usage of a taxonomy comprised of eight distinct types of school of thoughts about the competitiveness. The schools of thought classification is expected to help identify the areas and gaps in competitiveness research within the construction industry that are needed by both scholars and practitioners for further research.

Table 2: Distribution of Articles by the Main Theoretical Backgrounds of Competitiveness Research

	Positioning School	RBV	DCV	Process School	Core Comp.	Practice School	Action School	SWOT
2000	CME-56*							
	JME-19**							
2001	CME-54**							
					LPM-61**		LPM-61**	
2002	BRI-12*	BRI-12**	BRI-12**				BRI-12*	
	JCEM-70**							
							CME49/1*	
2003	CMEK-1*							
	CMEK-8*							
	BRI-11*	CMEK-8**						
2004	JCEM-57*							
2005	CME-34**							
2006	ECAM-12*							
		CME-34*						
	CME-32**						ECAM-12*	
2007	CMEK-3**	CME-37*						
	BRI-6*						CME-32*	
	CME-27*						CMEK-3*	CME-32*
2008		CMEK-3**						
		BRI-6*						
	CME-28*							
	CME-29**							
	CME-31*	JCEM-42**	BRI-6*	BRI-6*		BRI-6*		
	JCEM-42*							
	BRI-8*	CME-29*						
	CME-21*	CME-31*					CME-29*	CME-28*
	CME-22**						CME-31**	
	CME-23**							
	LPM-32**							
	JCEM-2**							
2009	CME-20*	CME-21*						
	JCEM-27*	CME-22*						
	JCEM-31*	CME-23**						
	JCEM-24*	LPM-32**						
	ECAM-9**	JCEM-2**	CME-31**	CME-31*		CME-31*		
	JCEM-4**							
2010	JME-4**							
	JCEM-17**							
	ECAM-4**							
2011								
	CME-6*							
	JCEM-11*	JCEM-17**						
	JME-3**	JMEK-7**						
2012		ECAM-4*						JCEM-4**
	ECAM-1**	LPMK-1*	JCEM-17*				JCEM-17*	JME-4**
	JCEM-1**							
		CME-6*			ECAM-5*			JCEM-17**
					JCEM-17*		JCEM-17*	
2013								
		LPM-3**	CMEK-4**					
2014								CME-6*
								JME-3*

The articles, which refers to the school of thought in literature review. ** The articles, which bases its theoretical background on the school of thought.

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A CONCEPTUAL FRAMEWORK FOR ACHIEVING FIRM COMPETITIVENESS IN CONSTRUCTION: A 'CREATING SHARED VALUE' (CSV) CONCEPT

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Experience in recent years has emphasized that social sustainability is a key to achieve long-term competitiveness and sustainable growth for firms. However, current studies on competitiveness in the construction management literature are mainly focused on achieving business values i.e. it focuses on an economic perspective of competitiveness but it often neglects social integration. Social dimensions are given relatively lower priority, analysed separately and treated outside the scope of business strategy. An alternative concept, Creating Shared Value (CSV) concept is considered. It aims to enhance a firm's competitiveness by advancing their business and social conditions simultaneously. It can help firms to better respond to societal, environmental, and market needs as well as business activities. However, the relationship between CSV and competitiveness is still unclear, especially in the construction management research. This study attempts to develop a CSV-competitiveness conceptual framework for construction firms based on the analysis of current CSV implementation strategies in other disciplines from a strategic management perspective. The framework categorises firm competitiveness into two dimensions- 1) business success and 2) facilitation of future growth and development. It also argues that through the CSV concept, firms can convert social issue into business opportunity - which is jointly measured in terms of social and business values. This ultimately leads to firm competitiveness. This study addresses how construction firms can achieve competitiveness by implementing the CSV concept.

Keywords: business strategy, business value, competitiveness, shared value.

INTRODUCTION

Ever since Shenhar *et al.* (2001), there have been discussions among researchers and practitioners on achieving business success, future growth and development, and long-term competitiveness for a firm. Such studies are mainly focused on the economic perspective of competitiveness but they generally fail to integrate the social dimension in the competitive process (Taatala *et al.* 2006). Moreover, despite experience in recent years which has emphasized that social sustainability is a key to achieve long-term competitiveness and sustainable growth (Osburg and Schmidpeter 2013), companies, especially construction firms, still give relatively little priority to social issues while accessing their competitiveness (Walsh *et al.* 2003). Social values are either analysed separately from business values or are usually disintegrated from the core business strategy (Porter and Kramer 2011). Although a few studies in construction management research have considered social dimension to access firm

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competitiveness (cf. Fergusson and Langford 2006; Tan *et al.* 2011; Wagner and Schaltegger 2003), such efforts are not holistic, based on weak credentials, and lack empirical support.

One of the concepts gaining importance in addressing the given challenges and fostering firm competitiveness is creating shared value (CSV) (Porter and Kramer 2006; 2011). The CSV concept argues that social problems are actually a firm's opportunities. It can generate positive externalities, and is scalable and self-sustaining solutions to social problems (Porter and Kramer 2011). Investment in solving social issues accounts for almost 75% of business success (Pot and Vaas 2008). Firms can gain tremendous economic value by solving social issues, which in turn helps firms to achieve their competitive edge. There is growing consensus that through CSV firms can better respond to the societal, environmental and market needs, support business activities, and develop innovative capacity.

Studies from various sectors (food, beverages, agriculture, pharmaceutical, health care, financial services, extractives, and natural resources) advocate that firms can enhance their competitiveness by embracing the CSV concept in their business strategy (Hills *et al.* 2012). Companies in these sectors are scaling up their business horizon through innovative products, reengineered value chain, and local cluster development. However, the results are mainly based on successful individual cases from large Multinational Corporations. The nature of the relationship between CSV and firm competitiveness in those studies is still unclear and has not been verified empirically. Moreover, management and organizational fields, especially construction management, is silent on this topic. In this respect, a study is needed to empirically investigate a new competitive strategy in the construction industry, which can add both social and business dimensions to business strategy and enhance firm competitiveness. Hence, the key question is: How can construction firms achieve competitiveness by implementing the CSV concept?

The key objective of this paper is to develop and demonstrate a CSV-competitiveness conceptual framework based on the analysis of current CSV implementation strategies in other disciplines and the dimensions of competitiveness as defined in the construction management literature. The aim of the framework is to assist construction firms to implement the CSV concept and evaluate their competitiveness in terms of business success, and future growth and development. It prioritizes measuring social and business values jointly rather than focusing on the two values separately as done in previous studies. In particular, this study discusses the characteristics of CSV and its implementation using strategic management theory.

FIRM COMPETITIVENESS IN CONSTRUCTION

Competitiveness is a concept that is central to normatively oriented strategic thinking, and can mean different things to different firms at different times (Barney 1986). It is a multi-dimensional concept that can be analysed at different levels: country (national), industry (sector), firm (organization or company) and project (Ambastha and Momaya 2004; Flanagan *et al.* 2007). Various competitiveness models, factors, measurement concepts, and indexes that have stemmed from different approaches have been explored in the construction sector (Flanagan *et al.* 2007). Prominently, the recent view on competitiveness of construction firms mainly focuses on economic perspectives but fails to integrate social perspectives.

To consider a firm's competitiveness based on economic dimension alone would be incomplete. Firms which fail to integrate social dimension while accessing their

competitiveness, may not succeed in achieving business success, and future growth and development (Porter and Kramer 2011). Thus in general, competitiveness is mainly focused on short- to medium-term goals (project efficiency: time, cost, quality, functional performance, and stakeholder needs or client satisfaction) whereas achieving long-term goals (securing business success and preparing for future growth and development) are overlooked (Shenhar *et al.* 2001; Walker and Rowlinson 2008).

Hence, in this study firm competitiveness is conceptualized into two dimensions - 1) business success, and 2) preparing for the future (Shenhar *et al.* 2001; Walker and Rowlinson 2008), which should be achieved by addressing social and business values simultaneously (Porter *et al.* 2012). The first dimension, 'business success' may include commercial gains; growth and profitability; and increase in market share. The second dimension, 'preparing for the future' or 'facilitating future growth and development of firms' refers to revenue growth; creating new markets, ideas and innovations (to become a market leader), and new product lines; developing and gaining command/leadership in a new technology; developing sustainable brand and reputation; enhancing recruitment and retention strategy; developing external relationships; and gaining additional skills, capabilities, and competencies.

STRATEGIC MANAGEMENT IN CONSTRUCTION

Strategic management is a process of formulating and implementing strategy in which the decision makers make both strategic 'what shall we do?' decisions as well as tactical 'how shall we do it?' decisions to determine a long-term performance of the firm (Langford and Male 2001). Different strategic frameworks have been developed in the construction industry, which lead to numerous schools of thoughts (Green *et al.* 2008). These frameworks include four generic procedures - strategic analysis, strategic formulation, strategic implementation, and performance evaluation and control (Langford and Male 2001). Strategic analysis involves assessment of both the external environment (opportunities and threats) and the internal environment (strengths and weaknesses) that affect organizational performance. Strategic formulation includes planning and making strategic decisions on how a firm shall compete to achieve its organizational goals. The next step, strategic implementation translates the planned strategies into action. It involves assembling resources, structuring work relationships, integrating and controlling people and activities towards achieving strategic outcome. The final step is to evaluate the achieved performance, and monitor and control the progress.

Strategy is a widely used and an important concept in business studies, including within the field of management. It can be planned, analysed and formulated at different levels - corporate, business and functional/operational (Daft 2006; Langford and Male 2001). This study focuses on business level strategy and primarily emphasizes on how firms compete in particular market and position themselves among the competitors.

THEORETICAL BACKGROUND ON THE CSV CONCEPT

Business success, and future growth and development can be achieved if firms adopt the creating shared value (CSV) concept (Porter and Kramer 2011). CSV is a differentiation strategy (Spitzeck and Chapman 2012) that creates business value by tackling social issues or converting social issues into tangible business opportunities using three pillars: (i) reconceiving products and markets, (ii) redefining productivity in the value chain and (iii) enabling local cluster development (Porter and Kramer

2011; Porter *et al.* 2012). Pillar one focuses on designing and determining new products/services that fulfils the unmet needs and reaches unserved or underserved customers. The second pillar addresses social and environmental issues, and maximizes the value creating activities in the value chain that in turn improves the efficiency of business operations i.e. internal productivity (energy use and logistic, resource use, and procurement). Lastly, pillar three deals with improving the external environment of the company; improving available skills through the education and training of workers; and strengthening local suppliers, contractors, institutions and infrastructures (Porter and Kramer 2011; Porter *et al.* 2012).

In general, numerous social issues such as generic social impacts, value chain social impacts, and social dimensions of competitive context impacts that influence society and environment, are associated with the company. The CSV concept focuses particularly on those issues within the business context that have significant impact on firm competitiveness, i.e. ‘social dimensions of competitive context impacts’. Firms need to identify, prioritize, and address those issues that are most relevant and the solving of which will make the biggest impact and lever competitive advantage for the firm (Porter and Kramer 2006). CSV is about creating social and business values simultaneously. Both values are relative to cost benefit, and are jointly measured to comprehend the total shared value created. The social values refer to positive improvements in the social issues targeted by the firm, and social outcomes or social changes that are needed to be achieved. The business values are the actual economic benefits to the firms (Porter *et al.* 2012). Figure 1 below demonstrates the CSV concept.

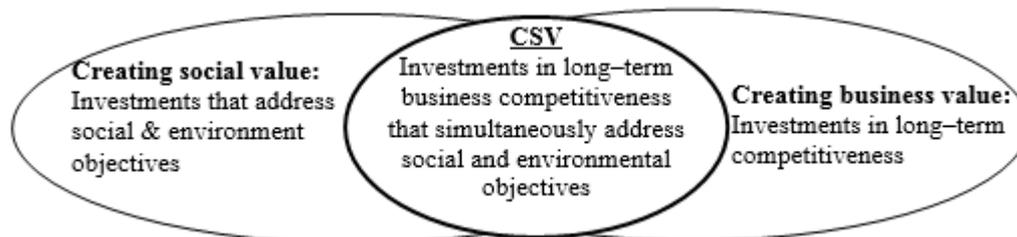


Figure 1: A creating shared value concept (Bockstette and Stamp 2011)

TRADITIONAL CSR VS THE CSV CONCEPT

Despite the tremendous contribution of the construction industry to the economic growth and development, its negative environmental and social impacts are undeniable (Welford *et al.* 2007). To overcome and neutralize such impacts, construction firms have embraced the concept of corporate social responsibility (CSR). CSR states that companies should be profitable, obey laws, be ethical, and be a good corporate citizen (Carroll 1991). Although, the firms spend huge amount of money through charity, philanthropy, or corporate giving, stakeholders still criticize companies for not being ethical and responsible (Porter and Kramer, 2011). CSR is limited to react against external pressure, mainly to satisfy stakeholder’s needs and maintain the firm’s reputation (Kanter 2011).

CSR has some potential to deal with environmental issues (e.g. carbon emission, pollution, waste disposal and oil spills) (Frynas 2009) and also emphasises various activities including corporate governance, sustainability, stakeholder management, relationship with employees, unions, suppliers and community representatives, commitment to transparent reporting, and harm reduction (Petrovic-Lazarevic 2008). However, these perspectives are reactive, defensive, lack active strategic choices

within companies, and fail to deal with key challenges in business-society relationships (Frynas 2009). Hence, CSR is typically an afterthought on how businesses operate. Companies often try to manage their impact on society and the environment after their business processes are in place. Therefore, CSR often remains at the periphery of business operation (Porter and Kramer 2011). In contrast, the firms embracing the CSV concept approach business operations in different ways. Rather than being an afterthought of how businesses operate, the CSV concept places social and environmental issues at the core of business operation. Although both CSR and CSV are based on the same overlapping concept - “*doing good by doing well*”, the former is about being responsible, whereas the latter is about creating new values. CSR is generally successful in achieving project efficiency and client satisfaction but it does not necessarily lead to business success and facilitate future growth and development of the firm. Figure 2 illustrates trajectories of the traditional CSR and the CSV concept.

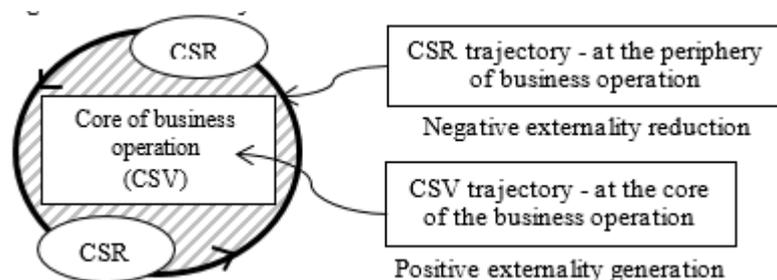


Figure 2: Trajectories of the traditional CSR and the CSV concept

DRIVERS OF CSV AND FIRM COMPETITIVENESS

Social problems can present intimidating constraints to business operations, but it can also provide massive opportunities for business growth. However, solving social problems requires innovation (Pfitzer *et al.* 2013), collective impact (Kania and Kramer 2011) and changes to the traditional mind-set. Hence, CSV needs various ingredients and constituents in order to effectively deliver or implement its strategy.

Porter and van der Linde (1995) expressed that a firm can improve competitiveness by reducing environmental impacts and integrating sustainability. Porter and Kramer (2002) advocated on context-focused philanthropy to enhance elements of social dimension of competitive context instead of goodwill giving, charity, and communal obligation. Prahalad and Ramaswamy (2004) highlighted co-creation as the basis for shared value creation. Gradl and Jenkins (2011) noted that inclusive business model acts as a catalyst for the CSV concept. Cross-sector partnership; collaboration and alliances with NGOs, governmental bodies and other business companies; co-creation with stakeholders; and development of new business models are the strategic dimensions to create shared value (Bisgaard 2009). Saul (2011) focused on social innovation to enhance shared value creation.

McWilliams and Siegel (2011) showed that through strategic CSR, firms can create and capture both economic and social values. It ultimately provides competitive advantage and enhances strategic positioning of the firms in the industry. Other researchers have emphasized on synergistic value creation for business and society through strategic CSR (Juscus and Jonikas, 2013; Porter and Kramer 2006). Strategic CSR helps firms to build trust and reputation, increase financial performance, minimize risk, gain competitive advantage and above all, lead to synergistic value creation (Porter and Kramer 2006). However, strategic CSR, value co-creation, social

innovation and inclusive business model follow the principle of the CSV concept (Porter and Kramer 2011). In other words, firms can be sustainable and profitable only if they are conducted along the line of the CSV concept.

TOWARDS A CONCEPTUAL FRAMEWORK

The literature on shared value provides a growing notion of firms towards adoption of a new business strategy. This suggests the need for developing a conceptual framework that would help firms implement the concept and allow them to generate cumulative knowledge on achieving competitiveness. As the CSV concept is a firm's business strategy to achieve competitive advantage (Juscus and Jonikas 2013; Porter and Kramer 2006; 2011), the conceptual framework is modelled using a perspective of strategic management process as follows:

Strategic Analysis

Strategic analysis starts with the identification of shared value opportunity (social needs vs. business opportunity or the opportunity for the greatest impact) (Hills *et al.* 2012) by scanning a firm's internal and external environment. Firms that want to make the greatest possible impact with the available resources should select an issue through which they can earn the most leverage. In other words, firms should choose those issues, which are best suited to generate the solution (Barney 1991). A firm's internal strength includes values and culture, its distinctive resources, capabilities, and expertise to deal with the issue. A firm's external opportunities are related to initial insight on societal drivers, market readiness and demand, government policies and availability of NGOs, external stakeholder opinions and agenda of other institutions, both outside-in and inside-out social linkages, and strategic social contribution.

Strategic Formulation

Firms should make the CSV concept as their core business strategy by incorporating it as their companies' mission and by having a vision to solve social and environmental problems. Once the potential social impacts are identified, the next step is to formulate a solid business case based on market study, research and development, and types (pillars) of the CSV concept. For each pillar of the CSV concept, first the related activities, desired targets, and tentative cost involved are identified, then possible business and social results relative to cost are modelled, and finally the go/no-go decision is made (Porter *et al.* 2012). This depends on the firm's strategic behaviour and management competences where stakeholder engagement, empowerment and commitment are the essential factors (Rowlinson and Cheung 2008).

Strategic Implementation

Adopting a new strategy like a CSV concept involves a higher degree of risk and threat. Hence, implementation of the CSV concept needs competencies, know-how, and optimal innovation structure (Pfitzer *et al.* 2013). Cross-sector collaboration, inclusive business model, strategic CSR, corporate social innovation and context-based philanthropy can pave and make strategic implementation effective. These relational approaches should be based on trust and ownership where the partner's motivation and commitment again play a crucial role (Rowlinson and Cheung 2008).

Performance Evaluation and Control

The final step focuses on performance evaluation, monitoring, and control. It involves three sub-steps: (a) estimation of business value and social value, (b) establishment of intermediate measures and progress tracking, and (c) assessment of shared value

results (Pfitzer *et al.* 2013). The first sub-step anticipates a degree of social change needed to unlock estimated business value with respect to available resources. Progress tracking involves monitoring inputs and business activities, and outputs and financial performance relative to the targeted social and business benefits. This is done by establishing intermediate measures during monitoring process using any performance improvement tool. In the final sub-step, joint business value and social value created will be measured which will be further assessed in terms of firm competitiveness in relation to 'business success' and 'preparing for the future'. Figure 3 below presents a CSV-competitiveness conceptual framework that emphasizes the link between the CSV concept and firm competitiveness.

A CSV-COMPETITIVENESS CONCEPTUAL FRAMEWORK

Firms gain competitiveness through competitive advantage. A firm's competitive advantage comes either from the competitive strategy adopted to cope with the competitive environment (Porter 1980; 1985) or from the possession and utilization of resources and competencies (Barney 1991; Prahalad and Hamel 1990). Similarly and as also discussed in the previous section, a firm's competitiveness in the CSV concept comes from business opportunity, simultaneously creating social and business values by solving social issues that impact competitive context of the firm (Porter and Kramer 2011).

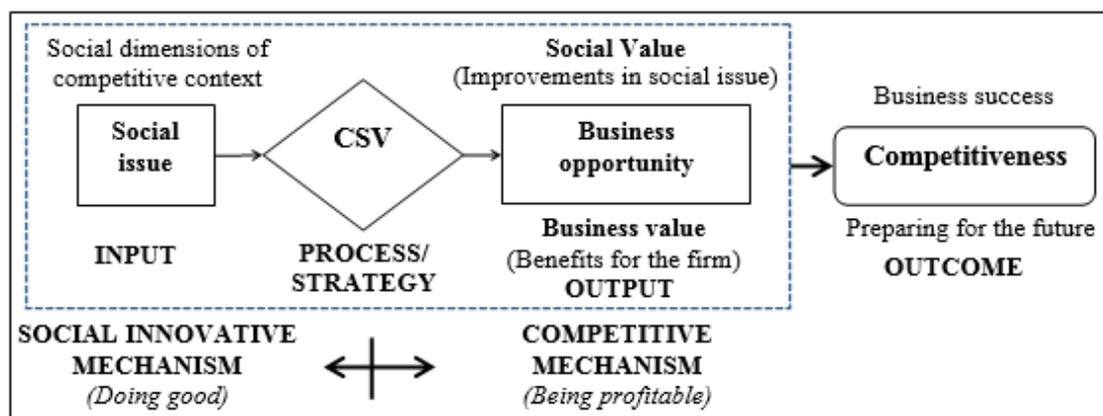


Figure 3: A CSV-competitiveness conceptual framework

The idea of the CSV concept emerges from a company's motive to solve social challenges and simultaneously obtain economic benefit to remain competitive and achieve a long-term sustainability. This will be shaped by social innovative mechanism of a firm's internal strength (value and culture, resources, capabilities and expertise) and external environment (opportunities to leverage shared value initiatives); driven by profit maximization or competitive mechanism of a firm's strategic behaviour and management competency (engagement, empowerment, commitment, trust); and supported by relational approaches (inclusive business models, corporate social innovation, strategic CSR, context-base philanthropy).

There are four major components in the framework: social issue, CSV, business opportunity, and firm competitiveness. These components are tightly linked to each other. A firm using this framework begins with the identification of social issue (referred to as 'input' in the framework) through which they can earn the most leverage. The CSV concept (process/strategy) then converts the social issue into business opportunity (output) using one of the CSV pillars. The business opportunity that the firm can gain using the CSV concept can be divided into two categories

(Porter *et al.* 2012). The first category is related to social values associated with the improvements in the social issue. It may include improved health and safety; reduced accident rate; improved education; reduced energy, water and raw-materials use; improved job skills and competencies; increased job creation; etc. The second group, which is the most important, is associated with the development of competitive advantage, and the economic and profit-related benefits. It may include increased revenue and market growth; improved profitability, productivity, quality, distribution system, and workforce access; reduced logistics and operating costs; secured supply; good relationship with subcontractors, suppliers, and other local organizations in order to develop future business activities in the emerging markets; enhancement in recruitment and retention strategy; achievement of additional or sustainable skills, capabilities, and competences; etc. These business opportunities will ultimately provide business success, and facilitates future growth and development of the firms (Shenhar *et al.* 2001; Walker and Rowlinson 2008), and finally enhance firm competitiveness (Outcome). Hence, the CSV concept creates win-win situation that prospers both society and the business firms.

CONCLUSIONS

Despite the notion that firms can achieve long-term competitiveness and sustainable growth emphasizing on social sustainability, construction firms give relatively low priority to social issues when accessing their competitiveness. Until now, much attention has been given to economic perspective of competitiveness, whereas social issues are either analysed separately from business value or are usually disintegrated from the core business strategy. This study argues that construction firms can embrace the CSV concept in developing fundamentally new approaches of business in order to generate values for both society and the firm, thereby strengthening their profitability and competitiveness. A CSV-competitiveness conceptual framework has been developed based on the analysis of current CSV implementation strategies in other disciplines using a strategic management perspective. The aim of the framework is to assist construction firms to implement the CSV concept and evaluate their competitiveness in terms of business success, and future growth and development. It prioritizes measuring social and business values jointly rather than focusing on the two values separately as done in previous studies.

However, given the complexity of the firm, different market and geographical conditions, and other factors might generate different issues that formulate the competitiveness of the firm; therefore, the model needs further refinement. It is expected that the present study would contribute to strategic management theory by adding a new business strategy (Creating Shared Value) to enhance firm competitiveness. A priority in future research will be to empirically test the model, investigate the tension and trade-offs between economic and social value creation, and develop a robust tool to jointly measure social and business values.

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BOUNDARY MAKING IN PUBLIC-PRIVATE-PARTNERSHIPS (PPP): A HISTORICAL ACCOUNT OF THE BRITISH RAILWAY INDUSTRY

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Since its emergence in 1980s, public private partnerships (PPP) have become a predominant approach for delivering social and economic infrastructure in the UK. This has inspired many scholarships into how such arrangements can bring about better performance for all. In much of the extant work, the focus has been on finding more effective ways of configuring the relationships between the public and private parties, often taking assumption that each of these sectors are homogenous entities. In this paper, we raise the question as to whether boundaries between the public sector and private sector are ever so clear cut. We do so by drawing upon an on-going archival study in to British railway industry in the 1960s. We found that the roles played by stakeholders were often messy, and that the labels of what constituted "public" and what constituted "private" were not always clearly defined. Indeed, relationships were often blended between the two spheres. Rather than to focus on finding better ways of bringing the public and private together in delivering PPPs, it is argued that these arrangements between public and private sectors are better studied as fertile context for boundary making and identity formation.

Keywords: archival research, boundary-making, public-private-partnership, railways.

INTRODUCTION

Since the 1980s, the idea of collaboration across sectors has developed considerably to tackle the need to deliver a more responsive social and economic infrastructure such as roads, railways, ports and airports. The constraints of ever-tightening fiscal budgets meant that more private-sector involvement in the provision of public services and infrastructure was gradually gaining more purchase. As Sandford and Milward (2010) argued, the involvement of private-sector partners in delivering public services would offer access to more resources and the sharing of risks that would otherwise be borne by taxpayers. Much work on public-private-partnerships (PPP) have centred on finding ways to increasing efficiency and improve effectiveness, and in what Huxham and Vangen (2005) termed as the collaborative advantage. So, it seemed that the 'traditional' approach where the public sector provides for the public interests is slowly becoming replaced by an ethos of the public sector enabling private sector involvement, with promises of greater investment potential and added value (Pongsiri, 2002). A great deal of research effort has unsurprisingly followed this trend to articulate the effective governance of public-private-partnerships, with particular emphases on how collaborations can overcome differences in values, norms and operational strategies between the public and private sectors (see e.g. Ng *et al.*, 2012;

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Gross and Garvin, 2011; Hellowell and Pollock, 2010; Hodge and Greve 2010; Sobhiya *et al.*, 2009; Robinson and Scott, 2009; Joyner 2007 and Jamali 2004).

Reflecting the extant work on PPPs, the point of departure in this article is to question the essential boundaries between the public and private sectors. While much work on PPPs in the engineering project management and construction management research domains centre on the development and transference of techniques and resources across the public-private divide (see e.g. Caldwell *et al.*, 2009; Barlow and Koberle-Gaiser, 2008), scholars in such other disciplines as public administration, political science and organizational studies have raised doubts as to whether the demarcation between the public and private sectors can be so neatly divided (Rainey and Chun, 2007; Dargie, 2000; 1998 and Doyle *et al.*, 2000). In this article, it is argued that neither the public sector nor private sector is homogeneous. Research into PPPs should not take for granted the notion that collaboration happens between these two internally-coherent but culturally-distinctive entities. Rather, as Simon (1998, 1995) observed even within each 'sector' it is possible that diverse sets of management settings and practices could exist.

It is this within-group heterogeneity that is rendered problematic in this article. By drawing on an on-going archival study of the developments of the British railway industry in the 1960s, an attempt is made to show that the role played by each sector was not as clearly delineated as perceived in the general literature. Rather, the emergence of a public-private-partnership was observed to be a result of a web of complex relationships between key parties found in a wide spectrum between the public and private sectors, which were shaped dynamically by social, economic and political forces at that time. Furthermore, there was no coherent entity known as the public or private sector; rather, the process of getting more private-sector involvement in the British railway industry signified a constant process of constructing and reconstructing boundaries in order to reinforce identities within the railway sector. Thus, the main contribution of this article is that research into PPPs should move beyond the narrow focus of finding more efficient and effective ways of configuring collaborations to attend more crucially to the (institutional) conditions and contexts that define/re-define interactions and boundaries within the partnership.

The article is organised as follows. Firstly, a brief overview of research on PPPs is traced with a view to problematise the essential categories of the public and private sectors in the production and performance of such collaborations. Secondly, the methodological basis of this ongoing archival research is described. Finally, some preliminary findings are discussed.

RESEARCH ON PPP: QUESTIONING HOMOGENEITY OR HETEROGENEITY IN PARTNERSHIPS

Public-private-partnerships (PPPs) have been subject to considerable academic debate, discussion and investigation. Proponents of PPPs tend to make the case for adopting such collaboration on the basis of delivering more efficient practices in the provision of public services and infrastructure. Tsamboulas *et al.* (2013), for example, argued that private sector involvement would create flexibility and enhance the value of transport infrastructure provision and operations. Barlow and Koberle-Gaiser (2008) studied hospital projects to conclude that PPPs can be a vehicle for stimulating innovation. Indeed, the dominant discourse in research on PPPs tended to be framed along the lines of the lack in public sector expertise, which can be resolved by bringing in the entrepreneurial spirit and efficient practices from the private sector.

Of course, there are also dissenting voices. Hellowell and Pollock (2010), for instance, questioned whether PPPs could really satisfy the public interest. Shaoul (2011), building upon extensive reviews of policy development, argued that the partnerships were likely to shift political authority and decision-making power from the hands of accountable public officials to the hands of businesses in the increasingly financialised world we live in today. Indeed, there is a chasm between scholars who view private-sector involvement in the provision of public services as a good thing and those who remain doubtful.

Nevertheless, there is considerable research that focuses much attention on how partnerships between the public and private sectors could be governed more effectively. These manifest in studies on relationship and stakeholders management (see e.g. Smyth and Edkins, 2007; Clifton and Duffield, 2006 and EI-Gohary *et al.*, 2006), financial structuring of partnerships (see e.g. Cohen and Kamga, 2012; Gross and Garvin, 2011; Macario, 2010 and Akintoye *et al.*, 2003) and allocation of risks (see e.g. Jin and Doloi, 2008 and Abednego and Ogunlana, 2006). These studies tend to implicitly assume that the public and private sectors must carry different roles, values and practices in what each sector does (Jones and Noble, 2008). Put another way, in much of the research on PPPs, scholars have tended to be concerned with the configurations of structure and relationships between the public and private sectors, taking for granted the boundaries between the two as static and clearly-defined. Thus, it would seem that we, the research and practice communities, know for definite what constitutes the public and private sectors.

Boundaries are certainly of interest to those who research PPPs. Studies on boundary spanning, for example, has quite some following. Stadler and Probst (2012) studied how organisations can broker more effective relationships in public-private-partnership projects (see also Jones and Noble, 2008). Yet, there is a growing body of literature that have begun to cast doubts on the distinction in the labels of the 'public' and 'private' sectors. Mahoney *et al.* (2009) pointed out that public and private sector labels represent a false dichotomy, and that the interests of the two sectors are often interdependent and entangled. Lofstrom (2009), in an investigation of inter-organizational collaboration projects, found that boundaries between parties might not as distinct as scholars perceive. Rather, there is a certain degree of messiness in performing the realities of such partnerships.

The blurring of the lines that separate the public and private sectors is, of course, not a new finding. Sullivan and Skelcher (2002), Pollock (2005) and Flynn (2009) have all highlighted this moot point. Others like Simon (1995; 1998) have also suggested the possibility of both sectors being more similar than different. Rainey and Chun (2007) also questioned if each sector is really that internally-coherent, and suggested that one could potentially find more heterogeneity within-group than homogeneity.

Surprisingly, what constitutes 'public' and 'private' is rarely reflected on in the research on PPPs found in the construction management research domains. There is often a taken-for-granted belief that PPPs are merely a configuration of stakeholders from a clearly-bounded group of public-sector and private-sector interests. In this article, the boundaries between what constitutes 'public' and 'private' are left open. It is argued that while the focus on finding more efficient and effective configurations of bringing the public and private sectors in such partnerships has generated productive lines of inquiry, there is a need for deeper understanding of just what these boundaries between the public and private mean. Furthermore, it is argued that these boundaries

are not states left undisturbed for the researcher to discover; there is ongoing constructing, reconstructing (and even destroying of) boundaries between the public and private sector that could yield so much research potential. One particular area that is relatively under-explored in research on PPPs is the role of 'identity work' (see Brown and Phua, 2011). It is, thus, this identity work in continuously forming and reforming boundaries (Sundramurthy and Kreiner, 2008 and Habbershon *et al.*, 2003) that is of concern in this article.

RESEARCH METHOD

The study reported here is based on an archival case study research (see Ventresca and Mohr, 2005) of the British Railway Industry in the 1960s. The motive of this study was to explore the institutional conditions and contexts that defined and re-defined interactions and boundaries between the public and private sectors, paying particular attention to the historical events that happened, which were shaped by the social, economic and political dynamics of the time. A collection of archival data (see Table 1 below) was amassed to piece together a narrative of the actors (i.e. who were involved?), events (i.e. what took place and how did it happen?), and emerging rationale (i.e. why did it happen in the way it did?) entailed in the growing privatisation of the British Railway Industry. As far as possible, the data collection was sufficiently open to allow the research team to track individuals, organizations, and institutions involved as they left a trace (in both intentions and actions) in the archives (Frisch *et al.*, 2012 and Berg and Lune, 2012). The study focused on the British railway industry in the 1960s as this was the period where some of the earliest reforms to increase private-sector involvement in the provision of public transportation infrastructure could be traced (arguably with a lasting legacy that can be felt even today with debates on High-Speed 2).

Table 1: Sources of archival data and their purpose

Sources of archival data	What purpose did these sources serve?
1. Inquiry reports (e.g. the Beeching report 1963; Joint Steering Group Committee 1967; Serpell report 1974 and Ridley report 1977)	Provided an account of the affairs of the British Railway Industry at the time, and enabled the research team to trace how the reform(s) of the sector took place and under what changing political, economic and social conditions
2. Cabinet Office papers/minutes of meetings in public office and Prime Minister Office Correspondence (PREM)	Enabled the research team to piece together the political narrative so as to facilitate an interpretation of the forces at play that influenced and shaped the mind-set of policy-makers, and the roles played by key social actors in the British Railway Industry at the time
3. Print-media such as local and national news papers, and broadsheets such as the Financial Times, The Economist etc.	Enabled the research team to get a snapshot of social conditions at the time, especially the response to the reforms of the British Railway Industry

For the purpose of this article, the archival data was analysed with a view to see if the 'boundary' - that is, the periphery between, or the shared spaces where the concepts of 'here' and 'there' are confounded in action (see Star, 2010) - between the public and private sectors could be clearly detected. We looked specifically for instances where boundaries between the public and private sectors were built, bridged and blurred.

BOUNDARIES BUILT BETWEEN THE PUBLIC AND PRIVATE SECTORS: BEECHING AND THE RESHAPING THE BRITISH RAILWAY INDUSTRY

Transport infrastructure such as the railway system is highly complex, often involving a range of institutional actors (e.g. policy-makers in central government, local

government, railway employees, commuters, communities, and the unions). Given the multiple parties and their interests, there are often tensions and contestations of power (Marsden and Docherty, 2013 and Oliver-Trigalo and Brone, 2011). These conflicts can certainly be witnessed during the early 1960s when the seed of forming partnerships with the private sector in the delivery of what was ostensibly a public service had begun to be sown. The problem was staged in the Transport Policy of 1960, which had arisen from a speech made by Harold Macmillan, the Prime Minister at that time in the House of Commons on 10th March 1960

"[...] First the industry must be of a size and pattern suited to modern conditions and prospects. In particular, the railway system must be remodeled to meet current needs, and the modernization plan must be adapted to this new shape"

According to the Ministry of Transport (1966; July, Cmnd. 3057), the modernisation, which continued for decades since, was

"[...] key to solve Britain's transport problem [which] lies in planning designed to reconcile our many-sided needs, national and local and regional, economic and social"

The rhetoric that was formed was that British Railway, a service and infrastructure provided by the public sector, was lacking, and what needed to happen was an injection of private-sector enterprise and expertise. This is clearly characterised by the well-known Beeching Report of 1963, entitled 'Reshaping British Railway', a government blueprint to run and organize the industry using private-sector principles and practices. Consequently, a third of the railway lines were closed. It is argued that Beeching's influence, as will be seen later in his enrolment of senior figures from private enterprise, represented a pivotal political moment in which the post-war logic of growing national industries was undermined, thereby providing a foundation for successive waves of pervasive privatisation.

At the time, and it is still the belief in some quarters, the problem lay with recalcitrant trade union members who were seen as a threat to the efficient and effective provision of this public service. Beeching, a former engineer from ICI, took the view that more private-sector involvement could turn around what was perceived by those who led the inquiry as a wasteful and inefficient railway industry. Thus, the scene was set with the public-sector pitched against the private-sector, the boundary between the two was clearly built to ensure the construction of the 'public-bad-private-good' political rhetoric.

BOUNDARIES BRIDGED BETWEEN THE PUBLIC AND PRIVATE SECTORS: POST-BEECHING RESPONSES

The view that the public sector was always lacking and that the private sector held the key to better performance was not always held even among private-sector actors. Businesses, for instance, could see how the reforms instigated by Beeching could lead to detrimental results for local, regional and even the national economy. Letters were sent in by members of the public and businesses to the local and national press to voice concerns over the privatisation of railway provision. Anger and resentment appeared to characterise the mood of mid-1960s. In one of the letters published in the Times newspaper in November 1964, the Managing Director of a logistics company wrote:

“At the time of the railway reorganization, the new highest Railway Executive issued instructions, limiting the number of containers in various railway stations so that each container was to be kept in constant use – in theory sound, but in practice unworkable for the daily fluctuation in trade. (Letter by Robert Fisher, Managing Director of Robert Fisher (Packing and Shipping) Times: 3 November 1964).”

Thus, the ethos of rationalisation, so often associated with the private sector was considered to be impractical in this instance. The letter by Robert Fisher subsequently led to an internal response by Eric Merrill, Public Relations Manager at British Rail, who wrote to his superiors, underlining the gravity of the post-Beeching situation with an emphatic message ‘This is not a PR problem’. Merrill wrote:

“I am particularly worried about containers. The demand for them is greater than the supply – and we have surely contributed knowingly to this demand by what we have said and published and are still saying and publishing about railway services to-day and in the future [...] As the Board’s policy is not to build any more conventional containers the shortage will presumably continue until Liner Trains relieve the pressure. What worries me is that by that time we may well have lost a great deal of business and, in the process, engendered a lot of ill-will. Mr. Fisher’s letter is a symptom of this. This is not a PR problem (Letter from Eric Merrill, public relations manager to the British Railways Board – 6 November 1964).”

Here, we see the boundaries between the public-sector and private-sector bridged in response to the unfolding drama of cutting the railway infrastructure as the Beeching recommendations were implemented. Private-sector businesses raised doubts over claims of financial benefits that were promised by the Beeching cuts to services.

"[...] Against what has been called the realities of railway finance, it must place, with such force as it can convey, other realities which are equally important to the national interest. [...] These closures would have a disastrous effect not only on the fast growing holiday trade of the south-western counties but on the tourist traffic to the north of Ireland by the short Stranraer to Larne route" (MT 97/688 Transport implication of the proposal for re-shaping of the railways. Post-publication of the Beeching Plan, Department for Transport:2 April 1963)

Thus, it can be seen from these responses that what started out as a framing of difference between the ways of working in the public sector and private sector gradually turned to a growing consensus that the reduction of railway infrastructure was potentially bad for business too.

BOUNDARIES BLURRING: THE STORY OF THE EMBARGOED INQUIRY

Bridging between the public and private sectors was evident in the membership of the various committees which led the inquiries that instituted reforms of the British Railway Industry. It was already stated that Beeching was formerly an engineer in ICI. In the Joint Steering Group Committee of the late 1960s, the involvement of private-sector actors was clearly present in public-sector affairs; the committee was made up of such characters as J.P. Berkin (formerly Shell Petroleum Company Limited) and J.G. Cuckney (formerly Standard Industrial Group Ltd) (see Railway Policy Review, Joint Steering Group, July, 1967). Thus, we see boundaries between the public and private sectors blurring as the public sector starts to forge deeper partnerships with the private sector in reshaping the British Railway.

While boundaries blurred between the public and private sectors, inconsistencies within the public sector were also noted. For example, the government's framing of the trade unions as the enemy to rationalisation was also found not to be uniform across the public sector. It was discovered, for instance, that the British Railway Board took a much more conciliatory position where trade unions were concerned. In 'A New Talk with Unions (The Times, London, England, Thursday, Jan, 07, 1965), it was reported that "*cooperation of the railway unions*" was vital and that the Board was prepared to "[conduct] research into the human factors involved." In another interesting exchange during the parliamentary proceedings on industrial disputes in the railways, the Chancellor of the Exchequer asked, "*But can we be tougher than Beeching?*", which led to the emphatic response, "*No: must let him play the hand: and to our political advantage to buy support for [Beeching] plan without bitterness of strike (recorded, 9 May 1963, 10am).*"

Although the legacy of Beeching (1963) remains well-known in terms of how it reshaped the landscape of the British Railway Industry, we soon discovered that this was not the only inquiry that took place at that time. Indeed, there were several reviews commissioned, some of which remained unpublished. One report, by the Guillebaud Committee charged with reviewing pay for railway workers (appointed in 1958), is worth noting for this showed fractures within the public sector. Claude Guillebaud was a Cambridge economist, who was previously appointed to chair a review of the cost of running the National Health Service (Ministry of Health, 1956). This earlier review took three years to complete from Guillebaud's appointment in 1953. The review concluded, much to the frustration of the Government at the time, that cost-cutting was not an inevitable option since the projections suggest that the Health Service was managing its costs effectively. So, it was somewhat surprising to find Guillebaud re-appointed to chair a review on pay in the British Railway Industry in 1958.

On closer scrutiny, however, we discovered how Guillebaud was not appointed by the Government to undertake a review of pay in the British Railway Industry. Rather, it was the British Transport Commission together with the Trade Unions who provided the terms of reference for Guillebaud's appointment.

"4. The Guillebaud Committee were not appointed by the Government, but jointly by the [British Transport Commission] and the Unions at the end of 1958. (p. 2 from a Memorandum by the Minister of Transport, A. E. Marples, dated 11 September 1962)."

It must be noted that the relationship between the British Transport Commission and central government was, at that time, somewhat fractured. The commission was resisting attempts made by government to centralise control within the treasury. In the earlier review of the health service, Guillebaud's findings did not align well with the government's intent, and so it was not surprising to see the firm statement by the Minister of Transport distancing themselves from the appointment of the Guillebaud Committee (the report was subsequently embargoed).

Interestingly, the Guillebaud report was well received by the trade unions, as shown in the somewhat favourable reception by the General Secretary of the National Union of Railwaymen:

"Mr. S. Greene, general secretary of the [National Union of Railwaymen], said after the meeting that his executive would be continuing their examination of the

[Guillebaud] report, which seemed to provide the basis for a reasonably satisfactory wage structure and conditions of service (*The Times*, 11 March 1960).”

CONCLUSIONS AND IMPLICATIONS

In this article, an attempt was made to problematise the notion of 'boundary' between the public and private sectors, using an archival case study of the British Railway Industry in the 1960s. This was a pivotal moment in the context of post-war developments of infrastructure in Britain, signalling the start of greater private-sector involvement in the provision of public services. Through excerpts from the often-messy archival data, it has been argued that public-private-partnerships are not simply about bringing the public and private sectors together. Rather, there is quite a lot of heterogeneity found within each of these 'sectors' and that boundaries are continuously built, bridged and blended or blurred.

What implications are there for construction management researchers who study such partnerships? While much research is predominately framed to view partnerships as a configuration of the two homogenous and homologous entities, where the public-sector is often lacking the private-sector's ability to be enterprising and efficient, the call is made to question the nature of 'boundaries' more deeply. Thus, rather than to focus solely on finding new or better ways of configuring and structuring relationships, we should also ask the question as to what it is we are trying to bring together. As our archival research demonstrates, the demarcations between what is 'public' and 'private' are not often clear-cut. Indeed, an awful lot of work goes on in constructing these 'boundaries', as powerful actors make their manoeuvres to build, bridge and blur boundaries for political (and at times, economic) advantage. Our brief historical sketch shows how the public and private sectors continuously engage in building consensus and struggling through contestations to preserve or increase their political and economic stake in the railway.

The contribution of this article is two-fold. Firstly, the assumption that PPPs bring about complementarities of different values, norms and practices between the public and private sectors is questioned. The archival analysis illustrates how the two sectors can be similar and not always different from each other. This invites the question as to what 'public' and what 'private' we are trying to form in partnership. Secondly, the dynamics of boundary-making - of building, bridging and blurring - are described. This, it is argued, adds a crucial dimension for reflecting in developing deeper understandings of the intervening contexts and conditions that shape the performing (and not just the performance) of partnerships between the public and private sectors.

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A PUBLIC COMMISSIONING MATURITY MODEL FOR CONSTRUCTION CLIENTS

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Being a public organization with construction needs, whether they are housing, building or infrastructure related, implies close co-operation and interaction with the supply chain. Substantial research exists that focuses on project related aspects of commissioning and on the role of the construction client in general. Only limited research has been done, however, into the impact of organizational characteristics on the level of professionalism and competences of commissioning entities. This research is particularly relevant, when public organizations are re-evaluating their sourcing strategy. As part of the establishment of a new chair of public commissioning, the development of a 'Public Commissioning Maturity Model' (PCCM) is presented in this paper. The model aims to identify the key characteristics of being a competent construction client. The overall aim of this research is to establish an overview of and insight into the nature and impact of characteristics of public organisations as determinants of their professionalism as public commissioning entities. In the PCMM, for each aspect of the commissioning role, maturation stages are defined. Research methods used include a literature survey and expert sessions. The model and methodology build on maturity models developed in asset and project management, supply chain management and purchasing. The research resulted in a framework containing a set of coherent aspects jointly framing the concept of 'professional public commissioning'. This framework can be applied by public commissioning entities to explore their current status and define their desired further development.

Keywords: client, maturity model, performance indicators, procurement, supply chain management.

INTRODUCTION

The construction sector is of vital economic importance. According to Eurostat (<http://epp.eurostat.ec.europa.eu>), construction activity accounted for 6% of the Gross Domestic Product (GDP) in Europe in 2010, generating over € 650 billion of added value. The public sector is responsible for approximately half of the production in the construction sector. Despite the importance of the sector, the sector is deemed to be underperforming, resulting in high failure costs (averaging 11,4% of turnover, EIB en CBS, 2008), poor quality, low efficiency and high risks (Boyd and Chinyio, 2006, Manseau and Seaden, 2001). For many years, a strong necessity is felt worldwide, to reform the sector. Egan's 'Rethinking Construction' (Egan, 1998) provides a clear and broad-based view on this need for change. His report forms the background to many

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nation-wide, sector-specific or organization-based change programmes in the industry afterwards.

Commissioning organizations ('construction clients') fulfil a dominant role in reform initiatives. For public organizations, expectations seem to be even higher. Their evident social responsibility induces a role of 'launching customer'. Both as an owner and due to their social-political responsibilities, public clients are expected to actively contribute to the innovation and improvement of the building sector (Boyd and Chinyio, 2006). OECD (<http://stats.oecd.org/glossary/detail.asp?ID=5862>) defines a construction client as "*the natural or legal person for whom a structure is constructed, or alternatively the person or organization that took the initiative of the construction.*" Most scientific publications use a similar concept, with Boyd and Chinyio (2008) and Haugbølle and Boyd (2013) specifically focussing on the role and characteristics of construction clients. The OECD-definition does, however, not explicitly recognize the role of clients in the existing stock of assets, although the volume of construction activity related to existing assets (maintenance, renovation, transformation) is substantial compared to new building. The connection between construction clients and the existing building stock is not too prominent in scientific literature either.

A multitude of studies has been executed in the area of public sector purchasing and procurement, new contract forms, public private partnerships, the briefing process, risk management, etcetera. In the majority of cases though, this research focusses on the commissioning role in specific projects or activities, and the ability of a construction client, whether public or private, to successfully manage those projects. Where the role of the construction client as a commissioning agent in single projects receives ample attention, the role of the construction client as a commissioning organization has only rarely been recognized (Eisma and Volker, 2014).

Since only limited research has been done into this specific area, there is an evident need to address organizational issues of public construction clients in research and contribute to knowledge development in this area. Given the impact of the construction sector and the dominant role of public clients, the research theme can be considered of substantial value to the sector as well as to the academic world. As many public organizations repeatedly (for instance municipalities, provinces, universities or hospitals) or even continuously (for instance housing associations, state building or infrastructure authorities) perform the role of public client in the development, renovation or maintenance of their assets, they can be considered to be 'commissioning organizations'. It is therefore interesting to examine the relationship between organizational characteristics and commissioning professionalism. Repeated commissioning tasks might require a higher level of professionalism than 'one-off' commissioning activities in public organizations with a limited asset stock.

In this paper the development of a Public Commissioning Maturity Model (PCMM) is described. First the research context and methodological development process is explained. In the following sections the concept and aspects of the maturity model are presented, followed by the draft version of the model that was validated in a series of expert sessions. Finally, further research is discussed.

RESEARCH CONTEXT AND APPROACH

Aim of the research

Unfortunately a recognized, coherent definition and representation of the characteristics of the commissioning role of public organizations is not yet available.

In the Netherlands, the Dutch Construction Client Forum recently established a new Chair at Delft University of Technology to specifically investigate and elaborate on this field. The aim of this chair is to establish an overview of and insight into the nature and impact of characteristics of public organisations as determinants of their professionalism as public commissioning entities.

As a starting point, research within the chair focuses on developing a 'maturity model' to investigate the level of competence of public construction clients. In this paper the development of this model will be described. The Public Commissioning Maturity Model (PCMM) aims to raise awareness among construction clients' organizations to the range and width of their commissioning task and is designed to be applied by board members and managers. The model provides a means to elicit discussion on the current and desired state of the organization's competences. The model is not configured for numerical ranking, sector-wide monitoring or benchmarking purposes.

Research approach

First, the results of an international literature survey by Volker and Eisma (2014) were used to construct a preliminary set of elements correlated to the concept of 'public commissioning' in the built environment. For some specific areas, additional scientific literature was required, for instance on commissioning aspects related to public values and governance issues, as scientific literature from within the domain of the built environment appeared to be limited and these issues were indicated to be relevant by the construction clients forum. These scientific results were supplemented with an analysis of the viewpoints of the Dutch Construction Clients Forum regarding the tasks and responsibilities of public construction clients. In this Forum (www.opdrachtgeversforum.nl) twelve large public construction clients are represented to jointly discuss and further develop their commissioning role.

Next, literature on 'maturity models' as a tool to identify organisational development stages was studied, in order to obtain design criteria for a new maturity model. Steenberg *et al.* (2010) provides guidelines for the development of maturity models, and recommends comparison with existing models, followed by an iterative procedure to define focus areas and capabilities, starting from literature, including expert input and possibly surveys in order to obtain a generally agreed model. This procedure is followed in the design of the PCMM.

As public commissioning was found to be an overarching concept, designing a 'maturity model' for public commissioning would need to interlink organisational development in a variety of domains. It is in this connection that the maturity model for public commissioning adds to existing knowledge and existing maturity models. This phase of the research project therefore covered studying literature on existing maturity models developed for adjacent areas, such as the Infrastructure Maturity Model of Volker *et al.* (2013) and Project Management Maturity Model of Ibbs and Kwak (2000). This study covered both the aspects to be included in the model as well as possible options for the maturity scale to be applied.

Then, all elements were summarized in an Excel sheet and clustered into a limited number of categories based on their similarities and differences, in order to obtain an comprehensible set of aspects to be covered in the maturity model. Furthermore, the development stages of maturity were elaborated. The combined results of the literature survey and insights from practice thus led to a draft version of the maturity model.

This draft version was discussed in a structured discussion in four expert sessions, held in April 2014. Two sessions were composed exclusively of representatives of public commissioning organizations, one consisting of 6 board members representing 6 different public organizations and one session with 9 senior managers responsible for internal commissioning of projects in 7 public organizations. The other two sessions were held with a mixture of practitioners and scientists, all directly involved in commissioning related activities and research. In all sessions both the aspects and development stages used in the model were discussed thoroughly, as well as the practicality of the 'maturity model' as an instrument. All discussions were documented and analysed by the research team. The meetings followed a fixed agenda, that had been send to the experts for preparation beforehand. The combined results of the meetings were reflected in an adjusted pilot version of the maturity model.

THE CONCEPT OF MATURITY MODELS

A maturity model describes key elements of effective processes connected to a specific organizational quality. The model draws the development path from an ad hoc, immature process to a mature, well-managed, disciplined and controlled process (Paulk *et al.*, 1993). The assumption underlying maturity models is that a mature level of development, will lead to improved business performance and therefore better results. Maturity models are often used as a self-assessment instrument and to define opportunities for further organizational development (Mayer and Lemes Fagundes, 2009).

One of the first maturity models, the Capability Maturity Model (CMM), was designed for software processes in de late 90's, by Paulk *et al.* (1993). Subsequently, maturity models were designed for a variety of processes in organizations. A maturity model usually consists of a matrix with key process areas on the one axis and development stages on the other. For ease of use in self-assessment situations, maturity models generally comprise no more than 5 - 10 aspects, and 3 to 10 development stages. Most models use a 4 or 5 level Likert scale.

INVENTORY OF ASPECTS OF PUBLIC COMMISSIONING

Results of literature survey on aspects of public commissioning

Eisma and Volker (2014) performed a systematic literature survey on the knowledge currently available on public commissioning organizations. They found that academic scholars mainly focus on issues related to organising the project (procurement, contracting and management) and many fewer dealt with portfolio management, the internal organization of the client and their need to operate in a transparent, objective and accountable way. Eisma and Volker (2014) found ten main domains of aspects related to public commissioning in literature: (1) Collaboration, (2) Contractor selection, (3) Project performance, (4) Service delivery, (5) Public private collaboration, (6) Modernising construction, (7) Delay and cost overruns, (8) Innovation, (9) Integrity and (10) Public project management.

This survey revealed that the phenomenon of 'public commissioning' lacks an accepted definition, although literature covers many elements contributed to its professional execution. Public commissioning appears to be an overarching concept, referring both to project related aspects as well as to organisational issues. This notion should be taking into account when developing a maturity model for this field.

Additional aspects covered by the Dutch Construction Clients Forum

The analysis of the work programme, products and meetings of the Dutch Construction Clients Forum revealed similar themes as found in scientific literature. Issues such as public values (e.g. sustainability, cultural values), answering to public expectations and administrative frameworks (integrity, transparency and procurement law), the development of integral, LCC-related, decision models for outsourcing, and coherence between organizational policy, asset portfolio and projects are dominant in discussions within the Forum and are less dominant (though not completely absent) in literature.

Aspects mentioned in existing maturity models

Generic maturity models

A multitude of maturity models on organizational processes has been developed before. The PCMM will build on the more generic maturity models focussing on business performance or quality management, as improving the quality of public commissioning tasks can be seen as a part of the primary business process of public organisations. Examples are the Business Process Management Maturity Model (Rosemann and De Bruin, 2004) and the EFQM Excellence Model (www.efqm.org).

The EFQM Excellence Model can be seen as an important, often applied, framework for assessing organizational quality. The model distinguishes 'Enablers' - criteria that cover what an organization does, from 'Results' - criteria that cover what an organization achieves. As 'professional commissioning' could be considered to be one of the required qualities of a public organization, a maturity model for professional commissioning would, following this line of thought, capture the 'enablers' for commissioning. The enablers in EFQM-related assessment models cover aspects such as 'leadership, people, policy and strategy, partnerships and resources and processes, products and users'.

Maturity models in related focal areas

Several maturity models have been developed covering themes closely related to public commissioning. Each of these maturity models contains important elements, although none of them covers the full scope of commissioning. The following models can be explicitly mentioned for their obvious relevance to the subject and have been studied to elaborate and add to the aspects to be covered in het PCMM:

- Infrastructure Management Maturity Model (IM3) (Volker, L. *et al.*, 2013), investigating the organisational maturity in asset management, covering dimensions such as: information management, internal co-ordination, external co-ordination, market approach, risk management, processes and roles, and culture and leadership.
- Supply Chain Excellence Maturity Model (SCEMM) (Noordhuis, M., Veen, van der, J., en Venugopal, V., 2013); investigating organisational maturity related to supply chain co-operation, based on EFQM and covering aspects such as: strategy and policy, organization and processes, monitoring and control, information technology, people and culture.
- Purchasing Excellence Publiek Model (MSU+) (www.nevi.nl); derived from the earlier Purchasing Excellence model developed by Robert Monczka. Investigating organisational qualities related to purchasing. The MSU+ model contains 8 strategic (insourcing / outsourcing, develop commodity strategies, world class supply base, supplier relationships, integration of suppliers,

supplier development and managing costs) and 6 supporting processes (strategies and plans, organization and team, deploy globalization, performance indicators, IS / IT systems, HRM and training).

- Infra Maturity Tool (IMT) (Hertogh, M. *et al.*, 2008); investigating the maturity of project management in complex projects, defining aspects such as: objectives and scope, stakeholders, financial management, organization and management processes, risks (threats and opportunities), contracting, legal consents, knowledge and technology.
- Project Management Maturity Model (Ibbs, C. and Kwak, Y, 2000), covering 8 knowledge areas related to the maturity of project management processes: scope, time, cost, quality, human resources, communications, risk, procurement.

This wide range of related models provided the context for the development of the Public Commissioning Maturity Model.

Identifying development stages

Each maturity model contains a scale, mostly based on Likert, to identify the maturity level of the aspects considered. Often, maturity levels are related to the extent of implementation of specific solutions or methods. The Public Commissioning Maturity Model refrains from prescribing specific solutions. It is believed that no specific solution or application suits all types of public organizations, as mutual differences are substantial, for instance in primary goals, size of organization, number and type of outsourced activities.

The public commissioning maturity model is intended to judge the extent to which an organization succeeds in carrying out an integrated assessment of its actions related to the aspects incorporated, makes informed decisions related to the approach of each aspect and acts according to these decisions. The model should therefore, for instance, not value the application of integrated contracts as a 'higher level' of commissioning than the use of traditional contracts. It is the integral assessment and the related subsequent action that is deemed to indicate professional commissioning rather than the specific choice itself.

For each aspect, the maturity model requires the judgement of four interrelated and subsequent indicators: (a.) the integral approach to the aspect; (b.) the level to which an organization has defined SMART-goals for this aspect and is accountable for the results and systematically evaluates goals and results; (c.) the level to which this specific aspect is embedded in the organization and therefore is known and acted upon by the employees involved in the related processes; and, finally, (d.) the level to which this specific aspect is supported and secured by dedicated processes, methods, instruments.

For each indicator a five level scale is used, from 'low' to 'high'. Each aspect is scored in the same way. As the model supports self-assessment and aims to support internal discussions on the status, importance and required level per aspect, the individual scores per aspect remain visible. No final, overall, score is generated.

DRAFT MATURITY MODEL

On the basis of the above sources and input, the first draft version of the Public Commissioning Maturity Model contained the following 8 aspects:

1. Organizational strategy and policy; 2. Cultural aspects and HRM; 3. Stakeholder management; 4. Portfolio management; 5. Public values and responsibilities; 6. Administrative rules and frameworks; 7. Managing the supply side; 8. Managing projects and assignments.

The first three aspects reflect basic organizational competences and are derived from the 'enablers' described in the general business process and EFQM-maturity models. They reflect generic preconditions to successfully improve the quality of business processes (such as public commissioning). 'Organizational strategy and policy' covers the extent to which an organization has developed a specific commissioning related strategy and policy, is actively improving and - if necessary - innovating its commissioning role, and applies a dedicated change strategy when changing its role. 'Cultural aspects and HRM' looks into leadership aspects, the extent to which a governance structure enhances commissioning tasks, and whether the organization has commissioning as a focal area in knowledge management and HRM. 'Stakeholder management' covers the ability of an organization to answer to the needs and expectations of users, political and third party stakeholders and the internal organization throughout the life cycle of the built environment. It also looks into the adequate interaction with and positioning of stakeholders in commissioning processes.

The next set of aspects cover specific public commissioning related issues. These issues are mainly derived from the literature on public commissioning and practitioners input from the Dutch Construction Clients Forum, and elements derived from the above mentioned related maturity models: 'Portfoliomanagement' includes the presence of a view on the total stock of work to be outsourced. The coherence between the performance of the portfolio and the requirements to individual projects and tasks (van der Velde, Klatter, and Bakker, 2013) should be taken into account. The aspect also regards the use of integral, TCO-oriented, decision models for choosing appropriate collaboration and contract forms (e.g. framework agreements, public private partnerships, integrated contracts, traditional contracts), covering both investment as well as exploitation related decisions on maintenance and management (Miller and Evje, 1999).

Aspects 5 en 6 specifically relate to the 'public' nature of construction clients. Aspect 5, 'Public Values and responsibilities', looks into the ability to incorporate a social mission and public values, including launching customership and exemplary behaviour, in the commissioning role. Many public construction clients serve as an example for less experienced construction clients (Winch, 2010). Public construction clients can motivate parties involved as well as other construction clients to strive for, for example, higher sustainability levels (Warren, 2010). Also the protection and upkeep of cultural and historic values and spatial quality are elements covered in this aspect. 'Administrative rules and frameworks' covers the ability to work according to administrative legislation and frameworks. Public organizations should abide to explicit and implicit rules regarding integrity, transparency, legitimacy and efficiency and procurement regulations (Schlössels and Zijlstra, 2012). The ability of an organization to deal with these expectations and still be effective in its commissioning role is covered in this aspect.

Aspect 7, 'Managing the supply side' covers the organizational competences related to supply management and purchasing excellence and is therefore strongly related to the above mentioned MSU+ and SCEMM- models. This aspect involves the ability of the public organization to 'read', collaborate with and obtain maximum added value from

its suppliers (Doloi, Iyer, and Sawhney, 2011). 'Managing Projects and Assignments' focusses on the competence of the organization to professionally manage its commissioning role in specific assignments, such as projects or maintenance tasks. The aspect covers similar subjects as included in the IM3 and Project Management Maturity Models discussed above. It looks at the organization's ability to specify, tender, contract and manage its outsourced activities. This aspect is strongly related to aspect 7, but covers the 'internal' abilities of the organization, including the competent application of different types of contract forms and the ability to skilfully manage projects (Hall and Holt, 2002).

FEEDBACK FROM EXPERT SESSIONS

Based on the draft version of the maturity model, a series of expert sessions was conducted to validate the design and functionality of the model. The expert sessions confirm that a maturity model for public commissioning is a valuable contribution to the knowledge field, specifically due to the overarching view combining organizational issues and project related competences. Also the experts felt that the aspects included in the model cover the relevant aspects of public commissioning. The experts suggest to add creativity and flexibility as important characteristics of any professional public commissioning organization and to separate culture and HRM into two individual aspects.

Figure 1. Final set of aspects



The development of the model from the focal point of enhancing awareness rather than providing a 'ranking and scoring' instrument, was applauded. At the same time, a 'sticks and carrots' effect was anticipated when results were shared between organizations. Experts valued the method chosen to define maturity levels on the basis of 'well-founded approach', but thought that scoring four indicators per aspect might easily lead to administrative behaviour, rather than thorough discussions. A generic four or five level method was deemed more practical. The current indicators should than serve as a basis for describing each level, but should not be used for scoring purposes.

The experts recommended to include an explanation of the mutual connections and interdependencies between the different aspects. Also, the experts asked to provide a clear guidance and explanation to the maturity model to enhance self-assessment possibilities. The suggestion was made to further develop the maturity model as a basis for a guided workshop within public organizations.

After discussions in expert panels, the following draft version of the Public Commissioning Maturity Model can be presented (see Figure 2).

Figure 2. The resulting draft version of the Public Commissioning Maturity Model

Aspects of professional public commissioning												
										Optimized	5	Maturity level
										Managed	4	
										Standard	3	
										Repeatable	2	
										Ad hoc	1	
Organisational strategy & policy	Culture and leadership	People and learning organisation	Decision models and portfolio	Stakeholder mngt	Public role	Public rules of play	Interaction with supply market	Managing projects and assignments	Creativity and flexibility			
												
1	2	3	4	5	6	7	8	9	10			

DISCUSSION AND FURTHER RESEARCH

Developing a maturity model in the area of public commissioning appears to be essential for the further development of the field. Based on a literature survey and thorough analysis of existing maturity models, a concept version of the Public Commissioning Maturity Model was developed. The results of the expert sessions will be used to improve the maturity model. We are currently preparing the application of the model in 3 to 5 cases, leading to a tested first version of the maturity model. A detailed explanation of the contents and application of the maturity model will be prepared and supporting material for workshop-based discussion sessions within public organizations will be provided.

Based on the experiences of the development of this model, we are convinced that a maturity model for public commissioning adds to the development of the existing body of knowledge on the role of public construction clients. Further research could be aimed to establishing successful approaches towards securing public values, improving business and public administration, purchasing and procurement, and decision models. Research could also incorporate the relationship between aspects and maturity levels and the actual performance of commissioning organizations. As a first step towards establishing this relationship, preparations are made to perform a large survey among public clients. The development of such a large a dataset could provide a representative picture of the commissioning activities of individual commissioning organizations and purvey insight into their commissioning results.

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EXPLORING THE MANAGEMENT OF MULTIPLE BUSINESS MODELS IN ONE COMPANY

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Increased demands for responsiveness and efficiency have led specialized Swedish manufacturing firms and contractors to adopt new production and product strategies. Some firms have adopted multiple business models (BMs) concurrently in order to be competitive in the modern market. A BM can be seen as a conceptual blueprint of a company's money earning logic, and can act as a guiding instrument towards competitiveness. It is known that companies trying to compete with both low-cost and differentiation BMs face challenges such as conflicting value chains and straddling costs. However, further understanding of various aspects of BMs, their implementation and effects (particularly in the construction industry) is required. Thus, the aim of this paper is to explore BM management in a manufacturing firm in the Swedish construction industry, which has adopted evolving BMs (some concurrently) in recent years. The results, based on analysis of long-term (15 years) process data, indicate that strategic events and decisions influence the management of parallel BMs, and that strategic events are important for competitiveness. They also show that successful balancing of concurrent BMs can yield synergistic benefits, such as resource flexibility and lower vulnerability in the construction market. Due to its exploratory nature, this work serves as a first step towards a wider and more general understanding of the management of multiple BMs in construction firms.

Keywords: business model, corporate strategy, longitudinal study.

INTRODUCTION

The development and use of appropriate business models (BMs) can offer companies significant strategic advantages (Zott and Amit 2008). Similarly, it has been argued that in practise BMs are often poorly understood, and that companies often fail commercially due to a lack of attention to their BMs (Teece 2010). There are differing views in the literature regarding the constitutive elements of a BM (Morris *et al.* 2005, Osterwalder and Pigneur 2005), but the creation and delivery of value are commonly held aspects (e.g. Teece 2010, Linder and Cantrell 2000). A BM is defined in this study, following Osterwalder and Pigneur (2005) and Zott and Amit (2008), as the mechanism(s) whereby a company's strategy is translated into a blueprint for the company's logic for earning money.

The aim of this paper is to explore the evolution, over 15 years, of a manufacturing firm in the Swedish construction industry, analysing the strategic changes that occurred (and decisions taken) from a BM management perspective. During the focal time period the company applied between one and four BMs in parallel, as a consequence of both intentional strategic decisions and events. From a strategic

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viewpoint the development of existing or emergent BMs should aim to align these models to business strategy and the value chain concept (Porter 1985), and thus include value systems and strategic positioning (Porter 1996). This view is elaborated by Casadesus-Masanell and Ricart (2010), who define a BM as a reflection of the firms' realized strategy. However, Stähler (2002) and Magretta (2002) stress that the concept of BMs, as opposed to strategy, does not include performance and competition. It is therefore important to determine to what degree the case company's changes in BMs can be seen as a reflection of the company's strategy, effects (intentional and unintentional) of strategic decisions from a BM perspective, and whether it is possible to relate strategy, BMs and performance. To investigate these relationships the presented analysis has the following three main objectives, to:

5. Identify major aspects and elements of BMs.
6. Examine changes in the BM constructs through the notion of management of a portfolio of parallel BMs within the same company.
7. Empirically identify how strategic choices and decisions affect BM management and the performance of the company.

The first two objectives are approached through deductive summarization of previous research on aspects of BM constructs and management, both generally and in the construction sector specifically. The summarized concepts provide a theoretical grounding, which is used to address the third objective.

BUSINESS MODEL CONSTRUCTS

Some authors have suggested that the concept of BMs has no place in economic theory, strategic studies or marketing science (for example Zott *et al.* 2011). However, Teece (2010) emphasizes that BMs have obvious importance in interdisciplinary dimensions that are frequently mentioned but rarely analysed. Furthermore, despite burgeoning literature on BMs within business and management fields generally, there is little understanding of BMs applied in the building and construction sector, and their effects (Pan and Goodier 2012). In two recent case studies BMs were examined in off-site house construction in the UK (Pan and Goodier 2012) and industrialized house construction in Sweden (Brege *et al.* 2014). Both papers review and discuss the BM concept in business, strategy and management theoretical frameworks. In their review Brege *et al.* (2014) outline how a BM construct describes the alignment between the environment, a company's offerings, its internal and external resource base and activity.

In their comprehensive study Morris *et al.* (2005) found that the most frequently cited elements of BMs (in any industry) are: value offering, economic models, customer interface/relationships, partner networks/roles, internal infrastructure/connected activities and target markets. However, BMs are often handled as meta models in the literature, reflecting a view that it is generally difficult for companies to implement them operationally, although all companies employ BMs, either explicitly or implicitly. Four main elements described by Osterwalder and Pigneur (2005) were recognized in the deductive summary of previous research (Objective 1), and used in the BM construct employed in this study. These also fall within the frameworks of both Brege *et al.* (2014) and Morris *et al.* (2005). The four elements are briefly described below.

Product

Product is defined as value, for both the customer and company, and can be seen as a measure of what needs are met, and how they are met, by a specific product or service.

Customer interface

Customer interface refers to channels used to reach and communicate with specified customers, and the company's relationships with those customers.

Infrastructure management

Infrastructure management refers to the activities and strategies involved in delivering value to the customer and the company.

Financial aspects

Financial aspects are the costs of the key resources required for the BMs, and commercial benefits associated with the BMs through the creation of value for both the company and customer.

MANAGEMENT OF A PORTFOLIO OF BUSINESS MODELS

In the customer-interface construct of Osterwalder and Pigneur (2005), a key aspect of multiple BM management is that different customer segments should be managed by different BMs, to avoid conflict. A common solution to this problem found in the literature is to house different BMs in separate business units (e.g. Christensen 1997, Porter 1986). However, such solution is not without risk, as more recent research has shown. Day *et al.* (2001) argue that strict separation between BMs can prevent certain ventures from obtaining valuable resources. Markides and Charitou (2004) identify further potential conflicts, such as customer base cannibalization and undermining of the existing distribution network.

Alternatives to separation have emerged, notably Markides and Charitou (2004) point out that firms must achieve a balance between distancing parallel BMs so that they do not suffocate each other, and keeping them close enough to exploit synergies. Ghoshal and Gratton (2003) advocate the creation of incentives that encourage cooperation among the separate units, while Govindarajan and Trimble (2005) propose systems that allow parent and separate units to cooperate while maintaining their independence, and O'Reilly and Tushman (2004) propose the integration of separate units into firms' existing management hierarchy. Sabatier *et al.* (2010) propose the use of a BM portfolio as a strategic tool that can help to improve the coordination of a firm's resources and capabilities. They present case studies on the use of different BMs by small biotechnology firms illustrating two generic strategies, named core competence extension (CCE) to enlarge markets and address additional customers, and core competence redeployment (CCR) to serve new markets with existing core competence. Thus, adopting a portfolio of multiple concurrent BMs theoretically permits a firm to diversify within its operational sector and extend its operational range (Sabatier *et al.* 2010).

A CONCEPTUAL FRAMEWORK

The conceptual framework of the concurrent management of multiple BMs applied here is based on the above literature review. The management of multiple BMs is a multi-layered process, and a schematic of the conceptual framework proposed to link these layers is presented in Figure 1. If the BM is seen as a reflection of a firm's

strategy, as proposed by Casadesus-Masanell and Ricart (2010), Osterwalder and Pigneur (2005) and Zott and Amitt (2008), it is important to understand how existing and/or emergent BMs are prioritized over time. Strategic decisions and events might cause unintentional or intentional changes in BMs, leading to strains or synergistic effects within and between the different BMs (Stähler 2002, Magretta 2002). It is also necessary to understand if and how activities are employed with respect to CCE to enlarge markets at different value chain stages or reposition offers towards other markets, and CCR to serve new markets or completely new offers (Sabatier *et al.* 2010). Lastly, it is important to understand how integrating mechanisms (IMs) are used to link separate units in order to balance the BM portfolio, as stated by O'Reilly and Tushman (2004).

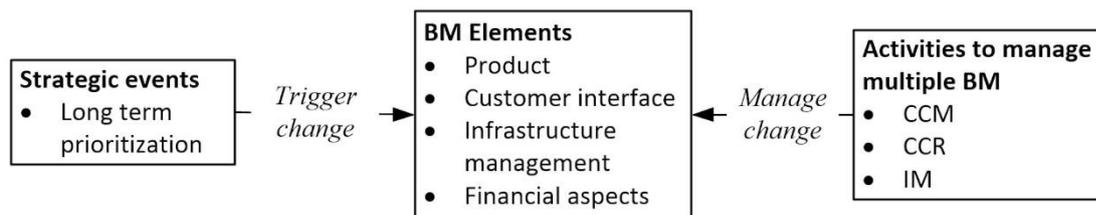


Figure 1: The conceptual framework

METHODS

This research is based on an explorative longitudinal case study performed within one company. The overall aim is to increase understanding of the management strategies adopted by the case company with regards to its handling of existing and emergent BMs, with a long-term perspective. A qualitative approach was applied to capture the business context more completely, in terms of apparent phenomena, that is currently possible using quantitative methodology (Yin 1994, Cronbach 1975). The particular company was selected because it had three particularly relevant characteristics. The company is a typical manufacturer in the construction industry, where volume production has to be managed together with various customised building projects. This leads to conflicts, discussed in the theory section, related to several concurrent BMs. The case company also expressed willingness to participate in the research to assist its efforts to enhance competitiveness by combining volume production with customised building projects. Furthermore the first author has an affiliation with the company, facilitating access to information regarding key historical and current processes, and financial data.

In order to validate the analysis and findings, data were gathered from multiple sources. Firstly documents and management protocols from 1997 to 2013, together with financial data, were examined to identify specific strategic events and decisions taken by the company board. Five workshops were subsequently held with the in-house management, in which different phases of the company's 15-year development were discussed to understand how events and decisions have affected the company. All workshops focused on the conceptual framework, including open questions related to products, customer interfaces, infrastructure management and financial aspects during different phases. Finally, structured interviews, also based on the conceptual framework, were held with the company's product manager, production manager, purchasing manager and CFO, all of whom have been working in the company since 1997.

Visual process mapping was used to identify patterns in the data including phases, events and decisions, and to understand how they affected BMs over time. This was done, using the conceptual framework displayed in Figure 1, in three parallel efforts to:

8. Identify the constructs and elements of the BMs intentionally and unintentionally adopted, based on the framework proposed by Osterwalder and Pigneur (2005).
9. Identify the long-term prioritizing of BMs through strategic decisions. Changes in these priorities are used to define different phases applied in the empirical description and illustrated in Figure 2.
10. Evaluate the management of concurrent and multiple BMs in a retro perspective to identify CCE, CCR and IM. Results of this evaluation are also summarized in Figure 2.

Visual process mapping provides only moderate generality, as the underlying elements are highly variable and some may not be present in specific cases. However, Langley (1999) argues that it provides opportunities to compare cases and identify common sequences of events and progressions, allowing assessment of the transferability of findings to other situations.

EMPIRICAL DESCRIPTION OF IDENTIFIED CHANGES IN STUDIED PROCESSES

Results obtained from examining relevant documents, workshops and interviews concerning the case company's strategic decisions, associated events, BMs and performance during four identified phases are summarized and visually mapped in Figure 2. Return On Capital Employed (ROCE) is used as an economic indicator to identify how strategic decisions affected the case company's performance in each of the phases. It should be noted that ROCE should be used cautiously in this context, as it may be influenced by underlying business and economic factors.

Phase 1

In 1997 the company focused on producing standardized products in a broad product set at a low price. Major customers were industrial house builders, and the company only produced through direct customer orders, using two old production lines and a small administrative unit, thereby keeping costs at a moderate level. The ROCE was positive with a relatively low turnover, sales increased by about 36% per year and earnings approximately doubled over six years. Much of the profit increase was attributed to greater exploitation of current production capacity with the same fixed costs.

Phase 2

In 2003 a new owner changed focus from the production of standardized products to their customization. The company could then offer products with higher initial prices through a higher degree of prefabrication. The organization was expanded, as the offered products needed higher technical expertise to provide support to its customers. The company also invested in a modern saw line to cope with the customization. For three years sales increased by 60% per year on average, but profits did not increase at the same rate. During this phase, the company developed its own building system, and target customers were existing single-family house manufacturers. To demonstrate this new building system to the market the company engaged in a major construction

project. One new resource, a salesman with the sole target of increasing sales of the building system, was brought in. No other specific resources were secured to handle the business and operational logistics of housing construction. During development of the building system the company also decided to invest in an additional plant for customization of the standard product.

Phase 3

Shortly after the investment in phase 2 another new company board issued new directives and decided to invest in a new production line for standard products to replace the two older production lines. The in-house leaders were still oriented towards customer order production and customization when the new production line was designed. The new board hastened the development of the new production line, but as in phase 2 (for the building system development) the company's core business resources were utilized to develop its specifications. To cover the investment, the board decided to expand into large-scale export markets.

Due to the combined stresses imposed by large-volume customer demands for low prices, the complexities of maintaining a production line designed for customer order production, and the ongoing development of the building system the ROCE dived. Problems with the new production line emerged, and eventually the company decided to replace the newly installed line with another brand new line, completely adapted for volume production. The new plant worked much more efficiently, but the board eventually decided to withdraw from the large-scale volume export market, because the venture had been unprofitable due to the price cuts made to enter it. Furthermore, at this point customers demanded small batches, and shifting between products took a long time with much material wastage.

Phase 4

In 2011 the company board decided to implement a Lean production philosophy. Slowly the company started to change the production approach to maintenance of small stock and used customer order management to minimize waste and costs, while simultaneously implementing practices to increase production flexibility. The organization also became aware of the parallel BMs being applied, and the board decided to split the company into two distinct BMs, one focused on production of standard products and the other focused on customization. The two parts were separated financially, but the company also saw synergistic benefits of keeping them within the same company. Specific resources and development work were shared, allowing the company to respond flexibly to shifts in demand for quantities and types of products by sharing resources between the two parts operating under different BMs.

MANAGING MULTIPLE BUSINESS MODELS

Seven observed events (ownership changes and strategic decisions) triggered changes in BMs and created four distinct phases in the 15-year study period, as described above. As illustrated in Figure 2, the key decisions were to: (I) develop the building system, (II) enter new export volume markets, (III) withdraw from these markets, (IV) implement Lean production philosophy, and (V) divide the company into two distinct BMs. Four BMs that were applied during the period can be identified (Figure 2), designated 1-4, and a sub-class (1b), regarded as a refinement of BM 1.

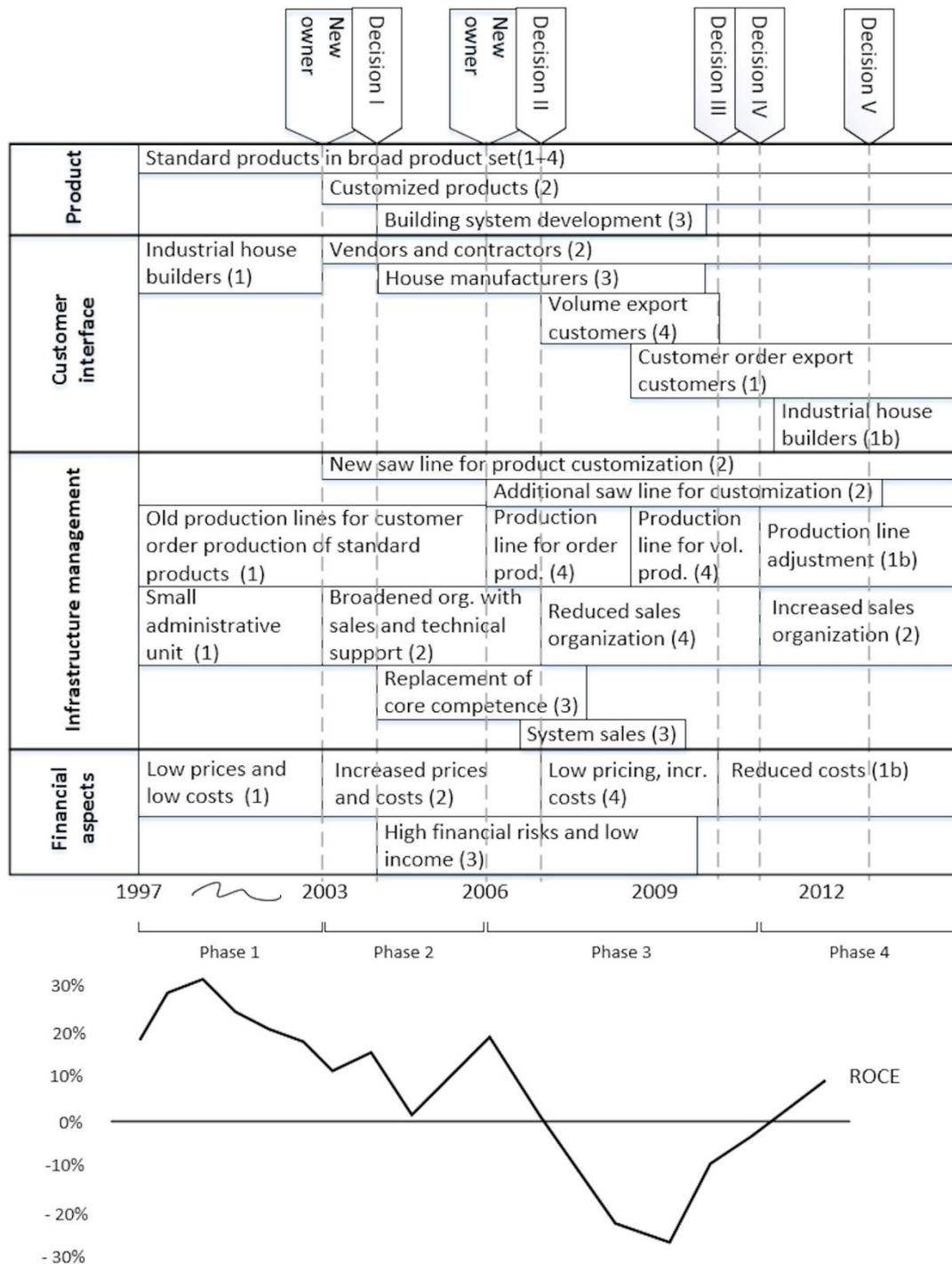


Figure 2: Longitudinal changes related to shifts in business models and ROCE

Analysis of the acquired data within the conceptual framework shows that the company initially had a strong focus on value during phase 1 with a targeted customer base, appropriate resources and high BM awareness. However, during phases 2 and 3 the company unconsciously attempted to apply parallel BMs, but failed to align them. This led to a mismatch of customer needs with resources. In phase 4 the company came to a new understanding of the reasons for the internal problems and losses of performance during phases 2 and 3, then acted to rectify previous mistakes.

From a BM perspective the four phases are quite distinct. Strategic events triggered the extension of old BMs, and unintentionally created new BMs. This is consistent

with the proposals by Casadesus-Masanell and Ricart (2010) among others, that BMs reflect firms' strategies. Signs of this unintentional management of the BM portfolio are visible in the changes in ROCE in Figure 2. The main findings, regarding synergies and interactions in the management of the BM portfolio, are further depicted in Table 1.

Table 1: Phases related to strategic triggers and activities to manage multiple BMs

	Phase 1 (BM1)	Phase 2 (BMs 1, 2, 3 and 4)	Phase 3 (BMs 1, 2, 3 and 4)	Phase 4 (BMs 1b and 2)
Long-term prioritization	Initial strategic decisions Focused marketing activities Awareness of existing BM	Awareness of BM1 and BM2 Lost focus on BM3	Unintentional new BM4 parallel to BM1-3 Split focus on BMs Lost focus on BM3	Intentional focus on BM1 (developed to BM 1b) Increased focus on BM2 Awareness of existing BMs
CCE		CCE for new market niche No CCE extension for BM3	Production and sales CCE for BM4 Decrease of sales resources for BM2	CCE in sales for BM2
CCR		CCR from BM2 to BM3	BM4 unintentionally linked to BM1 and BM2	
IM		BM1 and BM2 - tightly linked BM3 - stand-alone unit		BM1b and BM2 split with remaining synergies

The identified strategic activities (in terms of objective 3) are the allocations of resources and IMs that affected the BM management. In phases 2 and 3 decisions were clearly not taken from the perspective of multiple BM management, but rather as general strategic responses to topical market conditions. While the strategic decisions were intentional, they caused the emergence of unintentional BMs. These unintentional models (primarily BM3 and BM4 in Table 1) were not appropriately addressed, as evidenced by the lack of significant action (such as competency strengthening) to support the models and associated market positions. Consequently, BM3 was unsuccessful, a general effect of inadequate competence resources demonstrated by Sabatier *et al.* (2010). The long-term perspective of strategic events clearly shows that the need to align BMs, in order to optimize the BM3 money-earning logic, was not acknowledged or addressed. When multiple BMs were recognized in phase 4 the company decided to manage the two parts as separate units, but with integration mechanisms, in accordance with proposals by O'Reilly and Tushman (2004) and Markides and Charitou (2004).

Several management approaches inform the conceptual framework used in this research. While these concepts are all representative of BMs used in the literature, BM theory is not robust (see, for instance, Zott *et al.* 2011), thus optimal ways to combine the approaches, and their interactions, have not yet been established. Notably, several authors question the inclusion of strategy in the BM concept (e.g. Stähler 2002). Accordingly, this study shows that strategic events can (intentionally or unintentionally) trigger changes in BMs, indicating that strategy should be considered a factor that influences BMs, rather than a component of them. The empirical evidence further demonstrates that CCE, CCR and IM may all affect the management of multiple BMs. When unintentional CCE, CCR and IM became intentional at the case company, ROCE increased, indicating an increase in company performance. Clearly, further theoretical grounding of CCE, CCR and IM is required to enhance the theoretical rigour of the conceptual framework.

CONCLUSIONS

A BM is seen as a conceptual blueprint of a company's money earning logic, and can act as a guiding instrument towards competitiveness. However, the concept of BMs within the construction industry requires further theoretical development. The first two objectives of the research presented here were to identify major elements of BMs and examine change constructs using a conceptual framework based on a portfolio of BMs. Application of this conceptual framework revealed several interesting phenomena. Firstly, it showed that construction practise is insufficiently aware of BMs and consequences of BMs being unintentionally triggered by various strategic decisions or events. The framework provides a plausible explanation of the ineffective management of the case company, in terms of unintentional BMs. The influence of strategy on BMs, and its effects on parallel BM management, also becomes apparent. Finally, the framework provides a means to identify different BMs, and in conjunction with performance data (which was the third objective) reveals the importance of events and decisions for competitiveness. The results indicate that unawareness of BMs, and the importance of balancing BM portfolios, reduce management effectiveness and (thus) impairs performance.

In conjunction with empirical evidence the framework connects “*strategic*” activities to the management of a portfolio of BMs. Intentional balancing of a BM portfolio (as illustrated by phase 4 in the study) can provide synergistic benefits, such as resource flexibility and reduced vulnerability in the construction market. Owing to its exploratory nature, the results of the study provide a stepping stone for future research directed towards an understanding of construction firms’ management of multiple BMs.

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PLANNING, PRODUCTIVITY AND QUALITY

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REBALANCING THE CONSTRUCTION PRODUCTIVITY DEBATE

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Subcontracting is a common aspect of all construction markets but is a particular feature of countries like the UK, Italy and Australia, where similar statutory, political and regulatory changes have reduced the number of vertically integrated firms and driven increased fragmentation and self-employment in the industry. While subcontracting has produced many advantages, particularly around flexibility, it has also led to many challenges around coordination and productivity. It is therefore surprising that subcontractors have been missing from the productivity debate. To rebalance the debate, eight focus groups were conducted with seventy one of Australia's leading tier-one subcontractors. The results indicate that from a subcontractor's perspective productivity could be improved significantly by fairer and more inclusive workplace practices which provide more opportunities for subcontractor's to innovate and to share risk and reward.

Keywords: productivity, subcontractor, fairness, trust, risk, innovation.

INTRODUCTION

There are many good reasons for Australian construction firms to improve their productivity. Numerous reports have pointed to evidence of an increasing gap between wages and productivity which in the long-term is unsustainable (AIG 2008, BCA 2012, MBA 2013). This debate is not new and neither is it unique to Australia. While Abdel-Wahab and Vogli (2011) argue that productivity research is weak on empirical evidence and Sezer and Brochner (2013) argue that construction productivity data is inherently problematic because of the heterogeneity of inputs and outputs and because of the need to account for variations in service quality, there is significant evidence that there has been a persistently low rate of construction productivity growth in many countries. For example, Jergeas (2009) found significant room for improving productivity in the Canadian construction and engineering industry. Ailabouni *et al's* (2009) research in the UAE produced similar conclusions as did Chia *et al's* (2012) analysis of Malaysian construction productivity and Abbot and Carson's (2012) productivity analysis of the New Zealand construction industry. Abdel-Wahab and Vogli's (2011) analysis of productivity trends across Europe, Japan and the US showed a widening gap between productivity growth in construction and other sectors and that Japan and Germany even showed negative growth.

Given the above, it is not surprising that there has also been a vast amount of research into construction productivity stretching back over fifty years. A review of construction management literature published in eighteen leading internationally peer reviewed journals and conferences and PhD theses over the last thirty years produced

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four hundred and eight references looking at a wide variety of issues (ARCOM 2014). While this research has undoubtedly advanced our understanding of the subject of productivity, the literature at project level reflects of the dominant power structures within the industry and almost entirely presents a principal contractor's perspective. There are only two references to subcontractors across the entire sample of articles that relate to productivity and, in the same way that ever more risk has been passed down the contractual chain to subcontractors, the productivity literature reflects an assumption that there is only one side to the debate and that subcontractors' opinions are of no value in this debate.

Given the importance of subcontractors in the construction industry, there is clearly a need for a more balanced perspective. Subcontractors are absolutely central to the construction industry's productivity since they employ the vast majority of people in the industry and represent the front-line where the physical task of construction is undertaken on site. This imbalance in the productivity debate is especially inappropriate in the construction sector. As the CFMEU (2011) points out, the construction industry employs five times as many independent contractors as any other industry in Australia and accounts for 33% of all independent contractors in Australia. The situation is the same in many other countries such as the UK and USA, where subcontracting is the dominant form of employment in the construction sector. In relatively small markets like Australia, a focus on subcontractors is likely to be even more insightful. There are a relatively few tier-one subcontractors and most tend to work with most of the nineteen major contractors which undertake the vast majority of work in the industry. In Australia, tier-one subcontractor insights therefore represent multiple insights into how major contractors' management practices influence productivity in the industry. Within this context, the aim of this paper is to explore the issue of productivity from the tier-one subcontractor's perspective. More specifically, it is to explore what needs to be done to improve productivity from a subcontractor's perspective and to identify priority areas that should be focussed on.

CONSTRUCTION INDUSTRY PRODUCTIVITY

Every country faces different challenges in addressing the productivity issues highlighted above. In the UK, Horner and Duff (2001) argued that there had been precious few changes to the way construction projects had been managed over the previous fifty years and that there was huge room for improvement on most sites. The main causes of lost productivity in site were found to be: interruptions; size of the labour force; unplanned increases in labour force; working continuous overtime; poor site management; fragmentation; no focus on productivity poor productivity training; a lack of detailed planning; contractual conflict; poor design; lack of commitment to continuous improvement; a lack of trust; poor workforce consultation; productivity is not rewarded and; difficulties in measuring and monitoring productivity. Also, in the UK, Chan's (2005) interpretivistic approach to understand the factors influencing construction productivity concluded that site welfare, job prospects, skills training and qualifications were critical to sustaining long-term productivity improvements. Chan's research also discovered a chasm between white-collar managers and blue-collar operatives, and argued that more paternalistic supervision underpinned by a genuine desire to understand and respect the workforce would benefit productivity. In the US, CII (2008) analysis of over three decades of research data from the Construction Industry Institute's (CII) productivity database and field tests found that technology improvement was key to productivity improvement. While the productivity benefits of many new technologies remain untested, those that had been proven to increase

productivity included: construction automation; integration and automation of project information systems and; automated material identification and tracking systems. In Canada, Jergeas's (2009) work breakdown study of a wide range of construction trades showed that the average work time was 53.17% and that productivity could be improved by: better measuring of productivity; setting and communicating productivity targets; performance-based incentive programs; staff engagement programs and fostering a culture of productivity. Among many suggestions for improvement, Jergeas (2009) also pointed to the importance of: recruiting, educating and retaining productive and skilled workers; improved frontline management and leadership; of constructive workplace relations and scheduling that respect worker's rights and well-being; focussing. Ruwanpura's (2009) National Science Foundation project in Canada produced similar conclusions and Ailabouni *et al*'s (2009) analysis of 956 data sets across seven trades on six construction sites in the UAE found that the most significant factors influencing productivity were "*work timings, competent supervision, group dynamics, control by procedures, availability of material and climatic conditions*".

More recently, Chia *et al*'s (2012) analysis of Malaysian construction productivity census data found that 'machine-for-labour substitution' and 'industrialisation of the production process' were the main factors driving productivity. However, Abbot and Carson's (2012) productivity analysis of the New Zealand Construction Industry concluded that while productivity grew consistently up until 1975, it has been sluggish ever since, despite the introduction of labour saving technologies such as new equipment, tools and off-site fabrication.

Finally governments around the world have also made productivity a focus in recent years. The Singapore Government is arguably the most focussed of any government in driving up productivity in the construction industry and it has produced a 'Productivity Road Map' to guide this process. The Road Map comprises four strategic thrusts: introducing regulatory requirements and setting minimum standards to drive widespread adoption of buildable design and labour-saving technology; providing financial incentives to encourage manpower development, technology adoption and capability building; regulating the demand and supply of low cost foreign workforce and; enhancing the quality of the construction workforce. In the UK, the Strategic Forum for Construction, through demonstration projects, has sought to demonstrate the productivity benefits of following its six construction commitments: procurement and integration; commitment to people; client leadership; sustainability; design quality and; occupational health and safety.

METHOD

To explore and add to the above literature a subcontractors' perspectives on what should be done to improve construction productivity, eight focus groups were conducted with seventy one of Australia's most prominent tier-one subcontractors. Tier-one subcontractors or Prime subcontractors are defined as those which work directly for the membership of the Australian Contractors Association (ACA) which represents the interests of major contractors that dominate the Australian Construction market. Tier-two and tier-three subcontractors are those that are employed by the prime subcontractors further down the contractual chain. Unlike tier-two and tier-three subcontractors, tier-one subcontractors have a direct interface with these large firms and were chosen because this enables them to provide the most informed insights into common industry subcontract management practices.

Focus groups are under-used in construction research, but outside this field are widely recognised as an effective way to promote interaction and self-disclosure among a carefully structured group of respondents. As Morgan (1997) and Powell *et al* (1996) explain, focus groups are a form of group interviewing which involves presenting questions to a number of people at the same time. In contrast to individual interviews, focus groups have the advantage of eliciting a multiplicity of views and emotional processes within a group context, producing additional insights from the interactions between group participants that would be less accessible without interaction found in a group setting. Listening to others' verbalized experiences stimulates memories, ideas, and experiences in participants and group interactions enable participants to ask questions of each other, as well as to re-evaluate and reconsider their own understandings of their specific experiences (Lindlof and Taylor 2002).

While badly managed focus groups can also be intimidating at times, especially for inarticulate or shy members, the skill of the facilitator is to avoid this from happening to enable a collective mind to reveal collective insights in a way which could not be done if the same number of respondents were interviewed individually (Race *et al* 1994). Effective facilitation not only relies on the facilitator but on getting the right mix of people to stimulate debate and to provide diverse opinions and experiences (Goss and Leinbach 1996). At the same time, participants need to feel comfortable with each other. So in a construction industry context it is important to avoid people who might be in conflict or competition with each other. To this end, senior managers (managing directors and directors) from tier-one subcontractors from across Australia (Western Australia, New South Wales, Victoria and Queensland) were invited to one of eight, three hour focus group workshops. Individuals were invited on the basis of recommendations from one major Table 1 Sample structure (focus groups)

Table 1: Sample structure

Focus Group	Trade	Number of focus group participants
1	Structural, Formwork, Mechanical, Façade, Groundwork, Precast.	6
2	Stone, Cladding, electrical and communications, suspended ceiling and partitions, tiling, plumbing, joinery	7
3	Concrete, Tiling, Plumbing, Steel fixing, Structural, interiors	7
4	Shop fitting, Electrical (2), Groundwork, Plaster boarding, structural, services (2), precast	9
5	Plumbing, services (2), electrical (2), Structures, Concrete, painting, civil engineering (2)	10
6	Formwork (2), groundwork, electrical (2), facade, mechanical, concrete (2), Plumbing (2)	11
7	Glass and aluminium (2), services and air conditioning (2), Painting, Lifts/elevators (2), Interiors and fit out	11
8	Joinery, electrical, services, precast (2), painting, fit out (2), fabrication, plaster boarding	10
TOTAL		71

Each focus group was transcribed, summarised and presented to the focus group participants for feedback, editing and comment. These changes were then incorporated into the final transcript which were then synthesised into one combined transcript for narrative analysis, selections of which are presented below. As Meisel (2011: 2023) points out, the power of narrative is in translating respondent accounts into data that people can comprehend... *“Stories are an essential part of how individuals understand*

and use evidence". Clearly, from over thirty two hours of focus group discussions, it is not possible to recount everything that was said in this paper. So what is presented are the main points which were issues of agreement across all the focus groups.

DISCUSSION OF RESULTS

All respondents felt that productivity was strongly influenced by the quality of relationships on a project .. *"its all about relationships"* [Respond #60]. .. *"relationships are everything"* [Respond #44]... *"A good team can make a huge difference to productivity .. 20-30%"*... [Respond #7]. This data supports Chan's (2005) study which pointed to trust and respect between managers and workers being critical to productivity. However, in contrast the existing literature on productivity, tender practices also emerged as a strong recurring theme in the discussions. Timing, ethics and opportunities for innovation were the recurring themes which emerged from our discussions. As one respondent said.. *"There is no time to innovate. Tender periods are too short. .."* [Respond #39].... *"Subcontracts are let too late, especially if you are an up-front subby. We don't have time to plan"*. [Respond #23].... *"our experience is that our innovations are shared with competitors and used against us. So we keep any innovations in our back pocket. Trust and integrity is all too often missing"*. [Respond #16].... *"We hold back our smarts because we know they will share our IP. If there was more trust then we could contribute a lot of smarts up-front and make the project much faster"* [Respond #43]. While the repeated references to the ethics of tendering were new insights in the productivity debate, references to innovation were also significant since there has been a large amount written about this subject in the construction industry (Abbot *et al* 2007, Sexton *et al* 2008, Gambatese and Hallowell 2011). Our study provides, for the first time, specific evidence of a potential link between innovation and productivity which needs to be explored further. Another significant insight was the importance of good design as a driver of productivity. Poor design was identified by numerous authors such as Horner and Duff (2001) as a barrier to productivity but our study also notes, in support of Koskela *et al* (2002) that the quality of design documentation and design management is a major problem ... As a respondent said ... *"Jobs are being designed on the run – often behind construction.. This was seen as a particular problem on design and construct projects where the architect is novated to the contractor. A number of subcontractors argued that their loyalties often remained with the client and that they had already exhausted their fees. So .. as one respondent said.. "they are reluctant to do any more work."* [Respond #12].

There was also a widespread perception that the quality of management and supervision was compounding this problem, driven by an aging workforce and by an increasing reliance on graduates with little work experience to undertake site management roles. *"Companies are losing the older staff who understand how to build"*. [Respond #2]... *"the best site managers are from the trades ... They are the better supervisors since they know how to build and have more empathy with subby problems and challenges"*. [Respond #8]. One specific area of declining competence was in site scheduling and planning, supporting the findings of CII (2008) and Jergeas (2009). Our respondents suggested that in line with the tendency for principal contractors to transfer ever more risk to subcontractors, there was a growing tendency for main contractors to absolve their responsibilities in this area. ... *"Poor coordination is a major problem. Subcontractors are left to coordinate themselves"* [Respond #44].

Our findings also supported Horner and Duff's (2001) warning about the potential productivity implications of continuous overtime and unplanned increases in labour. However, it also extends Lingard's (2004) research on 'burnout' in the construction industry into the realm of subcontractors. 'Burnout' was a word that was regularly used by respondents to describe the impact of the problems discussed above on subcontractor site labour... *"..We work double shifts, overtime and night shifts. It's more of a catch-up speed rather than a start-to-finish speed. People are getting burnt-out"* [Respond #16]. The potential causes of burnout posited by our respondents were numerous and included references to poor planning and scheduling of work. However, they also pointed to a growing administrative burden on projects, especially around safety and environmental *"green"* compliance. *"..The volume of information on projects is becoming overwhelming and a serious burden. On some projects, it is not unusual for a subcontractor to have 40% of his workforce non-productive"* [Respond #19]... The perceived causes of this problem were principal contractors' over-reaction to new government regulation; poor document control and; inexperienced supervisors...

Finally, in support of Jergeas (2009) but in contrast to many other studies on construction productivity, all of the respondents identified industrial relations (IR) as a major productivity issue in the construction sector. In Australia, many subcontractors have to sign-up to Enterprise Bargaining Agreements (EBAs) which dictate minimum wages and entitlements for their workers. Controversially, union delegates are often employed on construction sites (and paid by contractors) in order to monitor the implementation of these agreements and to smooth industrial relations on site to keep a site productive. EBAs and the union delegates who enforce them were both a major concern among the respondents... *"If we know a certain delegate is on a job then we could price it 20% higher or even not price it at all. They make a huge difference to how the job runs. Some are reasonable to want to help. Others have their loyalties to the unions and can disrupt a job hugely by calling stoppages"* [Respond #38].

CONCLUSIONS

The aim of this paper was to explore the issue of productivity from a subcontractor perspective. The vast majority of the literature in this area takes the client's and contractor's perspective and there is a need for a more balanced approach which reflects who actually does the work. In general, across the seventy one major tier one subcontractors interviewed, there was widespread agreement on what needs to be done to increase productivity. While one could also argue that there is an equal tendency to point the finger and blame outsiders in the subcontracting fraternity as there is among main contractors, these views at least as a counterpoint to the dominant view represented in the current construction management literature. In particular it indicates that more attention needs to be given in this literature to tender practices (ethics and timing) to enable innovation and productive relationships to emerge. The ageing workforce is also an emerging issue around competency development as is design management and industrial relations. In terms of practical recommendations, our results indicate that contractors should avoid bid shopping, respect subcontractor IP, provide more time for pricing and involve subcontractors earlier in the process. Contractors should also encourage innovation and build trust by integrating their supply chain by sharing risks and rewards with subcontractors, forming supply chain partnerships, pursuing collaborative procurement and focussing on value not cost. There is also a clear need to up-skill junior staff in project management, planning, scheduling and coordination, communication, relationship building and business

ethics. Going forward, further research might explore the alignment of views about productivity between subcontractors and principal contractors and explore any differences which in themselves may be a cause of lost productivity in the sector.

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ENHANCING LABOUR PRODUCTIVITY WITHIN CONSTRUCTION INDUSTRY THROUGH ANALYTICAL HIERARCHY PROCESS, THE CASE OF GAZA STRIP

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Construction sector plays a leading role in economic growth for countries all around the world. Since construction is a labour intensive industry, productivity is considered a primary driving force for economic development. In the Gaza Strip, the economy is severely challenged by the combined effects of rapid population growth and the closure policy imposed on the area since 2007. Owing to this situation, construction projects are characterized by low profit margin, time and cost overrun making labour productivity a key component of company's success and competitiveness. Although, labour productivity has been subject of study by many researchers, a deeper understanding is still required to improve labour productivity. The main aim of this study is to identify key factors affecting labour productivity in the Gaza Strip. It also aims at formulating a labour productivity baseline model using the Analytical Hierarchy Process (AHP). By reviewing the literature and conducting depth interviews with experienced engineers, thirty critical factors related to labour productivity were identified and categorized into six groups: psychological, experience, supervision and leadership, physical, time and workload, and external factors. Based on the Analytical Hierarchy Process approach, a questionnaire was designed and delivered to sixty contractors to elicit the view on how labour productivity might be affected. A total of 56 feedbacks were analyzed through the AHP. The results indicated that Job satisfaction & security, lack of incentive scheme, skill & experience, drug use, overtime and weather changes have a significant impact on labour productivity in GS. In addition, the developed AHP model provides a framework that can assist managers in evaluating multiple factors and hence effectively improve labour productivity.

Keywords: analytical hierarchy process, Gaza Strip, labour, productivity.

INTRODUCTION

The construction sector plays a key role in boosting the economy, largely through the lens of generating the potential for employment. In this respect, the construction industry utilizes various types of resources that include; labour, equipment and materials. Particularly, in Palestine, Labour accounts for 30-50 percent of the project's cost (Mahamid, 2013). Such a statement would point to scoring effective planning and how to manage individuals in a team. These are not only necessary to deliver a successful project but also to realizing a healthy profit.

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The construction sector is one of the main driving forces to mobilizing economic growth. The statistics illustrates that the share of the labour force in the Palestinian construction industry increased from 13.2% to 15.6% for the years 2010-2013. (PCBS, 2013). Associated to labour, labour productivity is an issue of major concern in the Gaza Strip (GS). This is due to common phenomenon of project's time delays and cost overrun tied to poor labour productivity (Enshassi *et al.* 2013). Hence, improving labour productivity is vital to successful project management.

Fluctuation in labour productivity is caused by many qualitative and quantitative factors. Identifying these factors and quantifying the extent to which each might have an impact on labour productivity is important to better manage labour. Although, various aspects related to labour productivity within the GS construction industry have been documented, it remains to explicitly identify a clear set of factors affecting labour productivity taking into consideration the interrelated relationship among them. With particular focus on GS, the construction sector in this area is confronted with many challenges, but one of critical impact is labour productivity. The aim of this research is, first, to identify significant factors influencing labour productivity in the GS from contractors' viewpoint and, second, to initiate the basis for labour productivity model using the Analytical Hierarchy Process.

A LITERATURE REVIEW

The literature is rich in providing several contributions related to construction labour productivity within the construction industry. Categories in previous studies can be classified into either identification factors associated with labour productivity or developing the methods and techniques necessary for estimating labour productivity (Yi and Chan 2014). In doing so, a first step is to understand and evaluate how different factors influence labour productivity. This step is a preliminary step as it assists project managers in outlining the deficiencies and therefore establishing an overall optimization strategy. A significant body of research emerges which despite differences in many countries addresses different parameters affecting labour productivity (Karimi and Gidado 2012). Durdyev, *et al.* (2012), for example, suggest factors that affect labour productivity in Turkey from the perspective of consultants, contractors and subcontractors. Lack of local experienced labour, schedule pressure caused by the Government and working overtime have been, amongst others, the most distinguished parameters. Differently, but related, Ng, *et al.* (2004) have explored the de-motivating factors in Hong Kong within labour employed in civil engineering works and followed by suggesting the consequences on labour productivity. This study reveals that extensive reworks, overcrowded work areas, problems occurred in crew interfacing, availability of tools, delays in inspection, availability of materials and incompetence of site foremen have caused 5.1–13.6 lost in man-hours per week. Furthermore, Enshassi, *et al.* (2007) go further and identify ten main factors that negatively affect labour productivity within building projects constructed in Palestinian. These include materials shortages, a lack of labour experience and surveillance, in addition to drawings and altering specification occurred during execution and payment delays. Similarly, Soekiman, *et al.* (2011) classifies the key groups influencing labour productivity using a survey of the construction companies registered in Indonesia. These groups are supervision, material, execution plan and design. Another study has been conducted on Uganda construction industry (Alinaitwe *et al.* 2007). Its findings indicates that incompetent supervision, lack of skills, rework, lack/breakdown of tools, poor construction methods, poor communications, inaccurate drawings, stoppages due to rejected work, political

insecurity and weather conditions largely influence labour productivity. Collectively, it can be argued that there is a lack of universal set of factors affecting labour productivity due to varying country conditions. A second step is estimating the construction labour productivity in an effort to both improve labour productivity prediction and monitoring on-site performance. In this aspect, several models have been developed in the literature which their basis departs from the relationship between various factors. For example, methods such as regression analysis (Thomas and Sudhakumar 2013), Artificial Neural Network (Moselhi and Khan 2010), and Fuzzy Set Theory (Fayek and Tsehayae 2012) have been reported in several studies accounting for various factors affecting labour productivity. The two steps discussed above suggest a framework in this study which is adopted in the section that follows to examine the overlap occurred within different factors, thereby arriving at basis for a labour productivity model.

ANALYTICAL HIERARCHY PROCESS

The Analytical Hierarchy Process (AHP) developed by Dr. Thomas Saaty in the 1980s, is a multi-criteria decision making tool (Saaty 1980). It assists in structuring complex problems into a system by capturing both qualitative and quantitative factors. The first step of the AHP consists of building a hierarchy of elements describing the problem under consideration. The objective or goal from the decision-makers viewpoint is represented at the top level of the hierarchy. This is followed by the intermediate levels that demonstrate the criteria and sub-criteria contributing to the decision. Once the hierarchies have been established, the next step is finding out the weight of each criterion with respect to others within the same level. This is accomplished via pair wise comparisons using a nine-point scale (shown in Table (1)). Pair-wise weighting among n elements in each level leads to an approximation $a_{ij} = w_i / w_j$ which is the ratio of the weight of element i to element j . The estimated weight vector w is found by solving the following eigenvector problem:

$Aw = \lambda_{\max} w$ where,
 λ_{\max} is the principal eigen-value of A ,
 and

$$A = \begin{bmatrix} w_1 / w_1 & \dots & w_1 / w_n \\ \dots & \dots & \dots \\ w_n / w_1 & \dots & w_n / w_n \end{bmatrix}$$

Table 1: Pair-wise comparison scale for AHP

Definition	Importance
Equal importance	1
Weak importance of one over another	3
Strong importance	5
Very strong	7
Absolute importance	9
Intermediate values	2,4,6,8

The AHP has a unique feature in that it measures the reliability of the input data by means of a Consistency Index (CI), which enables decision-makers to determine judgments that need reassessment. The CI is a function of the maximum eigen-value (λ_{\max}) and the size of the square matrix (n). Saaty identified CI as:

$$CI = \frac{(\lambda_{\max} - n)}{(n - 1)}$$

If the decision maker is completely consistent λ_{\max} should be equal to n (CI = zero). In the case of inconsistency, λ_{\max} will be greater than n. The more inconsistent the decision maker is, the greater the value of λ_{\max} .

The AHP has been applied to a variety of areas since its development. The benefits of this approach in managing complex decisions has been discussed extensively in

literature including; Lee, *et al.* (2000), Cheung and Wan (2001), Khalil (2002), Abdi, and Labib (2003), Marinon and Hoppe (2006), Seyhan and Mehpare (2010), Moazami *et al.* (2011), Alam *et al.* (2012), Onder, *et al.* (2013).

METHODOLOGY

Thirty main factors affecting labour productivity were identified through an intensive literature and consultation of eight local contractors. Initially, a review of professional journals, publications, text books and previous research papers was conducted. A powerful Scopus search engine was selected to identify journals that have published articles related to construction labour productivity. The search was carried out under the “*title/abstract/ keyword*” field using ‘labour productivity’, ‘workforce productivity’, ‘construction productivity and labour improvement’. Then, eight local contractors with an experience of more than 10 years in the GS construction industry were consulted to give relatively accurate judgement on different factors affecting labour productivity. These factors were grouped into six categories: psychological, experience, supervision and leadership, physical, time & workload and finally external factors. Primary data for this study were collected through a questionnaire survey developed using the Analytical Hierarchy Process. The target population of the survey includes contractors holding a valid registration from the contractors union within the Gaza Strip; where the total number found to be 72 companies. The respondents were selected based on random sampling and a representative population size of sixty contracting companies was derived from the following formulas (Hogg and Tannis 1997):

$$m = \frac{Z^2 \times P^* \times (1 - P^*)}{\epsilon^2} \quad \text{and} \quad n = \frac{m}{1 + \left(\frac{m-1}{N}\right)}$$

Where: n, m and N are sample size for limited, unlimited available population.

Z: value (1.96 for 95% confidence level), ϵ : maximum error of the point estimate

P*: degree of variance between the elements of population (0.5)

$$m = \frac{(1.96)^2 \times 0.5 \times (1 - 0.5)}{(0.05)^2} = 384.16 = 385 \quad \text{and} \quad n = \frac{385}{1 + \left(\frac{385-1}{72}\right)} = 60.$$

RESULTS AND DISCUSSION

A hierarchical model for factors affecting labour productivity was developed consisting of three levels: the goal, the critical factors and sub-factors. This model was used as a basis for designing the questionnaire survey where relative importance of each factor in the hierarchy is determined (Figure 2). Experts have been asked to make pair-wise comparisons between two factors at a time, decide which factor is more important to labour productivity, and then specify the degree of importance on a scale between 1 (equal importance) and 9 (absolutely more important) to the more important factor. A total of 56 questionnaires were completed by contractors and engineers, representing a response rate 93.3 percent. The main characteristics of the populations being sampled were experts’ contractors with more than 14 years of experience in the GS construction industry having a direct and daily interaction with labour; as 50% of participants held a site engineer position. Therefore, the responses considered to be a good representation of the target survey population.

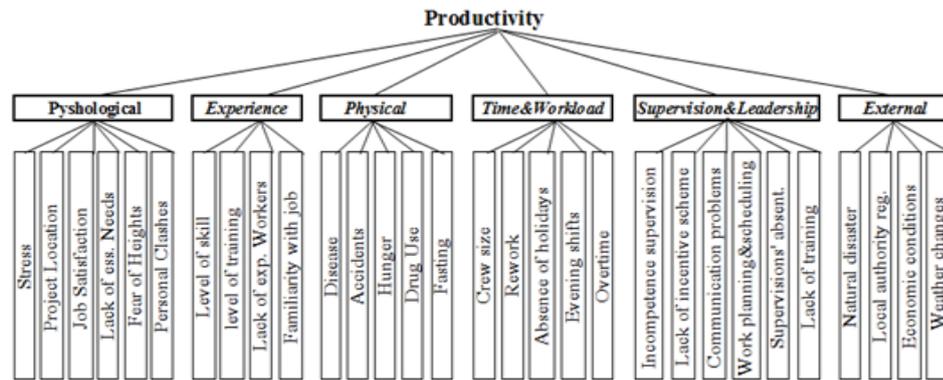


Figure 1: The Analytical Hierarchy Process Productivity Model

The geometric mean approach was then used to combine the individual judgments to resolve the lack of consensus on values. The geometric means of the judgments obtained for each group of factors are presented as the weight in Tables (2).

Table 2: The Geometric means of different groups of factors

Psychological Factors			Weight
Job satisfaction & security	More important than	stress	8
Job satisfaction & security	More important than	Personal clashes	7
Job satisfaction & security	More important than	Workers fear of heights	8
Job satisfaction & security	More important than	Project location	3
Job satisfaction & security	More important than	Lack of essential needs	3
Lack of essential needs	More important than	Personal clashes	6
Lack of essential needs	More important than	Workers fear of heights	7
Lack of essential needs	Equally important to	Project location	1
Lack of essential needs	More important than	Stress	7
Project location	More important than	Workers fear of heights	9
Project location	More important than	Workers fear of heights	5
Project location	More important than	Workers fear of heights	9
Stress	Equally important to	Workers fear of heights	1
Stress	More important than	Personal clashes	3
Workers fear of heights	Equally important to	Personal clashes	1
Experience Factors			Weight
Skill & experience level	More important than	Familiarity with job	4
Skill & experience level	More important than	Level of training	7
Skill & experience level	More important than	Lack of experienced labour	5
Skill & experience level	More important than	Familiarity with job	4
Skill & experience level	More important than	Level of training	7
Skill & experience level	More important than	Lack of experienced labour	5

Experience Factors			Weight
Familiarity with job	More important than	Level of training	3
Familiarity with job	More important than	Lack of experienced labour	3
Level of training	Equally important to	Lack of experienced labour	1
Physical Factors			Weight
Accidents	More important than	Disease	3
Disease	More important than	Hunger	3
Drug use	More important than	Disease	5
Disease	More important than	Fasting	3
Accidents	More important than	Hunger	5
Accidents	More important than	Fasting	6
Drug use	More important than	Accident	5
Drug use	More important than	Hunger	7
Drug use	Equally important to	Fasting	1
Drug use	More important than	Fasting	8
Time & Workload Factors			Weight
Crew size	Equally important to	Rework	1
Abs. of holidays	More important than	Crew size	5
Evening shifts	Equally important to	Crew size	1
Overtime	More important than	Crew size	8
Abs. of holidays	More important than	Rework	3
Rework	More important than	Evening shifts	3
Overtime	More important than	Rework	5
Abs. of holidays	More important than	Evening shifts	4
Overtime	More important than	Abs. of holidays	3
Overtime	More important than	Evening shifts	7
External Factors			Weight
Local authority reg.	More important than	Natural disaster	2
Economic conditions	More important than	Natural disaster	4
Weather changes	More important than	Natural disaster	7
Economic conditions	More important than	Local authority reg.	3
Weather changes	More important than	Local authority reg.	4
Weather changes	More important than	Economic conditions	5

After determining weights, the analysis was carried out with the application of the AHP using the 'Criterium Decision Plus' support software. The importance of each factor with respect to classified group was first developed (Tables 3-8). Then, an overall assessment was carried out. The consistency of responses is considered satisfactory; as the value of Consistency Ratio (CR) is less than 0.1 across different groups of factors.

Table 3: 'Psychological' factors weights

Criterion	Weight
Stress	0.046
Project location	0.237
Job satisfaction & security	0.425
Lack of essential needs	0.219
Workers fear of heights	0.039
Personal clashes	0.033
Consistency Ratio	0.061 < 0.1

Table 5: 'Physical' factors weights

Criterion	Weight
Disease	0.111
Accidents	0.228
Hunger	0.049
Drug use	0.566
Fasting	0.046
Consistency Ratio	0.057 < 0.1

Table 7: 'Experience' factors weights

Criterion	Weight
Skill and experience	0.613
Level of training	0.081
Lack of experienced labour	0.090
Familiarity with job	0.217
Consistency Ratio	0.027 < 0.1

Table 4: 'Sup. & leadership' factors weights

Criterion	Weight
Incompetence supervision	0.137
Lack of incentive scheme	0.344
Communication problems	0.047
Work planning & scheduling	0.265
Supervision absenteeism	0.163
Lack of training sessions	0.044
Consistency Ratio	0.058 < 0.1

Table 6: 'Time & Workload' factors weights

Criterion	Weight
Crew size	0.066
Rework	0.102
Absence of holidays	0.250
Evening shifts	0.057
Overtime	0.525
Consistency Ratio	0.037 < 0.1

Table 8: 'External' factors weights

Criterion	Weight
Natural disaster	0.061
Local authority regulations	0.109
Weather changes	0.612
Economic conditions	0.218
Consistency Ratio	0.072 < 0.1

Based on findings presented in Table (3), 'job satisfaction & security' is a dominant factor within the psychological group. It indicates a direct correlation between job satisfaction and productivity. Generally, a satisfied labour has a positive attitude towards job and high work commitment; tends to attend on time, work speedily with less absenteeism. In the GS context, due to the current political situation and imposed closure on the area, high unemployment rates exist. In effect, contractors depend to great extent on temporary contracts. These contracts are characterized by low average wage and long working hours, causing job dissatisfaction and insecurity within construction labour. Effect of 'job satisfaction & security' was further recognized among the important factors affecting construction labour productivity in other countries such as Turkey (Kazaz *et al.* 2008), and UAE (Ailabouni1 *et al.*, 2009). Meanwhile, the results of prioritization of the factors related to 'supervision & leadership' demonstrated that 'lack of incentive scheme' and 'work planning & scheduling' are ranked as first and second with a weight of 0.344 and 0.265 respectively (Table 4). Enshassi *et al.* (2007) supported this result; highlighting the fact that financial benefits play a vital role in motivating labour force to achieve the predetermined goals. In addition, similar results were obtained by Mahamid (2013) while discussing the influence of 'work planning & scheduling' on labour productivity. Furthermore, findings indicated that 'drug use' and 'accidents' are the most important factors within the physical group (Table 5). Clearly, both factors

contribute to on-site productivity loss; as drug use causes physical harms, while the effect of ‘accidents’ will vary depending on the accident type. With regard to GS construction industry, the scale of the drug problem is of a concern to labour productivity especially with the current lack of treatment and rehabilitation centres in the area. Findings also show that overtime with a weight of 0.525 has the highest rank within the ‘time& workload’ group (Table 6). Although, allowances attached to overtime will motivate labour and enhance productivity, working overtime on continuous basis create an adverse effect on physical strength of labour and thus lead to productivity loss. This result is justified; because of the nature of the GS construction industry, as it is mostly involve working overtime due to shortage in skilled labours as well as schedule pressure. It also aligns with those of Hinze (1999) and Durdyev, *et al.* (2012), who found that overtime has a significant impact on on-site labour productivity. In similar way, absence of holidays can cause work fatigue and hence the ability of workers to concentrate on work will decrease leading to decline in productivity rate.

‘Skill & experience’ and ‘familiarity with job’ are considered the most significant factors affecting labour productivity among the experience group (Table 7). Both factors were documented in literature (Alinaitwe *et al.* 2007 and Durdyev, *et al.* 2013) as constraints in attaining a full performance potential. This result reflects the skilled labour gap in the GS construction industry despite relatively high levels of unemployment. Also, based on the results of the external factor group (Table 8), weather changes obtained the highest weight, followed by economic conditions. Performing work in hot or cold weather can impact labour visibility, safety as well as comfort leading to productivity loss. With GS located on the Mediterranean Sea, the weather can be classified as hot and humid in the summer, meanwhile, rainy during the winter. In addition, economic conditions governed by unstable political situation, national inflation rates and construction employment can be classified as a main driver to productivity loss in GS construction industry.

Finally, an overall assessment for the main groups with respect to productivity was then carried out to establish the AHP model (Fig. 2). It can be seen that physical and experience groups have the most significant role in labour productivity (Table 9).

Table 9: ‘Productivity’ groups weights

Criterion	Weight
‘Psychological’ factors	0.087
‘Experience’ factors	0.261
‘Physical’ factors	0.304
‘Time & workload factors	0.174
‘Supervision & leadership factors	0.130
‘External’ factors	0.043

The model shown in Figure (2) pinpointed thirty factors related to construction labour productivity and mapped out their relationships in an AHP hierarchy. Deriving the priorities of these factors in the form of pair-wise comparisons yields reliable results, where the reliability of the pair-wise subjective judgements was verified using the consistency check. This model can be used as a reference for determination of areas to increase the value of construction productivity, by better planning and eliminating the impact on labour productivity.

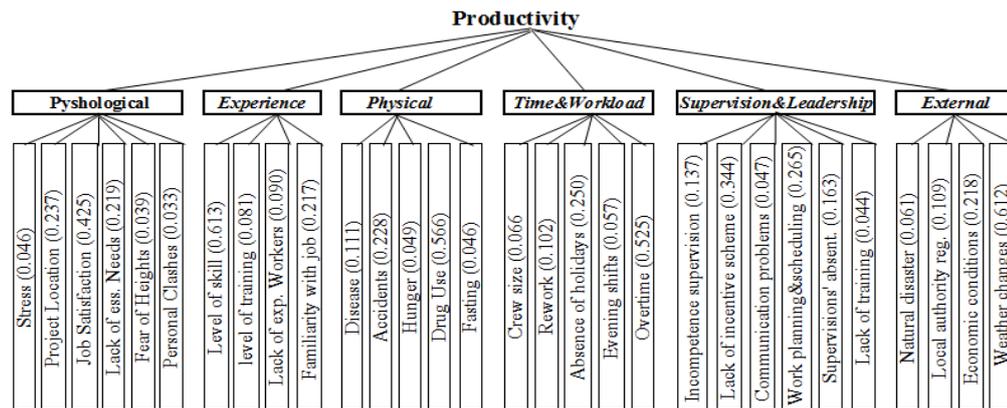


Figure 2: The Analytical Hierarchy Process Productivity Model

CONCLUSIONS

This study aimed at identifying factors influencing labour productivity in the Gaza Strip construction industry. Furthermore, it aimed at establishing the foundation of further study of labour productivity improvement by establishing a baseline model. In formulating this model, thirty factors closely associated with labour productivity were considered using the Analytical Hierarchy Process.

The Analytical Hierarchy Process has proven to be useful in quantitatively analyzing the interrelation between various factors. Results from different sub-groups demonstrated that Job satisfaction & security, lack of incentive scheme, skill & experience, drug use, overtime and weather changes have a significant impact on labour productivity. Meanwhile, with regard to main groups, physical factors group contributed the most to the onsite labour productivity.

This work provide a clear indication of the effectiveness of the established AHP model to offer construction companies in Gaza Strip an insight to critical areas for labour productivity improvement, thereby saving time and money. In addition, the AHP model is easy to apply and it also offers the flexibility to add more factors and continually refine the group's preferences among concerned criteria and sub-criteria.

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MODELLING MASONRY LABOUR PRODUCTIVITY USING MULTIPLE REGRESSION

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Construction labour productivity is influenced by a multitude of factors. Productivity models analyze and estimate the impact of the various factors on productivity. In the present research, multiple regression analysis was used to develop a model to quantify the impact of the influential factors on masonry labour productivity, in the context of a developing country. Previous studies to develop productivity models relied on data collected through questionnaires, wherein the influence of various factors was measured on a qualitative scale. The present study, however, utilized quantitative data directly collected from two case study projects, to develop the model. The regression model identified excessive overtime and material delays as the major factors impacting productivity. The mode of employment of labour was also found to have a significant impact on productivity. Sensitivity analysis was also performed to identify trends of the factors. The significant variables identified by the regression model emphasize the importance of efficient resource planning in achieving high labour productivity.

Keywords: labour productivity, modelling, regression.

INTRODUCTION

Construction labour productivity is a major determinant of success of a construction project. Time and cost overruns of construction projects are widely attributed to poor productivity of construction labour force. Considerable research has hence been dedicated to identifying opportunities for labour productivity improvement. Construction labour productivity is influenced by large number of factors. It is important to identify the relative impact of the various factors on productivity, so that effective plans are framed for productivity improvement.

Productivity models quantify the impact of various factors on construction labour productivity (Sonmez and Rowings 1998). Previous research on developing productivity models have heavily relied on qualitative data collected through questionnaires or historical productivity data. This introduced a lot of subjectivity into the data collection process, with the resultant errors in predicting the effects of the factors on productivity. The present research, however, utilizes actual data directly gathered from the construction sites, to develop the productivity models. Quantitative data, on masonry productivity and influencing factors, was collected on a day-to-day basis from two construction projects and the collected data was used in developing regression models.

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LITERATURE REVIEW

Though considerable research has been done on identifying the impact of various factors on productivity, many focussed on the influence of a single factor on productivity. Multiple regression models have been developed to quantify the impact of change orders, extended overtime, overmanning and shift work on labour productivity (Hanna *et al.* 1999; Hanna *et al.* 2005; Hanna *et al.* 2007; Hanna *et al.* 2008). Koehn and Brown (1985) developed non-linear equations to quantify the relationships between productivity and temperature and humidity. Thomas and Yiakoumis (1987) employed multiple regression techniques to quantify the impact of relative humidity and temperature on productivity. Moselhi *et al.* (2005) used neural network models to quantify the impact of change orders on labour productivity and Thomas and Napolitan (1995) quantified the impact of changes on labour productivity using regression analysis. Labour productivity, however, is influenced by multitude of factors and it is essential to study the influence of the multiple factors on productivity.

The impact of multiple factors on productivity has been modelled by various researchers. Fayek and Oduba (2005) applied fuzzy expert systems to model pipe rigging and pipe welding operations. Artificial neural networks have also been employed to model the impact of multiple factors on productivity (Moselhi and Khan 2010; Portas and AbouRizk 1997; Song and AbouRizk 2008; Sonmez and Rowings 1998; Zayed and Halpin 2005a). Productivity models to quantify the effect of multiple factors on productivity have also been developed using regression analysis (Sonmez and Rowings 1998; Zayed and Halpin 2005b). Regression analysis is advantageous in developing productivity models, chiefly because it allows for more parsimonious use of the free parameters (Sonmez and Rowings 1998).

Many of the previous studies utilized data collected through questionnaires or historical productivity data wherein the intensity of the influencing factors was measured on a qualitative scale. The models that used real time observations on productivity, however, did not collect data on the problems encountered and the corresponding time losses. The previous productivity models thus fail to quantify the impact of various factors on productivity accurately. The present research is therefore aimed at collecting data on the factors influencing productivity, including the time losses due to various problems encountered in the course of the work, and using the data collected in developing models to quantify the impact of the factors on masonry labour productivity, using regression analysis.

DATA COLLECTION

Data was collected from two high rise building construction project sites, located in the state of Kerala in India. The first case study project is a multi-storey residential building construction. The second case study project is an Information Technology (IT) park complex, located very near to the first building. Both the buildings were reinforced concrete framed structures with masonry infill. The two projects were selected for data collection as they were constructed during the same period, were located at close proximity to one another and employed the same structural framing system.

Daily visit method was employed to collect data from the two project sites. During the daily visit, information about the type of work, the type of labour, the working hours, the overtime hours and the crew size and composition was noted on the data collection forms. There were several crews engaged in masonry at different locations on the

project sites. A site diary was maintained wherein the locations where the work was being carried out during each day were noted. In addition, the locations were marked on the plans and elevations obtained from the project offices. A note of the characteristics of the work area was made in the site diary, which formed the basis of fixing a work complexity rating for the work observed. The output was measured the next day, prior to the start of that day's work. Maintaining the notes of the workstations in the site diary and the plans helped in accurately locating the workstations during the visit for output measurement.

During the visit for output measurement, the site staff was interviewed to understand the problems faced during the previous day's work. The site staff also provided an estimate of the time lost due to each problem encountered, in the course of the work. In addition, hourly relative humidity, rainfall and temperature data for the data collection period was obtained from Indian Meteorological Department (I. M. D.).

CHARACTERISTICS OF DATA COLLECTED

At both the sites masonry work was carried out using laterite, a natural building stone, abundantly available in Kerala. The laterite blocks were laid in stretcher bond. The labour force worked for 6 days a week, on an 8 hour schedule daily.

The contractor on the IT park project employed two types of labour force for masonry works on the construction site – labour directly employed by the contractor and subcontract labour. While the directly employed labour had fixed wages and was allowed overtime work, the subcontract labour was paid based on their output, i.e., the no. of masonry units placed during the day. The masonry work on the residential project site was done entirely by subcontract labour. The payment to the subcontract labour varied with the height of the wall, i.e., subcontract labour received a higher payment for work done above a height of 2.2 m. As such, data was collected separately for work done below and above the height of 2.2 m.

The materials required for the work were transported up to the respective floors via hoists and thereafter the horizontal transportation was carried out using wheelbarrows. The supply of the materials to the masonry crew was the responsibility of the site labourers, whereas mixing of mortar was done by the masonry crew. The scaffolding for the masonry work, if required, was prepared by a separate gang.

A total of 152 observations on laterite masonry was obtained from the project sites. Each observation was the data for the daily work a crew. The daily productivity values varied from a maximum value of 1.09 m²/man-hr to a minimum of 0.12 m²/man-hr. The mean value of daily productivity observed was 0.41 m²/man-hr.

Delays observed

The major cause of the delays on the case study projects was the unavailability of materials at the workplace. A total of 57 out of the 152 data points experienced delay due to materials. The daily time lost due to material availability ranged from 30 minutes to 5 hours. The time lost due to material unavailability amounted to a total of 525 man-hours, which is obtained by summing up the product of the duration of delay in each observation and the corresponding crew size.

Other issues observed on the case study projects were rework due to craftsmen errors, which occurred on two instances and three observations when the crew were kept waiting as scaffolding was not ready on time. Rework due to craftsmen errors resulted

in a total time loss of 18 man-hours, whereas the time lost because scaffolding was not ready amounted to a total of 23.5 man-hours.

Work content

As mentioned earlier, masonry data was collected separately for work carried below and above the height of 2.2 m and a difference in productivity was observed below and above the height of 2.2 m. In addition, differences in productivity were also observed for straight walls and walls involving numerous corners. Thomas and Zavariski (1999) proposed a work content (WC) scale ranging from 1 – 5 in defining baseline productivity. Following these lines, a WC scale ranging from 1 – 3 is adopted for the present study, where WC 1 represents straight walls of height less than 2.2 m, WC 2 represents walls with numerous corners of height less than 2.2 m and WC 3 representing walls of height greater than 2.2 m. The residential building site involved straight walls less than 2.2 m and was rated WC 1, whereas at the IT park site, WC ratings of 2 and 3 were observed. The residential building site did not involve walls of height greater than 2.2 m and hence a separate classification of straight walls greater than 2.2 m was not used in the present research.

REGRESSION MODELS FOR MASONRY PRODUCTIVITY

Stepwise regression procedure available in SPSS software was used for the model development. The various factors which were used as input to the regression model are given in Table 1. The average of the hourly rainfall, temperature and relative humidity data for the working hours served as input to the model. For mode of employment, directly employed labour was the reference category and was coded 0 whereas subcontract labour was coded 1. Work content scale ranging from 1 – 3 was adopted for masonry as discussed earlier, with WC 1 chosen as the reference category and coded 0, the other WC ratings expressed appropriately to represent differences from the reference category. Data transformation of the dependent variable was found necessary to meet the assumptions of regression analysis. Various transformations were tried and it was found that a log10 transformation of the dependent variable gave the best results.

Table 1: Factors used for regression

Factors	Type of data	Unit
Ratio of skilled to total labour	Continuous	Number
Total labour	Continuous	Number
Mode of employment of labour	Categorical	Coded
Overtime	Continuous	Hours
Rainfall	Continuous	mm
Temperature	Continuous	0C
Relative humidity	Continuous	%
Delay - materials	Continuous	Hours
Time lost - rework	Continuous	Hours
Tim lost - work not ready	Continuous	Hours
Work content	Categorical	Coded

Though eleven independent variables were used as input to the regression model, only four variables were significant in the final model. The final model had a R² value of

0.794 and an adjusted R² value of 0.787. The corresponding F statistic was 112.312, p value <0.001, ensuring overall fit of the regression model. The coefficients of the regression model along with the associated statistics are shown in Table 2. For the dummy or indicator variables interpretation based on standardized coefficients is not applicable and hence is not presented in the table. The tolerance values and the VIF are measures of multicollinearity. Tolerance values below 0.1 and VIF greater than 10 are indicative of high degree of multicollinearity (Field 2005; Hair *et al.* 2011). The tolerance value of all the variables was greater than 0.1 and the VIF less than the threshold limit of 10. Hence no multicollinearity was detected among the variables.

The positive coefficient for the mode of employment of labour which was coded as a dummy variable, indicates that the subcontract labour are more productive than the directly employed labour, the value of the coefficient representing the difference in productivity. Talhouni (1990) also has reported the superiority of the performance of the subcontract labour when compared to the directly employed labour. His studies on masonry work on seven Scottish construction sites revealed the performance of the subcontract labour being on an average 38% higher than that of the directly employed labour. A reduction in productivity with increasing levels of work complexities is also evident from the regression model as both the coefficients WC3_WC1 and WC2_WC1 are negative. The greater the complexity of work, the larger is the reduction in productivity as obvious from the coefficients in Table 2.

The findings of the regression analysis clearly illustrate the influence of excessive overtime and delays due to materials on labour productivity. The standardized coefficients reveal overtime to have a greater influence on productivity than delays due to materials. The effects of overtime on productivity have been widely studied by researchers and loss in productivity due to overtime schedules documented. An overtime schedule can result in various problems such as fatigue, higher accident rate, lowered morale of the workforce and in addition a higher cost per unit, all of which result in a reduction of productivity (Hanna *et al.*, 2005). Thomas and Raynar (1997) observed an average of 10% to 15% loss of productivity when working on an overtime schedule. They remarked that overtime schedules lasting 3 – 4 weeks can be used with little loss of efficiency, but longer schedules will lead to productivity losses from fatigue. It was concluded that scheduled overtime was a resource problem with productivity losses arising from inability to provide materials at an accelerated rate. This was true on the IT park site where overtime was allowed indiscriminately, without taking necessary action to ensure adequate supply of materials. Overtime in the past studies was defined as work performed over 8 hours/day and 40 hours/week. The previous research studies investigated 50 hour and 60 hour workweeks, while in Kerala, construction workforce normally worked 6 days a week for 8 hours /day thereby yielding a normal 48 hours week. Overtime was observed on 85% of the observations on daily productivity of the subcontract labour and 94% of the observations of the directly employed labour. For the subcontract labour overtime rarely lasted more than one hour, whereas for the directly employed labour daily overtime was on average 3.7 hours, with two observations having an overtime of 8 and 9 hours. Thus, for the directly employed labour, the weekly work hours were an average of 69 hours/week or more and the resultant detrimental effects on productivity.

Table 2: Coefficients and associated statistics of linear regression model for masonry productivity

Model	Unstandardized coefficients		Standardized coefficients	t	Significance
	B	Standard error	Beta		
Constant	-0.348	0.031		-11.245	< 0.001
Mode of employment of labour	0.157	0.027	N/A	5.930	< 0.001
Overtime	-0.024	0.006	-0.231	-4.124	< 0.001
WC3_WC1	-0.220	0.025	N/A	-8.652	< 0.001
WC2_WC1	-0.178	0.025	N/A	-7.050	< 0.001
Delay - materials	-0.024	0.009	-0.111	-2.685	0.008

The present study, however, did not recognize a relationship between the weather parameters and labour productivity in the state of Kerala. Masonry, being an interior job, may not be influenced by the weather parameters. Also, the effect of weather on productivity has been previously studied in the context of other countries with differing climates and environment. It is recommended that further studies are conducted, to establish relationships between weather and productivity in the Indian context.

Residual analysis

Examination of the residuals – the difference between the actual and predicted values of the dependent variable – is the principal measure for assessing the validity of regression assumptions and is achieved by plotting the residuals. The value of the Durbin-Watson statistic computed was 1.855 and the value being close to 2, indicated that the assumption of independence of errors has been met. Figure 1 shows the histogram of the residuals for the developed model. The histogram shows that the residuals are normally distributed. Figure 2 presents a plot of the regression standardized residuals against the regression standardized predicted values. The points are approximately randomly distributed in the plot and hence indicate that the assumptions of linearity and homoscedasticity or equality of variances are met. The partial residual plots also did not show major deviations from the assumptions of linearity and homoscedasticity. The residual analysis thus confirmed the developed model to be performing well with respect to the assumptions of regression analysis.

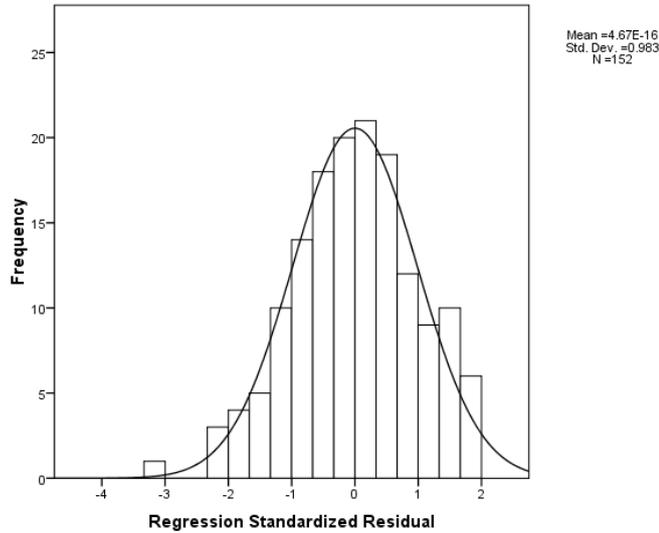


Figure 1: Histogram of residuals for the masonry regression model

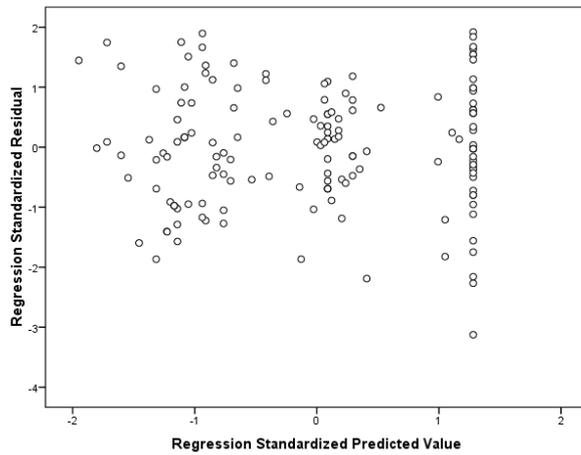


Figure 2: Plot of Regression Standardized Residuals against the Standardized Predicted Values for the Masonry Regression model

Model validation

The regression model developed was validated by the split sample approach. The data was split into two parts, with 70% of the data randomly chosen for estimating the regression model and the remaining data used for validating the model. To measure the predictive ability of the model, each case in the validation dataset was predicted with the estimated regression model and the mean square prediction error (MSPE) was calculated as follows (Kutner *et al.*, 2004):

$$MSPE = \frac{\sum_{i=1}^{n^*} (Y_i - \hat{Y}_i)^2}{n^*} \tag{1}$$

Where Y_i is the value of the response variable in the i th validation case, \hat{Y}_i is the predicted value for the i th validation case based on the model-building dataset and n^* is the number of cases in the validation dataset.

Stepwise procedure was adopted for estimating the model based on the split sample also. The significant variables in the model estimated with the split sample were the same based on the entire dataset, the R2 value for the split sample model being 0.783 (adjusted R2 = 0.772). Each case in the validation dataset was predicted with the estimated regression model and MSPR was calculated as per equation 1. The MSE based on regression fit to the model-building dataset was 0.0117 and the MSPR for the validation dataset was 0.0119, the MSE for the model based on entire dataset being 0.0113. The values of the MSE's and MSPR are very close and thereby validate the regression model.

Sensitivity analysis

The variation in labour productivity due to changes in the values of a factor, while other factors are held constant at their mean value, was studied. Figure 3 presents the variation of labour productivity with increase in overtime hours for subcontract labour at various work content ratings, when other factors were held constant at their mean values. The impact of material unavailability on labour productivity for subcontract labour at various work content ratings is given in Figure 4. Similar plots were also obtained for the directly employed labour. The figures indicate a deterioration of productivity with increase in overtime as well as delays due to material unavailability.

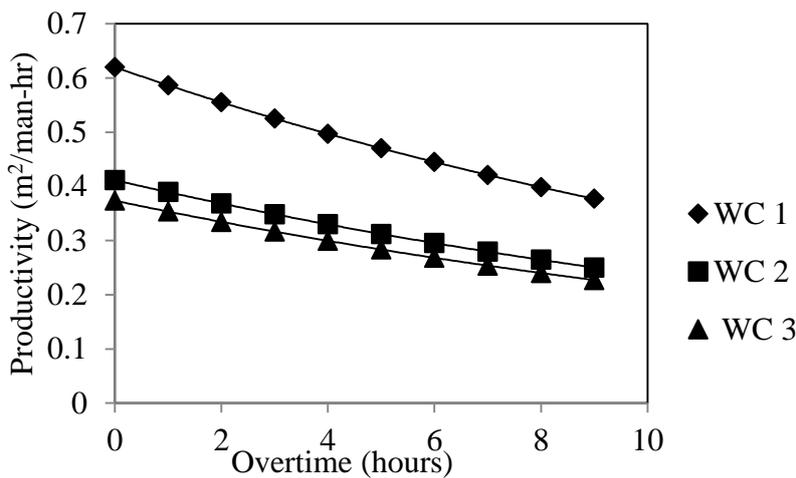


Figure 3: Impact of overtime on labour productivity of subcontract labour

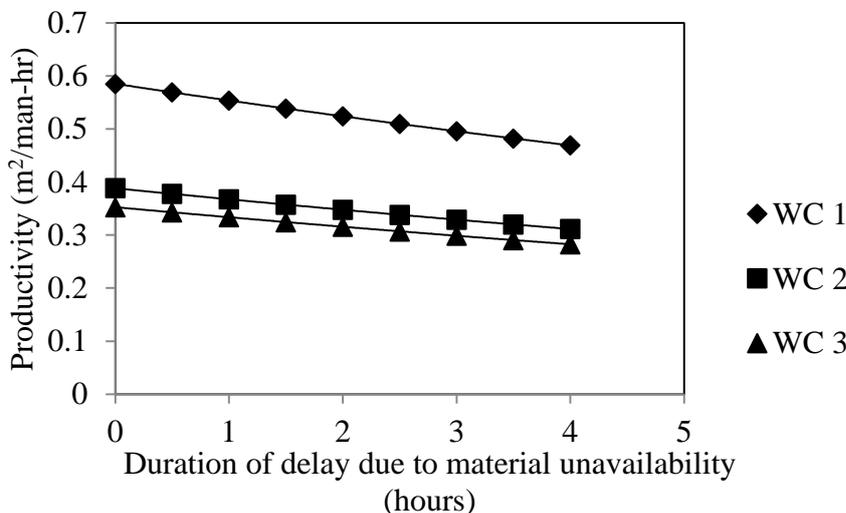


Figure 4: Impact of material availability on labour productivity of subcontract labour

CONCLUSIONS

Data on productivity, the factors affecting productivity as well as the corresponding time losses were collected from two high rise building construction sites on a day-to-day basis. The collected data was used in developing a regression model, to quantify the impact of the influencing factors on productivity. Stepwise regression procedure used to develop the productivity model has identified overtime, delay due to materials, the mode of employment of labour and the work content as the significant variables for masonry productivity, with overtime being the most important variable influencing masonry productivity. Residual analysis verified the assumptions of regression analysis and the model has been validated by split sample approach. The present research, however, did not identify any relationship between the weather parameters and productivity. The findings of the present study are limited to the data collected from the two construction sites. It is recommended that further studies, involving data collected from more number of construction sites, are carried out to study the impact of weather and various other factors on masonry productivity. The study has revealed poor resource management as a major reason for productivity losses on the construction sites and thus emphasizes the importance of proper resource planning to achieve high labour productivity.

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SOCIAL PERSPECTIVE OF PLANNING IN CONSTRUCTION: THE UK EXPERIENCE

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The demand for improvement in the UK construction industry and the dissatisfaction from end users has been a subject of debate over many years. These challenges have been attributed to the industry's fragmentation and the use of rational approach in the planning and execution of construction projects. However, in recent times, the need to replace the rational approach in planning of construction projects with a more social approach has been emphasised. The aim of this study is to establish the basis of the current rational or technical approach to planning in construction and to evaluate how it can be improved through social conversations such as the Last Planner System (LPS) of production control and collaborative planning (CP). Based on extensive critical literature review, in addition to demonstration project review, the findings indicate that the current rational approach to planning in the construction industry is based on the Rational Comprehensive Model (RCM); which is responsible for the unimpressive performance of the industry. The study went further to evaluate the potentials of the five elements of the LPS in improving the current approach to planning. This was further supported with the UK experience from the Construction Lean Improvement Programme (CLIP) demonstration project reports. The study reveals varied practices with regard to the use of LPS and collaborative planning in the UK. In view of this, the study recommended that further empirical study should be conducted in order to expose the current practice to enable improvement, such as developing a framework for implementing the LPS and CP in the UK construction industry. The study concludes that the practical application of these social conversations will assist construction organisations in delivering more predictable and reliable projects with improved value for the client.

Keywords: collaborative planning, Last Planner®, lean construction.

INTRODUCTION

Government in its effort to keep the construction industry in the firing line has not reneged on reviewing the performance of the industry in order to identify areas for improvement. With the commissioning in 1929 of the first construction industry report that reviewed the UK construction industry performance (Cain, 2004), several reports such as Simon Banwell, Latham and Egan have been commissioned by the UK government since then to improve on the performance of the construction industry. The Egan report of 1998, challenged the lack of collaboration in design, planning, and execution of work in the industry, and recommended the adoption of lean principles

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for efficiency in the industry (Egan, 1998). In response to Egan's recommendations, the Construction Lean Improvement Programme (CLIP) was formed by the Building Research Establishment (BRE) in 2003 to drive lean in the industry.

Unfortunately, the current traditional approach to planning and execution of construction work does not support lean principles. According to Ballard and Howell, (1998) the traditional approach to planning is activity to activity centred, thus ignoring the need for flow in the production process and making planned task unachievable. In reality, the traditional approach to planning which is based on the Rational Comprehensive Model (RCM), views planning as a technical scientific discipline that can only be performed by the expert without any form of input from the stakeholders (Guton *et al*, 2003). Although this view has been criticised, its effect on construction process improvement is enormous. For instance, it has been reported that only 54% of planned tasks on construction projects are completed as planned due to the traditional approach to planning and execution of work on site (Ballard, 2000). There is also evidence that 50% of construction projects in the UK experience cost and time overrun or even both (Crotty, 2012). No wonder productivity within the sector is still pegged around 40-45 % on the average (Nasir *et al*, 2013).

The need to replace the RCM in planning and execution of construction projects with CP has become essential. The generally used lean philosophy for CP is the LPS, and its goal is to deliver a more reliable and predictable construction project (Kalsaas, 2012). More importantly, it is a social approach to planning, as against the technical approach to planning. The need for collaboration among construction project stakeholders has been emphasised in literature with focus on collaborative working (Xue *et al*, 2010; Yeomans *et al*, 2006), and modelling collaborative information process system (Baiyi *et al*, 2006). However, none of these studies addressed the inefficiency associated with construction planning from a social perspective (human relation) based on production planning, since the technical approach to planning based on logic diagrams, critical path, and contract has failed over time.

In view of these, this study critically reviews the rational approach to construction planning, underscores the 'magic' of CP in construction planning and provides an evaluative approach for addressing the rational approach to planning based on LPS.

RESEARCH METHOD

Dainty, (2008) identified four commonly used research methods in construction management; quantitative, qualitative, mixed methods and reviews. The review approach was adopted as it allows the researcher to gain sufficient insight and good foundation in order to further conceptualise the study (Gameson, 2008; Burgess *et al*, 2006). A critical literature review on the rational approach to planning in construction, and an evaluation on how this approach can be improved through social conversations based on the LPS was evaluated. 30 CLIP demonstration project reports were accessed and reviewed to examine CP practices in the UK. This was compared with global CP practices based on LPS, as reported in proceedings from the International Group for Lean Construction (IGLC) conferences.

Evaluation of the Rational Comprehensive Models and its Practice in Construction Planning

The use of (RCM) also known as technocratic planning dates back to the end of the Second World War, in the 1950s in North America. This model was commonly used by the Urban and Regional Planning (URP) department in the planning of spaces and

cities. According to Susskind *et al* (2000) RCM views planning as the singular responsibility of the manager who is seen to be the expert in making major decisions on assignments to be executed. Champions of the RCM believe that planning is a technical undertaking that uses scientific principles, thus, decisions should be left in the hands of the planning experts (Gunton *et al*, 2003). Similarly, Susskind *et al* (2000) observed that the model assumed only planners have the knowledge required for planning while the planning agencies have autonomy over planning decisions.

The model depicts the planning approach used in the construction industry in which the construction planner, plans activities to be executed on site and imposes it on the team without any form of input from the constructors. As clearly identified in Ballard, (2000), and Koskela and Howell, (2002) the traditional approach to planning in the construction industry is based on RCM. For instance, in the traditional project management approach, construction programmes are usually planned by the professional construction planner or the project manager who is believed to have a technical knowledge in planning (Mossman, 2013; Hass, 2007). However, such approach to construction programming or planning has been criticised in the literature. Kastalli and Neely, (2006) and Hayek, (1945) argued that the knowledge needed for holistic planning is not at the disposal of the planner alone, as most times it is dispersed in separate individuals required to execute the task. In addition, the traditional approach to construction programming focuses on sequencing of activities, developing schedules, and budgets by the project manager or the planner which is usually based on assumptions; thus making planned task uncertain (Crotty, 2012, Hass, 2007, Ballard and Howell, 1998). Since the programmes are usually imposed on the personnel doing the work, this results in delay and non-completion of planned task, due to breakage in flow of activities in the execution phase (Hass, 2007; Ballard 2000).

In fact, the present technical approach to planning is not only subjective but also project specific and conveys mostly the experience of the planner; thus hindering learning and innovation (Crotty, 2012, Kastalli and Neely, 2006). Howell and Ballard (1998) further argued that the current traditional approach to planning leads to 'push' of planned activities due to lack of flow in the production process owing to variability in the production process. The traditional project management approach tends to assume what site operatives should do, but in reality, such anticipated tasks may not be achievable by the team on site because of uncertainties that could surface due to lack of collaboration in planning (Mossman, 2013; Koskela, 2002). However, the LPS has been identified as a magical instrument to effectively control and reduce variability through its social conversation processes in ensuring planned tasks are predictable and reliable through CP (Daniel, *et al*, 2014; Koskela, 2002).

The Evolution of Social Perspective of Planning

The concept of CP came into the planning system due to the demerits of the RCM. In the 1960s, the RCM approach was greatly challenged because of its shortfalls, especially, the lack of representation of stakeholders' views in the decision making process (Guton *et al.*, 2003). In response to this, the planning bodies (i.e. Regional planning council and Metropolitan planning organisation) recognised the need for collective involvement of stakeholders in the planning process as a criteria for delivering value to the community and adopted it the model for all planning decisions (Guton *et al*, 2003). More importantly, this led to the development of the CP process, which occurs in various forms, such as workshops, public planning meeting, task

force, and adversary committee among others. Indeed, this approach views planning from a social perspective and also as a conversation.

Basically, the main target of CP is to create participation platforms for stakeholders before decisions are made. This approach to planning has been criticised by some; that it tends to take away power from those it has been vested with (Hearley, 2003). However, research has shown that the participation of the public or stakeholders in the planning process will give legitimacy to the planned task, and also motivate the stakeholders to be fully committed to the task (Mossman, 2013). This planning philosophy negates the traditional approach to planning that tends to be imposed. It is worth stressing that this concept of CP has diffused into the construction sector.

Social Perspective of Planning in Construction

The origin of CP in construction can be traced to the research work carried out in the 1980s on construction productivity improvement by Glenn Ballard and Greg Howell (Mossman, 2013). The principal outcome of the research was the development of the LPS of production control. The goal of the LPS is to deliver a more reliable and predictable construction project by identifying relationships and matching it with plans, while ensuring cooperation and commitment from all project participants in order to deliver value for the client (Kalsaas, 2012). This implies that CP is not a standalone concept but it is solely based on the LPS philosophy.

Mossman, (2013) argued that the concept of CP has been in use in engineering and construction for over two decades and provides a unique approach to planning. In essence, it is a planning concept that involves group of people, teams, and partners all working and learning from the planning process with a view of identifying and agreeing on the best options to address problems and opportunities inherent on the project (Cardwell and Redican, 2009; HA, 2010). Indeed, this approach contravenes the traditional approach to planning. Dua, (2006) opined that the philosophy of CP is to create a forum that will accommodate the client, contractors, consultants, sub-contractors, and vendors into a team with a view of creating a structure that will allow all members to work together in order to achieve the agreed common goals of the project. However, Rix, (2004) cautioned that the common goal must be based on the business need, which must be fully aligned in order to create a win-win situation for all members. This suggests that CP is quite different from cooperation between people or organisations without any common business goals or intentions.

Mossman, (2013) further emphasised that CP is a short-term planning ideology that is used in managing construction based production activities with a view of improving project program, safety, predictability, productivity, speed of delivery, profits, and wellbeing of team members. CP is unique in its own way as its characteristics differentiate it from all other forms of planning approach used in construction. Koskela and Howell, (2002) opined that organisations could build on their capacity with other members of the project team through collaboration which helps in reducing fragmentation, waste and mistrust among the team. This implies that CP does not only keep the project team focused on the goal of the project, but it also creates a sense of ownership of the project among the team. This approach has been implemented on construction projects with tangible improvement in construction process in USA, UK, Chile, and Denmark among others.

The UK Experience of Social Perspective of Planning

The Latham and Egan reports led to various initiatives in the UK and challenged the construction industry to improve its image and performance. One of such initiatives was the formation of Construction Lean Improvement Programme (CLIP) initiated by Building Research Establishment (BRE) in 2003. CP was among the key approach used in CLIP. The CLIP programme was implemented on over 50 demonstration projects based in the UK (BRE report, 2006). Thirty reports on the demonstration projects were accessed online and reviewed to determine the CP approach used, its impacts on construction process improvement, and to finally compare it with the global practices of collaborative conversations as reported in IGLC conferences. The review identified some key social conversations used as presented in Table 1.

Table 1: Social conversations used in CLIP demonstration project report

Forms of Social conversations used in CLIP	Rate of use in case study
Using a master programme	Very frequently
Developing collaborative programme or Phase scheduling	Very frequently
4-8 weeks lookahead planning	Sometimes
Weekly site meeting/ review	Sometimes
Detailed production planning including make ready process	Inadequate
Measurement of Percentage of Planned activities completed (PPC) in order to learn	Not at all
Detailed identification of reasons for non-completion with follow-up actions	Inadequate
Use of visual display board for communication to team	Very frequently
Use of external facilitator	Very frequently

These social conversation approach employed by CLIP was claimed to encourage learning, prompt feedback on performance for participating organisation, develop and sustain skills for site operatives (Constructing Excellence, 2007). The claim in the report suggests that the implementing organisations recorded measurable progress in process improvement. Specifically, 40% improvement in productivity; 50% reduction in project lead time; 65% reduction in defect rate and 30% reduction in terms of project duration were achieved through the use of CP (Constructing Excellence, 2007; BRE report, 2006). Although, this result could be subjective since it was based on demonstration projects with likelihood of bias, its demonstrates the potential of CP in a social conversation process for construction process improvement, which is contrary to what is obtainable in the traditional approach to planning. Ballard (2000) and Kalsaas, (2012) argued that CP makes the implementation phase of the project easy. It is worth stressing that some key elements of the LPS are missing in the current practice. This includes the MakeReady process with clear consideration flow requirements and constraint removal before production; production evaluation and planning; measuring of Percentage Planned Completed (PPC); and learning. The danger with partial implementation of the LPS in the social conversation process is that, full benefits of the system will not be enjoyed by the organisation.

Social Conversations: Antidote to Rational Approach to Planning

The LPS is increasingly been used in the construction industry. It is a production planning control tool that uses a social conversation approach in delivering reliable and predictable projects (Kalsaas, 2012, Ballard and Howell, 1998). According to Ballard and Howell, (2004), Koskela, (2002) LPS provides the missing component in the traditional project management toolkit. Ballard and Howell (2004) stated the missing component in the traditional project management toolkit as production control; this is responsible for poor project performance in the traditional approach to planning. This suggests that collaborative conversations in the LPS could address the inherent problem in the traditional approach to planning. The collaborative conversation is based on the five key components of LPS as presented in figure 1.

A critical evaluation of these components indicates that they work effectively on any project that requires coordination of human elements. In reality, it is a progressive process that yields enormous benefits. The next section provides an evaluation on how these conversations could be used to address the rational approach to planning in construction.

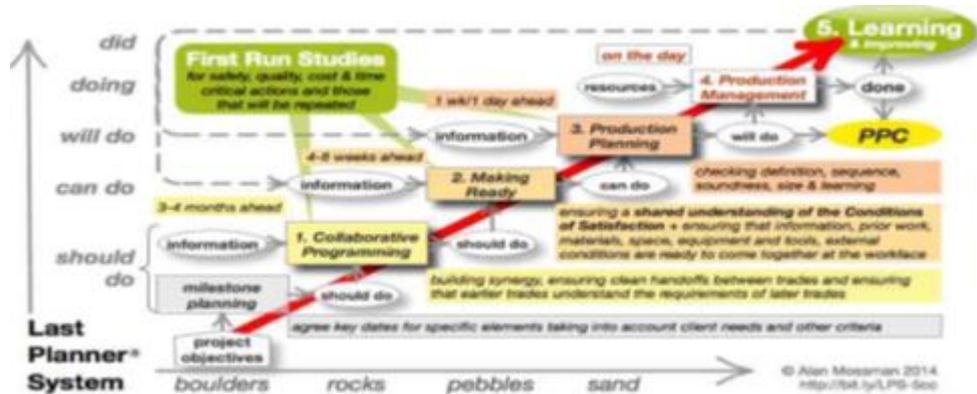


Figure 1: Last Planner System key conversations. [Used by permission: Mossman, (2013)]

Collaborative Programming

The first step in any collaborative conversation is collaborative programming. This process is used in developing a reliable programme from the master programme by direct involvement of the subcontractors, contractors, suppliers, designers and other stakeholders on the project at the early stage of project planning. This is done by presenting logical arguments to agree and develop the construction programme (Mossman, 2013; Anderson *et al*, 2011; Ballard, 2000). This increases transparency and builds trust among the project team. However, this approach has been viewed to be non-existent in the traditional approach of project planning which is characterised by lack of trust and collaboratively agreed procedure for delivering projects (Zaghloul and Hartman, 2003). Ballard and Howell, (1998) argued that the non-existence of collaborative programming in developing construction task and activities is one of the major causes of construction project failures.

Anderson *et al* (2011) opined that CP in construction reduces issues such as changed orders, delays, rework, non-value adding activities, and litigation during the construction phase. This is so, since the process allows the team to develop a better understanding of the task and the process to be adopted in executing the task. However, this has remained an illusion on many construction projects due to the complex nature of relationship that exist among stakeholders associated with construction projects. This is even made worse with the use of rational approach in planning. Pasquire, (2012) argued that the non-existence of common understanding among project stakeholders is responsible for higher tenders, conflicts, projects running over time and budgets; and subsequently challenged the industry to adopt collaboration in planning in order to address the anomalies in the industry.

Make-Ready Process

The Make-Ready process is used in eliminating constraints to planned activities before the production or implementation stage on construction site. According to Ballard and Howell, (1998), and Ballard, (2000), the process is focussed on matching the available resources with the present realities on the construction site, such that production can proceed at an optimal level. The process is aimed at encouraging all the stakeholders to collaboratively identify and remove all the likely constraints that

could show up at the work phase before the actual commencement of work (HA, 2010, Mossman, 2013). This approach is used in controlling the production system. However, Ballard, (2000) observed that most scheduled activities in traditional approach to planning are not completed as planned because they were not ‘Make-Ready’ prior to the production phase. This further magnifies the need for removing constraints from the production process in order to create flow in the entire process. Lindhard and Wandahl, (2012) and Koskela, (2002) argued that the lack of flow and the failure in removing constraints from the construction process contributes to non-value adding activities in the construction phase.

The goal of the Make-Ready process is to develop sound activities and assignments from the Lookahead activities which will subsequently be moved into the backlog of sound assignment for use in the Weekly Work Plan (Mossman, 2013; Lindhard and Wandahl, 2012; Ballard, 2000). The Make-Ready process improves construction planning reliability even on complex projects, using systematic approaches (Ballard and Howell, 1998).

Production Management, Measurement, and Learning

Production management is the approach used in controlling material and human resources deployed into the production system from the “*Make-Ready process*”. This approach is used in maintaining the entire production system to ensure the designed or intended output is achieved at the end of the production. Production management can therefore be viewed as production control, which entails the coordination of production planning, material coordination, and the control of planned tasks and production units (Ballard, 2000). However, unlike the traditional approach of project control, production management refers to the shaping and deployment of workable backlog into the production system while also ensuring these workable backlogs are delivered as specified (Ballard and Howell, 1998). Koskela, (2002) argued that the traditional approach of project control on site is based on assumptions and most times this leads to shifting of activities during production on site due to inherent variability in construction. It has been argued that the ‘model’ of control used in the construction industry is based on project control rather than production control (Koskela, 2002, Ballard and Howell, 1998). This implies that the production management in CP is not based on project control that emphasises conformity to plan not minding the overall effect of such changes on the production system as shown in Figure 2. However, project control rather than production control has been identified as a common occurrence or norm in the traditional project management approach (Koskela, 2002; Ballard and Howell, 1998). It is worth noting that in CP social conversation, these inadequacies are addressed since production control or management is done collaboratively with project stakeholders such as foremen, site managers, and subcontractors who are the responsible persons to deploy and manage resource in the production system on site.

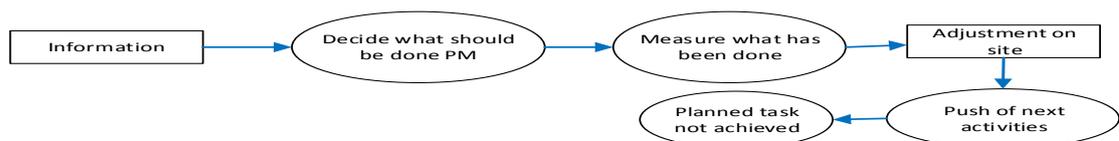


Figure 2: Rational Comprehensive Model approach to planning on site

Furthermore, production management entails recording of Percentage Plan Completed (PPC), while also identifying reasons for non-compliance. The reasons for non-compliance or late completion are recorded on a Pareto chart which will guide the team in making more reliable and predictable plans in the weeks ahead. PPC

measurement also enhances learning across the team which is a key goal of the social perspective to planning. In reality, PPC measurement does not only encourage learning but could also be used to determine productivity. For instance, Liu and Ballard, (2008) confirmed a strong correlation between PPC and productivity on engineering construction projects. The uniqueness of social conversation is the learning curve which is subsequently deployed into the production system as shown in Figure 3. This is contrary to the traditional approach used in managing projects, which focuses on ‘push’ and adjustments, all at the system expense thus hindering learning.

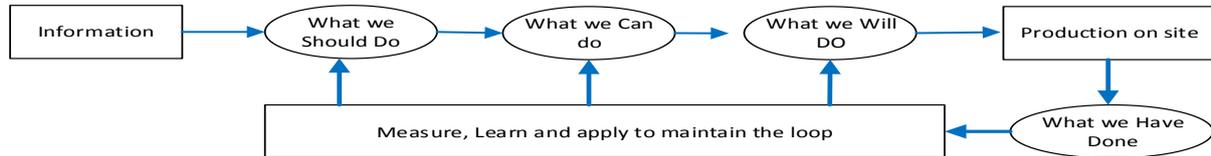


Figure 3: The social Perspectives to planning loop

The key element of the CP conversation is learning, which obviously is absent in traditional approach to planning (Kalaas, 2012).

SUMMARY FINDINGS

The aim of this study is to establish the rationale and implications of the use of traditional or technical approach to planning in construction, and to evaluate how this can be improved through LPS. Findings from the comprehensive literature reviews reveal that:

- The technical approach to planning in construction is based on the RCM which view planning as scientific and technical discipline and thus believed that the knowledge needed for planning lies in the hand of the planner and the planning authority alone.
- The finding indicate that only 54% of planned task are achievable on site via traditional planning approach, because of uncertainties and variability that will usually show-up on site due to lack of collaborative conversation in the planning process; a major contributing factor to construction project failures.
- The study identified the LPS of production control as a "magical" instrument with enormous potential to reduce uncertainties and variability in the traditional planning approach via its social conversations to make planned task predictable and reliable.
- The review indicates that the application of the social conversation (LPS) in the UK seems to be at variance with global practices as reported at the IGLC conferences. However, it showed some benefits in terms of time, cost, productivity, and construction process improvement.

CONCLUSION

This study established that the technical approach to planning in construction is derived from the principles of RCM which originates from URP since World War II. Although, URP has replaced this approach with collaborative planning, its use is prevalent in the construction industry with detrimental effects on project outcomes. Again, since the proponents believe that the knowledge needed for planning lies in the hand of the construction planner alone, other stakeholders on the project will not have input in the planning process; this implies planned tasks will not be achieved, thus resulting in project failure.

However, it is encouraging to know that the study has revealed the potential of the LPS in improving the current rational approach to planning in construction through its five key social conversation process as indicated in figure 1 and subsequently discussed. The LPS collaborative conversation achieve this, by identifying relationships and matching it with plan, while conversing for collaborative commitment from all the stakeholder on the project in a systematic way, thus reducing uncertainty and delivering a reliable and predictable construction project for the client. Since collaborative conversation in the LPS brings all the team together, it will not only lead to learning but also innovation and creativity as team members will benefit from each other's know-how.

The study observed that the application of the social conversation based on LPS in the UK construction industry is at variance with that commonly reported in the IGLC conferences. Since these claims cannot be substantiated, as the findings are only based on the review of 30 demonstration projects in the UK, an empirical study is required to expose the current CP and LPS practices in the UK to enable improvement. The empirical investigation of CP and LPS practices in the UK and a critical evaluation to development of an implementation framework for it in the UK will form the next stage of an on-going research by the authors. The study concludes that the practical application of these social conversations will assist construction organisations in delivering predictable and reliable projects with improved value for the client.

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SOLID WALL INSULATION RETROFIT IN UK DWELLINGS: CRITICAL FACTORS AFFECTING MANAGEMENT AND QUALITY

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Driven largely by government policy instruments, the UK solid wall insulation (SWI) industry today is experiencing explosive growth rates. This research explores critical factors in the industry's efforts to overcome a legacy of poor design and build quality in retrofit work. The research employs qualitative and ethnographic methods across a range of UK area-based retrofit projects and installer training programmes. It includes participant observation made while working in the role of SWI installer, and an extended study of a leading SWI installation company and its construction management processes. Findings identify patterns of 'short-termism', financial pressure, limited technical understanding, and point to immature management practices as recurrent impediments to installation quality. The research argues that in the context of a social-technical-political environment which hinders attainment of quality, new approaches to management are needed in the SWI industry.

Keywords: retrofit, quality, policy, training, organisational culture

INTRODUCTION

'Solid wall insulation' (SWI) refers to insulation applied to the internal or external face of an exterior solid or 'hard-to-treat' cavity wall. Recent rapid growth of SWI retrofit in the UK have been driven in large part by several government policy instruments. Statistics suggest that the total number of installations in the UK roughly doubled between mid-2011 and mid-2013, and roughly tripled from early 2009 – growing at approximately 30 per cent to 45 per cent per annum. Despite this, the latest estimates suggest there is considerable work to be done; of the 5.3 million homes without cavity wall insulation, 4.6 million are hard-to-treat. Meanwhile, approximately 3 per cent of roughly 7.8 million solid wall homes have been insulated. SWI represents a niche component in UK construction with the total number of SWI installations in the UK only recently exceeding 200,000. (DECC 2012; 2013)

Installation work is widely carried out by SMEs, which in turn often subcontract to small and micro enterprises in what are essentially design-build contracts (the requirement for 'design' in SWI is limited to 'buildability workarounds' to manufacturers' standardised installation specifications). Against a history of limited take-up (and low rates of innovation), the SWI installation industry today is a highly

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fragmented group of actors with a legacy of varying build-quality and appropriateness in specification practices and generally immature construction management practices.

Poor installation or specification of SWI retrofit presents significant risks of unintended consequences. These include interstitial and surface condensation, impacts on indoor air quality, moisture ingress, vapour build-up, and excessive summertime internal air temperatures (May and Rye 2012). These risks are significant to performance gaps, integrity of existing fabric and hazards to occupant health. Mitigation of the risks requires that installers have appropriate levels of skill and understanding, and work within a system of effective construction management.

This research is situated in the context of today's rapidly growing SWI installation industry, and the imperative to limited unintended consequences due to poor practices. It develops understanding of the key drivers of, and obstacles to, appropriate practice. It adopts a 'bottom-up' inductive approach based on qualitative methods. Findings are interrogated against existing theory, and analysed to develop new understandings.

LITERATURE REVIEW

The critical factors that impinge on design and build quality are too many to discuss in detail here. However, it is worth summarising the key points of theoretical context on topics such as quality, knowledge and skills, management and communication.

'Quality' in construction

The risks presented by poor installation and specification make clear that there is a need for the industry to improve quality in these processes. 'Quality' is a multidimensional concept in construction. Lavender (1996: p.284) argues that "*there is often a misunderstanding... It does not necessarily mean something which is good. Rather, it means conforming to a standard or requirement which has been set or which is expected*". Harris and McCaffer (2013) reason that it reflects processes of organisation, production and pre-production dynamics, and they add attributes such as 'respect for people', 'continuous improvement', and 'response to change'. Increasingly, authors' definitions blur distinctions with 'quality management' and industry thought leaders imbue 'quality' with aspects of process and conformance.

Knowledge, skill and 'doing' work

Securing better 'quality' will rely on developing consistent technical understanding and skill across the industry. This will require support for knowledge exchange pathways and mechanisms through considered management strategies. The distinctions between 'tacit' and 'explicit' knowledge made by Nonaka and Takeuchi (1995) are useful in understanding the dynamics of construction and its management. In design circles, Donald Schön popularized the notion of *reflection-in-action* (1991); borrowing the term 'tacit knowing' from Polanyi (1958), he asserts that we know more than we can say. The acknowledgement of 'know-how' as a form of knowledge that differs from 'knowing-that' and the claim to primacy of practical knowledge is found in Polanyi and Dewey (1922: pp.177-8). This tacit knowledge can never be fully articulated and is characterised by Schön as *knowing-in-action*. Schön notes, "*although we sometimes think before acting, it is also true that in much of the spontaneous behaviour of skilful practice we reveal a kind of knowing which does not stem from prior intellectual operation*" (1991: 51). Improving exchange of explicit and knowledge between actors is vitally important and will benefit from significant investment in structured approaches (Robinson, *et al.* 2005).

Individual knowledge can be contrasted with organisational learning, which occurs in networks, or in ‘communities of practice’ (Wenger 1998). Expansive literature has already outlined organisational learning models (e.g. Bell, *et al.* 2002), and many authors have studied their application to the UK construction industry (e.g. Tennant and Fernie 2013). Little study to date has examined their relevance to the SWI industry.

‘Doing good work’ and ‘abilities to do’ are distinct concepts. Beyond ‘know-how’ and ‘know-that’, there are knotty issues of motivation and quality. These are discussed in Richard Sennett’s work on craftsmanship (2009). Sennett (pp. 244-246) recognises that quality ‘becomes an issue’ and is internalised to create ‘quality-driven’ cultural norms. For instance, while observing ‘obsessional energy’ in the sushi chef and the electronics manufacturer, he notes that perfect consistency and quality are not just achieved via processes, but become defining, intrinsic personal and sociological values. Textbook definitions of quality, in their focus on productivity, distract us from the critical issues of motivation, aspiration, and socio-cultural context.

Construction management: quality and process

Writers on construction management place advancing quality management as a central concern. Harris and McCaffer (2013: p. 7) argue that quality management has “*become a strategic business function accounting for the raison d’etre of construction companies*”. They trace the evolution of quality management in construction over the past three to four decades from an inspection-based and intervallic approach, to the ‘quality assurance’ model still widely seen today (e.g. ISO 9000 standards family), and ultimately to growing adoption of Total Quality Management (TQM). The mantra of “*do it right and do it right the first time*” has been internalised in many areas of construction and reduction of rework and call-backs are held as important objectives.

Communication, learning and professionalisation

Fryer and Fryer (2004: p.142) report data collected by the BRE that place human factors as central to failures in design and construction phases. These included “*poor communication, inadequate information... inadequate checks and controls, lack of technical expertise and skills, [and] inadequate feedback...*”.

Learning within organisations remains a challenge in construction. This may be exacerbated by a history of low enrolment in higher education degrees (Dainty and Edwards 2003) and has implications for thought leadership. Approaches to capturing knowledge from projects have long been discussed (e.g. Latham 1994) yet remain underdeveloped (Tennant and Fernie 2013). Techniques such as post-project reviews (debriefing participants after project completion), intranets to capture and distribute knowledge, and ‘centres of excellence’ to centralise knowledge and expertise are not new (Winch 2002), but have remained underused (Carrillo, *et al.* 2013).

Hartenberger *et al.* (2013) argue that the construction industry might look to medicine for models of education, professional identity and ethos. The parallels between construction and medicine are noteworthy: they are both atomised professions consisting of networks of specialisation, and both have traditions of apprenticeship, and inter-and intra-disciplinary learning and interaction. The authors argue that professional practice in the built environment is impeded by barriers such as poor information capture, communication, rivalry and hierarchal thinking. Medicine offers models of problem-based learning, ‘closed practice-research-education-training’ loops, and unification toward a common ethos and identity (i.e. Hippocratic Oath).

AIMS AND OBJECTIVES

This research aims to improve understanding of the challenges the industry faces in delivering consistent build quality in light of dramatic changes in its landscape, and widespread concern that a legacy of inconsistent build quality and performance gaps is being perpetuated. The work analyses a small subset of the industry as it seeks to build new theory. Recognising limitations in generalizability inherent in its qualitative origins, the work is undertaken to complement other primary research and secondary analyses of SWI installation and performance, and study of the application of process and knowledge management practices in the SWI industry.

METHOD

This research used qualitative and ethnographic methods, following traditions of inductive theory-generating analysis. Since Glaser and Strauss introduced the concepts of constant comparative method and grounded theory (1967), discourse has muddled the bipolar distinctions between deductive theory-testing approaches and inductive approaches to analysis. Further arguments have debated the tenability of theory 'discovery', asserting that the research 'world' is fundamentally a socially constructed one (Orton 1997). This project recognises the complexity of 'knowing' and situating discovery, and is informed by numerous traditions including ethnography, inductive and interrogative approaches, and organisational research.

The research evolved in three phases which narrowed in focus from discovery to directed investigation of a single organisation. Discovery research included unstructured and semi-structured interviews (typically one hour) with 24 academic and professional experts to document prevailing perceptions and concerns about SWI installation practices and performance gaps. In the second phase, roughly 300 hours of non-participant observation and unstructured interviewing included an array of actors (installers, surveyors, researchers, energy company staff engaged with ECO, training colleges and trainers, site managers, principal contractor officers). In this phase, themes discovered in Phase 1 were explored in greater detail, and new themes were allowed to emerge. In the final phase of research, 18 weeks of non-participant and participant observation -- including several weeks working in the role of SWI installer -- took place in a leading SWI installation company. Here, the majority of study focused on contract managers and site managers, but included installers, trainers, surveyors, senior management, business development, and a QA officer.

Professionals and institutions across central and southern England and southern Wales were included in the first two phases of research. The extended study made in the third phase of research was sited in a leading SWI installation company which works across England and Wales. The vast majority of observation was made in area-based retrofit projects through shadowing and conversing with participants. The inductive nature of the research demanded that a cross section of industry and SWI actors was captured and that sustained access was available in order to develop nuanced understandings. The methods employed were selected to enable the collection of 'rich' data and to develop an understanding of the complex actor-networks at play. Certain challenges were encountered; most noteworthy were the minimisation of researcher bias and 'observer effect' and creating and sustaining access at both individual and 'community' scales. Bias and observer effect are -- to an extent -- inherent issues in the research methods. Mitigation was sought through the employment of strategies such as coding, constant comparative method (triangulation), and 'theoretical saturation'.

Observation was limited to the number of actors and sites that could practically be included in the research, and it is recognised that the theories generated should be tested in future research. Research captured roughly 100 experts and professionals and 1,000 in-process or newly-completed retrofits. Observation was made in varying degrees of duration -- wherever possible, over hours or across days. Shorter interactions and observations (not included in the above numbers) contributed to 'saturation' in analysis but did not provide a substantive basis to the research.

RESULTS

Results are reported here by significant themes and topics emergent in data analysis.

Industry overview

The SWI 'industry' is more aptly described as an atomised system of actors working in diffuse subcontracted relationships. Contracts are led almost exclusively by SMEs which allocate works broadly to micro- and small-scale organisations. Specialist installers of SWI are very often 'upskilled' tradespeople with backgrounds in the 'biblical trades'. With recent growth in the industry, an emergent population of workers for whom SWI installation is their first profession can be found.

Installation quality

From initial stages of research, consistent anecdotal reports described a legacy of poor build quality in the SWI industry. Observation in subsequent stages suggested the persistence of this problem as quality defects (aesthetic and functional) in installation were observed repeatedly. Although this was not a quantitative study, it was clear that significant defects of both types were common (perhaps appearing in one of two retrofits observed), with more serious defects being observed in roughly 5-10% of retrofits and minor defects being nearly ubiquitous. Aesthetic defects were largely in either rendering or detailing. Examples of common functional defects included:

- Poor butting of insulation boards or inadequate fixing
- System boundaries not sealed adequately
- Emergency gas shut-offs or ventilation openings inadvertently blocked
- Weep holes or capillary grooves in windows and cills compromised
- Inappropriate insulation material or render specified for local climate
- Renders and adhesives applied or stored in unsuitable conditions
- Vapour control missing/ 'vapour permeability' not provided
- No insulation installed in floor-ceiling voids, floor or roof junctions

Policy and 'artificial pressures'

The primary business model of nearly all SWI principal contractors (as reported by participants) is to secure and deliver contracts with energy companies under government-led energy and emissions reduction programmes (e.g. ECO, CESP, Green Deal). The UK's largest energy companies are required to fund energy and carbon reduction projects. In these programmes, companies negotiate with contractors (or agents) who in turn deliver notional reductions in emissions through SWI retrofit.

What emerges is a 'low hanging fruit' scenario. Natural economic forces dictate that the easiest and cheapest reductions will be made from area-based projects of homogenous building stocks. This results in a 'gold rush' phenomenon: a scramble to secure funding and deliver as many retrofits as possible at the lowest possible price.

Meanwhile, policy instruments set de facto quality norms such as required guarantee periods or prescribed QA obligations. Rather than serving as minimum acceptable standards, these become normative influences. The 25-year guarantee period introduced by ECO (expanding the 10-year period in CESP) was seen to trigger a concentrated effort to improve build quality, but only to the 25-year threshold.

Training and certification

Formal structures for learning and certification serve ‘first-tier’ agents (e.g. installers) but no directly relevant structures serve management or ‘second-tier’ roles. PAS 2030 certification is an integral part of new government-led programmes and has triggered an increase in enrolment in programmes leading to NVQ 2. This is one of the few formal mechanisms of skill and knowledge assessment, though manufacturers widely offer abbreviated training and certification related to their proprietary systems.

Participant observation of training programmes found a heavy emphasis on ‘site proficiency’ (e.g. health and safety, rudimentary process skills, procedural knowledge). Little content highlighted the unintended consequences of improper installation, nor instilment of professional ethos or identity. Moreover, trainers frequently betrayed poor understanding of fundamental concepts.

Perhaps more troubling was opinion registered from several figures of authority that training colleges have a “*money first, quality not*” outlook. One NVQ instructor noted, “*these places are like [expletive] factories. It’s like a conveyor belt. It’s been quantity over quality. Because it’s about money at the end of the day you know, isn’t it. They just care about numbers. They just race them through here and as long as they make their money, well if they [installers] learn something on the way through that’s great.*”

‘Short-termism’ and workplace culture

“*I honestly believe that in the coming years, companies are gonna be making a lot of money doing remedial works to the systems that have already been installed*”. This sentiment was relayed by a senior installer/NVQ instructor/assessor, and echoed that shared by several other actors. It conveys a dispiritedness with the work-world in which the installer produces and suggests an emotional distance from the ‘companies’ (capital holders) who stand to gain/endure in a system of poor production quality.

Professional pride was observed to vary widely, but generally was limited. Crews worked frenetically in response to ‘pricework’ (pay based on insulated wall area). This parallels principal contractors who are paid on a ‘carbon tonne saved’ basis. The role of ‘EWIer’ was spoken of by one particularly enthusiastic trainer, but this was a rare recorded instance of shared professional identity. Pride largely was observed in relation to ability to produce ‘coverage’ (i.e. earn money quickly), but seldom in relation to tacit knowledge, skill, or technical expertise. In contrast to Sennett’s (2009) observation of “*obsessional energy*” in the manufacturer and sushi chef, little evidence was found of a culture that internalised quality as a personal or sociological value.

Construction management and quality assurance

Site managers, contract managers, directors, and quality control officers had most commonly ‘moved up’ from working as installers and had learned management ‘on the job’ with little or no formal training. Although their background positioned them to possess important tacit knowledge, they displayed little understanding of technical

knowledge or expertise in formal management practice. Some formalised elements of management practice were visible; for instance, risk and methods statements (RAMS) were widely used in order to comply with health and safety norms and regulations. CESP and ECO (among other programmes) require inspection and documentation and this clearly stimulated a degree of formal management practice. Equally important, the area-based scale at which organisations now work demands effective approaches (be they formal or informal) to process management.

Rudimentary management practices were observed as dominant, with broad reliance on informal techniques. Quality inspections in one company, for instance, were based on the use of a tick-box inspection using an inspect-and-display system akin to the proprietary Scafftag system used for scaffold safety inspection. The ‘QA card’ for each house was filled in during a sequence of post-task inspections by site management. It served a complex function – as much a signifier of control, or agent of power used to concretise management’s authority, as a technically functional tool. Viewed another way, the card provided talking points, and so structured and enabled casual discussion between actors on site. As a primary tool of management, though, it was wholly unsophisticated and incapable of capturing the complexity of retrofitting.

Senior management in all but one principal contract organisation indicated that they rely heavily on ‘walk-arounds’ and site managers to ‘catch’ poor practice and determine retroactive solutions (rework). In Lavender’s (1996) analysis, this represents the lowest form of management evolution. The system’s limitations did not appear to be recognised by senior management; one officer discussing the inadvertent covering of an air vent for a gas fire remarked *“it’s not a procedure problem, it’s a person problem – somebody’s not following it [best practice], you know”*.

Contractors, energy companies, manufacturers, policy instruments (e.g. ECO, CESP), and regulators rely on systems of third-party guarantors to insure against poor delivered quality. Distrust of this system was routine as many doubted that guarantors would in fact ‘pay out’ in the event of failures. In one installer’s words, installers would ultimately be *“hung out to dry [for] anything and everything”*. This view was echoed by an NVQ assessor who told several installers, *“I don’t care how good you are, you will miss something out – whether it’s a bead or a fixing or a seal – and that’s what they they’re [manufacturer’s warranty guarantor] looking for; it’s a way out, to throw it back at you.”* Rather than unifying multiple roles toward a pursuit of quality, this system appears to perpetuate a culture of transferred responsibility.

DISCUSSION

Unintended consequences

In principle, installation of SWI is a simple undertaking and installation procedure is dictated by manufacturer specifications for material selection, installation procedure and standardised detailing solutions. This systemised approach to ‘design’ is largely effective in securing build-quality. Crucially, however, failure to follow specification, or recognise instances when it was insufficient, appeared to occur regularly. Specifications are an important ‘safety valve’, but poor planning and oversight of their realisation propagates risks of underperformance and unintended consequences.

Understanding, expertise, motivation and technology

Levels of competency and technical knowledge in the industry were generally observed to be low. Formal training programmes have a crucial role to play here but require retooling to better distribute technical knowledge. Meanwhile, conveyance of

tacit knowledge appears limited in formalised structures and is impeded by ‘clustered’ knowledge flows in everyday work-life. Knowledge management strategies highlighted by Winch (2002) and Carrillo (2005) may offer useful lessons. Incorporating the ‘knowledge integrator’ concept (Janda and Killip 2013) and breaking down boundaries of traditional identities (Hughes and Hughes 2013) may also be important strategies for accumulating and dispersing new knowledge bases.

Installation quality is largely the result of innumerable small-scale decisions made during the process of deploying SWI. These decisions are formed largely in the context of the complex work-world (external forces) and its shaping of individual producers. Hence, quality is a ‘human’ problem with all of the complexity that this entails. It would be an incomplete analysis, however, to understand quality only in combinations of social or institutional analyses. Clearly, the agency and constraints of technology exert a normative and determinative force too; appropriateness of selection of materials, strategies of work, and systems of oversight seem to suffer accordingly.

Policy

Top-down mechanisms for incentivising retrofitting have clearly stimulated remarkable growth in SWI installation. Their disjointed nature, however, has inadvertently exacerbated difficulties in achieving consistently high levels of quality. Principal contractors cope with temporal pressure while striving to maximise productivity within funding windows; this ‘gold rush’ mentality trickles down to sub-contractors. Meanwhile the de facto standards and expectations imposed by these programmes (e.g. ECO’s 25-year guarantee period) were generally observed in the field to have minimal real impact on quality or management practices.

Management

SWI retrofitting, like nearly all refurbishment work, is inherently an unpredictable endeavour. Systems of management must control as well as respond to this unpredictability. Compared to other sectors, new domestic construction exhibits less formal and often less sophisticated management practices. Perhaps it is unsurprising, then, that the domestic ‘repair, maintenance, and improvement’ sector – of which SWI retrofit is a part – exhibits wholly immature management practices (Killip 2011). Loosely formalised and primitive forms of management are clearly not passing the ‘fit for purpose’ test; indeed even more codified but traditional approaches to quality control – last at the vanguard of management practice several decades ago – are routinely failing the SWI industry as it strives to improve ‘quality’.

‘Quality’ has been described as a multi-faceted concept. Effective quality management is built on better ‘systems of work’, but it also draws on complexities of identity constructs, organizational and personal communication, knowledge management, and shared aspirations and professional pride. Moreover, management must meet the challenge of facilitating exchange of explicit as well as tacit knowledge.

The industry must pursue procedural improvement while also seeking to inspire Sennett’s concepts of motivation and pride. The industry is shaped by a variety of forces: its inherited legacy, dependence on instruments of government policy, reliance on outside (i.e. not SWI) educational entities, its supply chains, and internal structure are all significant. Meanwhile, Latham’s critique remains deeply relevant. Wherever possible, the industry should be compelled toward progressive action and adoption of best (if not vanguard) construction management practice.

If it can curtail poor practice, the industry stands to make substantial gains by capitalising on the momentum of government support for SWI. This will be jeopardised by collective failure to advance practices. To date, advances in construction management practices have been imposed via policy instruments (e.g. ECO and Green Deal), and this may continue to be an effective mechanism for progressive reform. In addition to improving ‘quality’, management practices can also serve to forge common identity, pride and ethos, and to bolster knowledge exchange.

CONCLUSIONS

This paper has presented preliminary results and analysis from extensive qualitative research in the UK SWI retrofit industry. Findings corroborate anecdotal reports that the industry perpetuates a legacy of poor build quality and immature construction management. The research goes beyond this to develop new approaches to understanding drivers of and barriers to improvements in SWI practices.

Patterns of ‘short-termism’, financial pressure, policy impacts, limited technical understanding and immature construction management practices are identified as recurrent impediments to installation quality. In light of the industry’s recent explosive growth and its legacy of poor installed quality, the research asks how these barriers might be overcome and how more robust management practices might be adopted for use in the retrofit context.

Analysis of the research is still at an early stage and will continue to evolve over the coming year. Certain limitations are inherent in the research design and these include the generalizability and the vulnerability to (or reliance on) subjective interpretation of data. In light of these limitations, further work on the topic might either enhance the work’s generalizability or challenge its theoretical bases.

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ASSESSING RISK DYNAMICS IN PUBLIC PRIVATE PARTNERSHIP PROJECTS

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There have been many instances of unsuccessful public private partnership (PPP) projects. Traditional reductionist approaches to risk assessment appear inadequate to manage the complex and dynamic interdependencies which exist on such complex projects. Systems dynamics methods have been used extensively outside construction to assess risk in other complex systems and theoretically show great promise in PPP projects. However, interviews with sixteen senior construction professionals with experience of PPPs, while indicating openness to new approaches, revealed significant short-comings in adopting such an approach in this context. It is concluded that if systems dynamics is to be used as a new way of assessing risk on Public Private Partnership projects, existing dependence on linear methods needs to be broken through more education about the merits of system thinking.

Keywords: risk, systems, public private partnerships.

INTRODUCTION

Definitions of PPPs vary around the world but typically refer to a procurement approach where a private sector consortium contracts to finance, design, construct and operate public infrastructure against defined public service standards (Yescombe 2007). In very simple terms, the clients buys a stream of services rather than an end-product and the consortium is paid (or abated) according to the achievement of these service standards over a concession period which can last for decades. As Howick *et al* (2009) point out, PPP projects tend to be large, complex, last over many years and involve many parties in dynamic relationships with a multitude of interdependencies and risks. This makes the assessment of risk a very challenging process which many authors have argued are undermined by traditional reductionist approaches to risk management which inherently assume that risks occur in a linear predictable fashion (Kapsali 2011, Lehtiranta 2013).

According to Koubatis and Schonberger (2005) the main problem for managers in assessing the risks in complex systems is their property of ‘self-organization’ – the ability of a system’s connections and interdependencies to change, adapt and develop on their own without the influence of external managers. While self-organizing systems tend to be highly efficient and find a natural equilibrium, in doing so they also tend to settle at a ‘critical edge’ where a small change in the system can lead to catastrophic changes in the overall system. Kampmann (1999) famously illustrated this with the analogy to a pile of sand. As each grain is added, it displaces the grains of sand around it but at some point, as more grains are added, one grain will act on the

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whole system and cause the pile to collapse and find a new equilibrium. According to Kampmann (1999), complex systems evolve gradually and smoothly at a steady pace to be punctuated by occasional and inevitable catastrophic changes. While they may appear under control on the surface, in reality they exist on the edge of chaos and it is impossible to predict when the sudden change in equilibrium will come. Complex systems theories have been used to explain the behaviour of many self-organizing systems such as the stock market, traffic jams, epidemics, volcanoes, evolution and extinctions, forest fires and economic cycles. They have even been used to understand risks in PPP projects (Nyagwachi 2008, Masafumi 2009, Aragão and Nascimento 2010, Jang 2010, Xu *et al* 2012). However, despite demonstrating the value of this approach, we have little understanding of what the barriers in adopting system thinking may be in practice. As Koubatis and Schonberger (2005) and Helbing (2013) both point out, this involves a major ‘paradigm shift’ away from linear reductionist thinking about risk to a new perspective which requires risk managers to think about the dynamic interdependencies which can cause PPP projects to fail.

A SYSTEMS APPROACH TO ASSESSING RISK

According to Kapsali (2011) ‘systems thinking’ is a holistic approach which views organisations as a series of interrelated subsystems of people, processes and technologies that cooperate towards the achievement of a common goal. Systems thinking focusses on ‘relationships’ rather than individual ‘parts’ and on the effects of cyclical relationships rather than linear cause-and-effects. The field of Systems Dynamics (SD) has developed to help us understand and model the structure and dynamics of complex systems (Sterman 2002). From a risk assessment perspective, SD enables risk managers to experiment, in a virtual world, with different risk control strategies to optimise project outcomes (Martinuzzi and Kopp 2011). Typically, the SD methodology consists of four main stages: Qualitative reflection; Computer Model Formulation and Simulation; Simulation Testing and Evaluation and; Simulation Policy and Interaction Experiments (Zagonel 2002).

Stage one

The first stage of qualitative reflection usually happens in a workshop of key stakeholders who are asked to describe the system under consideration, its critical resources and their dependencies. The aim of qualitative reflection is to create an aggregated model of the system. This is often done using a rich picture diagram (RPD) which is simply a pictorial multi-layered representation of the real world using symbols to represent sub-systems and their relationships within a defined system boundary (Patching 1990). This can then be synthesised into a single map of linked concepts, where relationships between main concepts are connected by linking words or linking phrases. There are precious few examples of RPDs in construction but Figure 1 shows one adapted example of a simple RPD which represents how one potential PPP risk (Force Majeure) could affect the facilities management of a major hospital is presented in Figure 2.

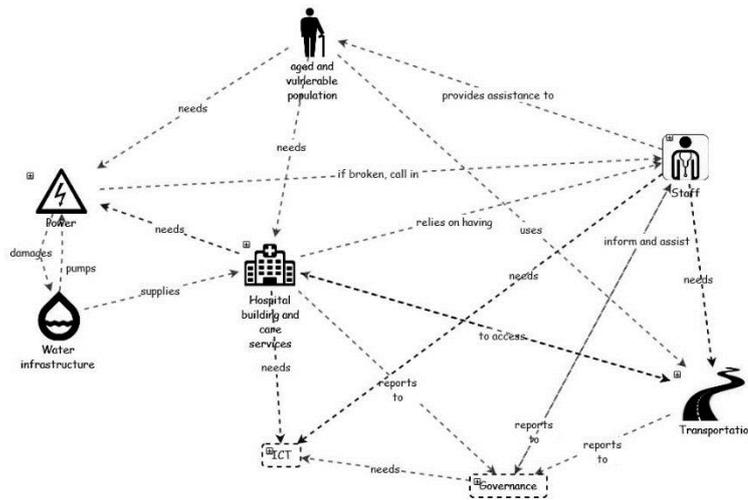


Figure 1: Rich Picture Diagram (Source: Chow *et al* 2012)

While used in another context by Chow *et al* (2012), Figure 1 shows how components of a hospital system (during the operational phase of a PPP project) could be affected by a force majeure risk (in this case an extreme weather event such as a heatwave). It shows how the continued delivery of hospital services is dependent on a whole range of other infrastructures and governance systems and that hospitals should not be seen or managed in isolation from these systems. Maintaining health services to defined KPIs during such an event is therefore determined by how well these interdependencies are managed.

Stage two

Following the ‘Qualitative Reflection’ stage, the “*Computer Model Formulation and Simulation*” stage involves converting the RPD into a dynamic map of stocks and flows (a stock and flow diagram) to show their underlying physical and feedback control structure (Sterman 2002). Figure 2 is a stock and flow diagram developed by Chow *et al* (2012) and shows the flow of patients from the community to the hospital and the top of the diagram shows the timing of the force majeure risk event, its consequences for the hospital, the effect on community infrastructure and its impact of the hospital and its impact on flows of patients and levels of care provided to the community.

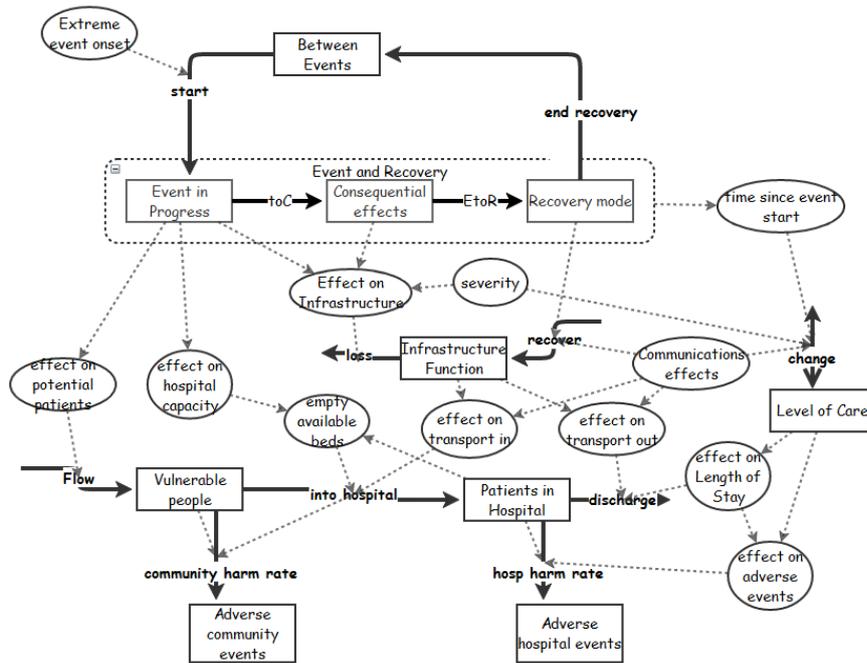


Figure 2: Stock and flow diagram created using Insight Maker (Source: Chow et al 2012)

Stage three

During the third “Simulation and Testing” phase the stock-and-flow model is progressively refined over multiple iterations with stakeholders to ensure any differences between the real world event patterns and the model outputs are minimised. Sterman (2002:852) describes modelling as “... a process of communication and persuasion among modellers, clients and other affected parties. At the end of the simulation and testing process the model should accurately represent the behaviour of the system over time and allow risk managers to understand how different risk scenarios impact on the KPIs of the system being modelled.

Stage four

In stage four of the SD process, managers conduct ‘virtual intervention experiments’ to explore how alternative management strategies can minimise impacts on KPIs, testing them using the SD model. The alternative policies, strategies and structures tested will rest on the imagination, experience and skill of the system stakeholders and the SD model will show which options are ‘likely’ to produce the best combined outcomes for the stakeholders involved.

METHODS

In order to explore the barriers to implementing a SD approach to risk assessment on PPP projects, we undertook semi-structured interviews with sixteen people, from a range of professions, who had held senior roles on major PPP projects in Australia and overseas (see Table 1 for sample structure). Each of these people had worked on several PPP projects and were identified through references from their peers as recognised experts in the PPP field.

Table 1: Sample structure

Research participants by profession	Number of research participants
Systems thinking experts	2
Project managers	1
Quantity surveyors	2
Risk management professionals	7
PPP/Infrastructure experts	4
TOTAL	16

Our semi structured interviews lasted for an average of one hour. We first educated our respondents about the SD approach (since this methodology is rarely used in construction). Gall et al (2003) and Turner (2010) recommend that when conducting research about past events, it is good practice to 'jog' respondent's memories of the phenomenon in question. To this end, we started our interviews by asking our respondents to reflect on the PPP projects they had worked on and the challenges they had encountered. This process helped to reduce potential recall error. We then asked the respondents the three main research questions:

1. If a systems thinking approach were to be utilised, what would be some of the challenges involved?
2. How could systems thinking benefit the identification and management of risks in PPPs in the future?
3. What are some of the reasons why the traditional risk management approach is still used?.

The aim of the first question was to explore the main barriers that would need to be overcome in introducing a systems thinking approach into the risk management of PPP projects. The aim of the second question was to explore whether respondents saw any value in the SD approach to managing risks in PPP projects. The aim of the third question was to identify some of the reasons why SD is not widely adopted in the construction industry. In presenting the results of our analysis we present the narrative of the discussions rather than reduce the data to quantitative counts of variables via content analysis. There are two reasons for this. First, we did not seek to test the relationship between any independent and dependent variables. We simply wanted the respondents to tell us about their experiences of working in the industry on PPP projects. Second, we wanted the results to retain the full richness of insight contained in the narratives we collected from these highly experienced respondents. As Meisel (2011) notes, the power of narrative is in translating respondent accounts into data that people can comprehend. Clearly, it is not possible to recount everything that was said in this paper. So what is presented below are the main points which were issues of agreement across all respondents.

DISCUSSION OF RESULTS

Question one - If a systems thinking approach were to be utilised, what do you think would be some of the challenges involved?

Most participants believed that the SD approach was overly complex and that there would be significant cognitive challenges in shifting people to a systems thinking approach:

“Well, I think the big challenge is actually getting people to think systemically.” (Resp #1).

"I think it could benefit by simplifying it for a lot of people. If it's simpler, then people will adopt it." (Resp #8) ...

Notably, it was argued that the adoption of a systems approach would threaten established power structures on projects and challenge path dependencies by requiring people to communicate in new ways:

“...the challenge is how do you bridge those different interests in the process over time It's also communication. Not just from the initial design intent through to operation but back the other way as well, from the operational functional need back to those who are conceiving and designing. (Resp #6)

In contrast to the free, integrated thinking which a systems approach allows, our respondents expressed some discomfort and insecurity with the lack of standardised guidance and education around the systems approach compared to established methods of managing risk.

“If there's some sort of background of information, guidance, what needs to be done, standards. What we're doing is based on the ISO 31000 and that standard, that's world documented. (Resp #13).

“Part of the problem is that it's not taught in schools and it's not taught in schools. Firstly, the teachers don't know it themselves and it's very rarely taught in any universities. It's not embedded in anyone's psyche. We just don't think that way. (Resp #1)

Some respondents also pointed to the legal implications of moving to a systems perspective and defended current approaches which allowed them to offload risk. This suggests that current ways of thinking about risk are largely dictated by the way they are distributed in traditional construction contracts.

“One of the benefits of the current more narrow approach is more rigid allocation of risk and that means that one party is usually then accountable for a loss in the event that that risk arises. One of the challenges for adopting a slightly broader approach is to then say ..Well, haven't you actually then blurred who's actually responsible for that risk and shouldn't you actually be trying to hold parties accountable for the specific roles etc. that they've actually taken on?” (Resp #2).

Question two - How do you think a systems thinking approach could benefit the identification and management of risks in PPPs in the future?

Despite the many barriers above most saw the SD approach as offering potential to facilitate a more collaborative and holistic understanding of risks on PPP projects.

“..what you're describing in terms of a system based approach to risk assessment, I think would be crucial to looking at projects holistically. Too often our industry looks at things in a fragmented approach. So you end up with a disconnect with what the vision was through to the concept, to the design, to the construction, to the operation. ..., all this fragmentation creates inter-phases and that's where the risk is more likely to occur. So yes, you need a more system based approach” (Resp #6).

Our respondents provide numerous examples of problematic PPP projects which might have benefited from a SD approach.

“The best example where systems thinking wasn’t applied was on the Cross City Tunnel. The tunnel basically runs from east to west across the city. They put a toll on it with forecast traffic projections which were wrong. And then everybody started using what they call “rat runs” just to avoid it and go through the backstreets of Kings Cross and so started blocking the streets. That could have been foreseen if someone had used a systems thinking approach and looked at it holistically on what’s going to happen if you put a toll on this road and what alternatives they had. And in fact it ended up costing the head of the RTA his job so it had big political ramifications.” (Resp #2)

Question three - What do you think are some of the reasons why the traditional risk management approach is still used?

The majority of the research participants believed that the main reasons why the traditional risk management approach is its simplicity. Importantly, it is also supported by an international standard.

“I think people can understand it. It’s structured, it’s straight to the point and you can do it. People who know a project can do that relatively easily. And it’s quite logical – you identify the risk, you work out what can I do to mitigate that risk. The tables are all there, you plug the numbers into an excel spreadsheet and it works it all out for you.”

Our respondents also indicated that traditional linear methods give people certainty over allocation of risks and responsibilities and therefore greater accountability, whereas an SD approach might confuse this.

“The risk management approach deals with risk items separately and therefore seems to be more accountable and measurable. In a management point of view, one would like to see a straight forward result of his/her adopted strategy, rather than to see a mixture of impacts that becomes so remote to one’s direct effort.” (Resp #7).

Finally, it was clear that most people felt comfortable with the linear thinking required by the traditional approach.

“It’s pretty much idiot proof. People understand that matrix of low, medium, high and extreme. The way it’s presented and coloured. I think that it’s very transparent. It allows people to schedule what the problems are. I’m a person that likes lists. Even when I come in during the day, I’ll have a list of what to do and prioritise them. And once you put in the likelihood of all the risk issues, it lists them in order of the problems. So in doing that it kind of gives people an attack list. The risk actually becomes actionable. So it allows people to do things about risks rather than just accept them for what they are.” (Resp #11)

CONCLUSION

The aim of this paper is to explore the current barriers in adopting a systems thinking approach to managing risk in PPP projects. Our results indicate that despite the proven benefits of this approach in theory, the practical implementation of these ideas in reality is likely to be problematic. Most professionals are unfamiliar with the systems thinking process, have not been taught to think in this way and feel comfortable with traditional methods which provide a standardised, simple and well-established approach. This is despite a realisation that risks on PPP projects are highly complex

and that many projects fail due to unanticipated risk arising from complex interdependencies which were not detected. Our findings focus and further the important work of Stewart (1995), McLucas (2003), Kapsali (2011) and Lehtiranta (2013) who question the efficacy of linear risk management thinking and present a practical reality-check to the work Nyagwachi (2008), Masafumi (2009), Aragão and Nascimento (2010), Jang (2010) and Xu *et al* (2012) who have conceptually demonstrated the potential value of a systems thinking to overcome this problem in PPP projects. By better understanding the barriers which have to be overcome in implementing such an approach we are now in a better position to understand and explore the cognitive and behavioural barriers to implementing a new approach to risk assessment on PPP projects.

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USING APPROPRIATE TOOLS AND TECHNIQUES FOR RISK IDENTIFICATION IN UK CONSTRUCTION'S SMES

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Risk Management (RM) techniques are important for any organisation. Those firms that have implemented a RM process have recognised that there would be a higher probability of failure if appropriate techniques are not carefully employed during the risk identification stage. This requires proportionate selection of techniques that are compatible with the organisations' needs and limited resources. A literature review on RM indicates the inadequacy in a number of empirical studies done on how techniques influence the RM process. This work investigates the efficacy of the techniques of risk identification within Small and Medium Enterprises (SMEs) in the UK construction industry. Results from a questionnaire survey shows the challenges faced by SMEs in undertaking risk identification and highlights the most common techniques adopted among 153 organisations. Documentation review, expert judgment and checklist analysis are seen as the most important techniques within risk identification; which are practiced for their valuable results, uncomplicated processes and easy to understand structure. Conversely, the group-based techniques like brainstorming and Delphi techniques because of SMEs' inadequate level of knowledge and resources are less practised.

Keywords: risk identification, risk management, small and medium enterprises.

INTRODUCTION

The Global Construction Perspectives and Oxford Economics (2013) forecasted that the construction sector will grow by over 70% by 2025. This significant growth in the global construction industry will create considerable opportunities for the UK construction organisations, but will equally generate demand for adequate reforms in project performance (Mlybari, 2011). In order to improve the performance of the construction industry and take advantage of the new business environment, a number of studies have specified the key role of the RM practice (Tabish and Jha, 2011). Chapman and Ward (2008) explained that implementation and subsequent practise of RM contributes to enhanced project performance. This view is also confirmed by the UK Government through the British Standard focusing on RM (BS 31000:2009). BS (31000) states that the practise of RM in organisational management resulted in the

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control of delays and budget overruns, which ultimately promotes the competitive advantage of organisations.

Recent studies in the UK construction industry presented the weak reputation of RM within organisations (Smith *et al.*, 2014; and Lyons and Skitmore, 2004). Kim and Bajaj (2000) and Frimpong *et al.* (2003) investigated that the construction professionals' low level of familiarity with techniques and inability to elicit results of the processes are the most influential factors which impact the adoption of RM in organisations. Chapman (1994) and Couillard (1995) added that, even professionals with frequent use of RM have difficulty to understand the rationale of RM techniques' outputs in new projects. This difficulty is also compounded by SMEs' restricted resources which make both implementation and practice of RM more complicated (Debrah and Ofri, 2006). The take up and practice of RM techniques involves a considerable level of investment which in some cases is unaffordable for SMEs. This investment signifies the high degree of effort required to understand and to learn how to use the techniques at both organisational and personal levels. Review of literature on RM in SMEs implied that the users' knowledge and experience in RM have precedence over organisational constraints (Henschel, 2007). This reinforced the viewpoints of Chileshe and Kikwasi (2013) that lack of awareness and experience in RM tools and techniques are two key innate problems of professionals in construction organisations.

The question of major relevance to SMEs considering the practice of RM is: which tools or techniques can provide the greatest benefits?

RISK IDENTIFICATION TOOLS AND TECHNIQUES

The Risk Identification (RI) process, as the initial step of RM, forms the structure of the whole process (Chapman, 1998; Ward and Chapman, 2003). Failure in the identification of risks can cause inadequacy in the whole process of RM, which can in turn critically affect the organisation's resources. This process assists organisations in RM to: (1) recognise the best and most relevant input data (2) understand the benefits of the process (3) recognise risks and their potential impacts (4) provide information for decision-makers (Simu, 2006; Henschel, 2007; and Wang *et al.* 2007). The RI process or risk information gathering process can be achieved with the aid of different tools and techniques. The most common tools and techniques are: documentation reviews, expert judgment, diagramming techniques, assumption analysis, information gathering, checklists and SWOT technique (Chapman, 1998 and BS, 2010).

Chapman (1998), through the behavioural scientists' framework which was developed by Handy (1993), conducted an empirical research on the effectiveness of risk identification and assessment techniques in construction projects. The research divided risk identification tools/techniques into three main categories by the degrees of involvement of people, comprising: identification by expert; one-to-one interview; and working group led by analysts. The result cited that the brainstorming technique which involves the analyst leading a working group is the most widely used risk identification technique in large organisations.

Further, Lyons and Skitmore (2004) sought the frequency of use of risk management techniques in the construction engineering industry. Project managers from 44 enterprises highlighted that the checklists, brainstorming, case-based approach and scenario building were the most frequently used tools and techniques for identifying

risks. They indicated that the success rate of their projects was highly influenced by the association of techniques.

In organisations, a series of factors are involved in the practice of techniques in risk identification (Raz and Michael, 2001). These factors affect the effectiveness of techniques in achieving their objectives, and include: given, intervening and output factors (Chapman, 1998). The givens embrace the organisation's existing factors which impact outputs. The main given factors comprise resources, leader knowledge and skills, and tools and technologies. The intervening factors are temporary factors which are adopted to improve the productivity or user satisfaction such as leadership and procedure. Finally, the output factors cover the satisfaction and user-expected results in terms of their objectives.

In the context of SMEs, restrictions imposed by organisational given factors, such as finance and technology; force SMEs to adopt cost-effective and time-effective techniques (Welsh and White, 1981). Hence, working group techniques like brainstorming for risk identification which was highlighted by Chapman (1998) and Lyons and Skitmore (2004), are not appropriate for most SMEs. This paper attempts to identify the most common tools and techniques in the risk identification process, and assesses their efficacy in SMEs in the UK construction industry.

RESEARCH METHODOLOGY

This research was part of a mixed method study which aimed to identify key tools and techniques in the RI process in SMEs in the UK construction industry that can be applied to the development of a Scaling Risk Management process for SMEs. As a whole, the study was based on a sequential explanatory mixed method and included quantitative and qualitative studies. This paper embraced the quantitative part of the study with literature review that assisted to conduct semi-structured interviews for further qualitative study.

The data for the study was obtained by means of a postal questionnaire. Organisations which participated in this study employed more than 10 people but less than 250 employees. Database for the study was obtained from the Office of National Statistics (ONS), the Small Business Gateway, the Financial Analysis Made Easy (FAME) and the Scottish Centre for the Built Environment (SCBE). The period of the study was from the 15th of February to the 31st of May 2013. 113 small and 40 medium-sized enterprises participated in this study (Table 1). Attempts were placed to have samples across architecture, engineering and construction organisations.

Table 1: Organisation distribution which participated in the study

Organisation	Architecture	Engineers	Contractors	Total
Small	26	25	62	113
Medium	16	10	14	40
Total	42	35	76	153

The questionnaire comprised of three sections. Section 1 explored general information about the participants. Section 2 collated general risk and RM information, and asked respondents to indicate the most important difficulties in terms of their impact on the implementation of RM. Section 3 evaluated the risk identification and risk analysis tools and techniques, and investigated their efficacy regarding the organisational characteristics.

The answered questionnaires were analysed by using the Statistical Package for the Social Sciences (SPSS) version 19. The data collected through the questionnaires was based on the key identified tools and techniques from the literature review which were subjected to Principal Component Analysis (PCA) to determine their scale of importance in relation to risk identification. To evaluate the suitability of factor analysis in the preliminary test, the Kaiser-Meyer-Olkin (KMO) value was found to be 0.847 (significant value = 0.6) (Tabachnick and Fidell, 2007), Bartlett’s test of the Sphericity (Bartlett, 1954), $\rho=.00$ (significant value $\rho <.05$). (Table 2)

Table 2: Kaiser-Meyer-Olkin (KMO) and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.847
Bartlett's Test of Sphericity	Approx. Chi-Square	726.354
	df	21
	Sig.	.000

The Kaiser’s criterion (Kaiser, 1960) was conducted to determine the smallest number of factors that are required for factor analysis. In Kaiser’s criterion, the values above 1 in the Total Variance Explained table in column Initial Eigenvalues (Table 3) highlight the number of required factors which include 4.424 and 1.034. These two factors define a total of 77.98% of the variance (Table 3, Cumulative % column). Therefore, two-factor solution for the factor analysis method was considered to extract the key tools/techniques in the RI process.

Table 3: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadingsa
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	4.424	63.205	63.205	4.424	63.205	63.205	4.141
2	1.034	14.772	77.977	1.034	14.772	77.977	2.817
3	.463	6.612	84.589				
4	.396	5.653	90.242				
5	.353	5.041	95.283				
6	.205	2.924	98.208				
7	.125	1.792	100.000				

To aid the interpretation of these two components, *Oblimin Rotation* (Costello and Osborne, 2005) was performed. This process indicated the highest loading tools and techniques which contain: documentation review; expert judgment; checklist analysis and information gathering techniques.

TOOLS AND TECHNIQUES: EMPIRICAL FINDINGS

Chapman and Ward (2008) stated that the techniques in risk identification call for thinking and imagination about unthinkable which fosters creativity and assists to seek the experience of the personnel. In practice, an adequate set of techniques improves: information capturing; communication; quality of risk analysis; and prioritising of activities and resources. There is a wide range of techniques in the risk identification phase and each of them is appropriate for a particular task (Raz and Michael, 2001). Techniques are mostly adopted in organisations based upon the degree of the practitioners’ familiarity with and ability in understanding the benefits of them (Brassard, 1989). This study adopted the BS 31010 (2010) tools and techniques to

identify the most common techniques among construction SMEs for the risk identification process.

In section 3, the first question in the risk identification part of the research questionnaire pointed out the SMEs' familiarity with techniques, and subsequently, the usage rate of them was assessed through the second question. The results indicated that the top four tools and techniques were: documentation review, expert judgment, checklist analysis and information gathering.

1. Documentation Review

The respondents outlined various tools and techniques that they practiced in their role within their organisations to identify risks (Figure 1). The first tool that emerged was the documentation review. 142 out of 153 companies were familiar with this tool and 81% of them considered the tool as the first preferred tool to identify risks in organisation. Collecting data by reviewing existing documents is known as the documentation review technique. This review covers documents of the previous business plans, strategies, activities, contracts and other stored information in either hard copy or electronic formats. The technique is used to collect background information to understand and identify new business probabilities and uncertainties. This review assists to recognise the strengths and weaknesses of the organisation and understand the history and philosophy of the business. SMEs highlighted that the technique helped them to develop the risk identification process by assessing the organisation's existing documents to set up focus groups or devise an observation framework.

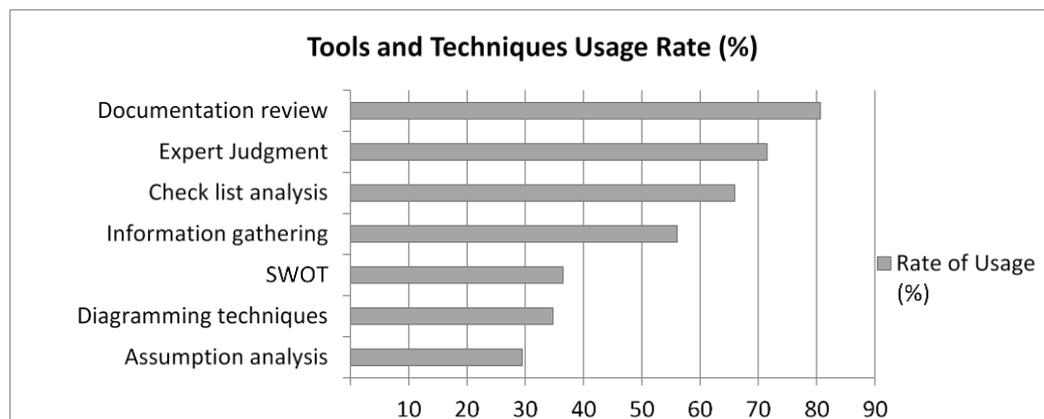


Figure 1: Percentage of Tools and Techniques Usage among SMEs

The participants explained that this technique contained the assessment of the existing documents at the start of the process which was to find out what types of information were available and which part of them were required for further review. The assessment step is followed by the compiling process which specifies the limit of the review for answering the evaluation questions. Then the accuracy of the compiled information needs to be checked by the management team. In this step, the usable part of the information is critically analysed to derive the key information from documents (Witkin and Altschuld, 1995).

2. Expert Judgment

The second risk identification tool/technique that emerged from 129 questionnaires with 71% usage rate among SMEs was the expert judgment. The expert judgment tool is widely practiced in different stages of businesses and potentially covers both internal

and external risks. The SMEs stated that the expert judgment is implemented and practiced because of: its affordable required resources in terms of time and budget; valuable results and outcomes; uncomplicated process to set up and quick to produce results. They noted that the outcomes of this technique can be as accurate as other costly tools and techniques like the diagramming techniques.

The expert judgement is a process which is founded on the knowledge and experience of individuals or groups. The people with specialised knowledge whether part of the organisation or involved in a specific activity of the business, are known as the experts of the business (Otway and Winterfeldt, 1992). The research revealed that the expert judgment in SMEs highly relies on the experience and skills of the SMEs' owners and managers. 87 companies indicated that they used their management experience due to their familiarity with the business activities instead of the costly advice of consultants. Few companies argued that if the firm could hire a part-time consultant with relevant expertise, knowledge and skills, they would do so to afford the business with more success probability (fewer risks). They believed that utilising the services of an expert is more beneficial and operational than business management analysis. A business manager from a medium-sized company highlighted that the efficacy of the expert judgement technique highly depends on both internal and external experience. The identified risks by the management team should be reviewed by a consultant with relevant experience of similar business areas to achieve the best possible outcomes.

3. Checklist analysis

The third emerging technique was a checklist analysis which was familiar to 127 organisations out of 153. 66% of organisations stated that this technique was currently being practiced by their business management. This technique is known as a basic method of risk identification in which pre-identified threats and opportunities are investigated for signs of potential risk situations (Duncan, 1996; Kumamoto and Henley, 1996). Checklists within organisation are developed over time through functional experts' contributions and collective experience (Ward 1999, and Chapman and Ward, 2008).

A number of organisations named the checklist as the starter of the risk identification which gradually forms the structure of the process. Checklist helps to speed up the whole process and stops organisation from forgetting the critical steps caused by disruptions. A medium-sized company presented the checklist as the source of the Risk Breakdown Structure (RBS) which supports the team in better understanding of the risks involved. This company analogised the RBS with the Work Breakdown Structure (WBS) in mapping the details of activities. More than 25% of participants noted that lack of investment in training and technology were the main barriers to replacing alternative (new) methods with old-fashioned techniques such as checklist analysis.

4. Information Gathering

The fourth common set of techniques which was practiced in more than 56% of SMEs was information gathering. 115 out of 153 organisations were familiar with the information gathering techniques. They indicated that the process of information gathering helped to enhance the organisation's memory, develop effective management and save resources. The most important techniques in this method include interviewing, brainstorming, Delphi technique and root cause analysis. 27 participants named the interviewing and brainstorming techniques as the most used information gathering techniques in risk identification.

Risk identification through the interviewing technique can be an individual assessment or involve a group of people (Chapman, 2001). This technique is categorised as a resource-intensive technique due to its dependence on the organisational resources and time. The collected information through this technique is used to provide a ground for further risk identification. Chapman and Ward (2008) believed that the individual straightforward approaches such as the pondering approach which is based on individual identification assessment could be more beneficial for organisations than that of costly interviews.

Brainstorming is the second common technique in the information gathering process among construction SMEs. The aim of this technique is to provide a comprehensive list of risks with the aid of business team and multidisciplinary specialists. Osborn (1963) introduced the brainstorming as a problem solving method that provides a considerable range of ideas in less time. This technique contains identifying problems, creating ideas, introducing and developing solution sub-processes (Chapman, 1998). The results of the study revealed that the medium-sized participating firms were more likely to implement this technique for the reason of being familiar to them and its time effectiveness character. Two of those companies indicated that they used semi-structured interviews for the ground phase of the risk identification and used its generated information as the identified problems in the brainstorming technique.

CHALLENGES FOR RISK IDENTIFICATION TOOLS AND TECHNIQUES

There are many barriers associated with RM process within organisations such as the adaption of risk management with business plans, identification of the most appropriate RM tools and techniques (Carter, 1972), the importance of adequate resources (Hull, 1980) and need for cultural improvement in organisations (Leopoulos *et al.*, 2006). One of the key important barriers highlighted by the majority of SMEs in this study was the identification of appropriate techniques in RM. The organisations indicated that the techniques that support the data collection in the risk identification stage perform the key fundamental role in the whole process of RM. In large construction projects, the judgments attained from the project core team outlined that the most effective risk identification techniques belonged to the group work techniques (i.e. brainstorming and Delphi techniques) (Chapman, 1998). In line with the Chapman study, Raz and Michael (2001) stated that the checklists, brainstorming, risk documentation form and periodic risk reporting were the most common risk identification techniques in the software and high-tech industries which were frequently practiced among large organisations. However, the current study within SMEs in the UK construction industry revealed a different set of techniques which included documentation review, expert judgment and checklist analysis.

The results indicated that employing a technique in a process is influenced by the characteristics of the organisation which affect the effectiveness of the process. These characteristics are defined by three distinct classifications: (1) individuals, (2) organisation and (3) environment (Handy, 1993). In small to medium-sized companies, due to their low degree of complexity and high level of centralisation in management (Ghobadian and Gallea, 1997), the individuals' factors such as personality, aptitude, experience, knowledge, leadership etc. have more impact than those of the organisation (i.e. group work and relationships). In addition, restrictions imposed by organisational factors, such as resources and technology, force SMEs to adopt cost-effective and time-effective techniques. Therefore, the techniques like

brainstorming which was highlighted by Chapman (1998) and Raz and Michael (2001) are not appropriate for most SMEs' due to their noted barriers.

The participants named: uncomplicated process to set up and practise; easy to understand for practitioners; time and cost effectiveness; valuable results and outcomes; being familiar to other management processes; dependence on old-fashioned methods (unwillingness to learn and practise new methods); lack of investment in training to learn alternative methods, and low degree of budget to replace new methods (Software-Technology) as the most important issues in the adoption of techniques.

The results of the research indicated that among all risk identification techniques the documentation review was the most cost and time effective technique because of its independent character and uncomplicated process. This technique can be implemented independent of other resources, and obtaining information through it is completely affordable. However, the quality of information being gathered is not controllable and needs to be assessed together with the outcomes of other information collecting techniques such as interviews, questionnaires and checklists.

CONCLUSION

On the basis of a survey with the UK construction enterprises having adequate knowledge and experience of construction management, 3 key tools and techniques were identified on an assessment of their likelihood of usage and degree of efficacy in risk identification. The documentation review, expert judgment and checklist analysis were highlighted to have significant impacts on the efficiency of risk identification. The attempt to evaluate these key tools and techniques from the perspective of organisational characteristics indicated that valuable results and outcomes; time and cost effectiveness; and uncomplicated processes are the main reasons of their practice within small and medium sized enterprises. Conversely, the group-based techniques like brainstorming because of SMEs' inadequate level of knowledge and resources are less practised.

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ARE WE ADDING RISK TO OUR PROJECTS BY MIXING OBJECTIVE ASSESSMENTS OF COMPOUND CONJUNCTIVE AND DISJUNCTIVE PROJECT RISKS WITH INTUITIVE APPROACHES?

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Various forms of quantitative analytical tools and techniques have emerged through the evolution of construction risk management systems but their full benefit on project performance are yet to be realised. Construction risk analysts continue to rely on statistical and probability tools in their risk data presentation whilst risk management decision-making process tends to reflect the use of intuition rather than rationality. Drawing theories and concepts from systems thinking, and behavioural sciences, the implications of applying quantitative analytical tools and techniques within an instinctive construction risk decision-making context is evaluated. The analysis of construction risk management decision making systems, and discussions relating to the instinctive processing of statistics and probability data, reveals evidence associated with the incompatibilities of mixing objective and subjective approaches to project risk assessment and response. The inference being that, effective instinctive construction risk management practices may require data formats that are compatible with instinctive decision processing. In conclusion, the research provides conceptual analytical evidences for stimulating further investigations into the appropriate format for construction risk management data analysis and presentation.

Keywords: instinctive decision making, probability prediction, risk, statistical data, systems thinking.

INTRODUCTION

Kahneman (2011) identifies two systems of thinking and decision making; the *fast* system which relies on instincts and subjective methodologies, and the *slow* system involving the application of rational tools and cognitive analysis. Kahneman goes further to illustrate this by contrasting the decision processes of analysing a picture of an angry woman versus calculating a multiplication equation. Whilst the analysis of the picture occurs spontaneous and effortless, through the modelling of the decision flow in patterns similar to previous exposures (Benthin *et al*, 1993), the processing of the mathematical equation involves slow and deliberate effort of the mind and body through the recollection of the relevant cognitive programme, decomposition of the equation into sequential order, tensing of the muscles, increase in blood pressure, and dilation of the eyes. Again, the *fast* system appears to be constantly active and difficult to tame unlike the *slow* system which requires conscious effort to activate. Decision procession of the *slow* system usually originates from the *fast* system in the

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form of perceptions, impulses and impressions which requires further analysis to validate them into beliefs and actions (Kahneman, 2010). Table 1 below describes the main differences between the two systems.

Table 1: Differences between fast and slow systems of thinking and decision making (The fast system has been named the “Experiential system”, and the slow system as the “Analytic system”) - Slovic et al (2010:24)

Experiential system (fast system)	Analytic system (slow system)
1. Holistic	1. Analytic
2. Affective: pleasure- pain oriented	2. Logical: reason oriented (what is sensible)
3. Associationist connections	3. Logical connections
4. Behaviour mediated by “vibes” from past experiences	4. Behaviour mediated by conscious appraisal of events
5. Encodes reality in concrete images, metaphors and narratives	5. Encodes reality in abstract symbols, words and numbers
6. More rapid processing: oriented towards immediate action	6. Slower processing: oriented towards delayed action
7. Self- evidently valid: “experiencing is believing”	7. Requires justification via logic and evidence

Construction project management, being a decision science discipline, likewise employs tools and techniques from the *fast* and *slow* systems in the identification and treatment of project risk events (Lock, 2003; Winch, 2010; Loosemore *et al*, 2006). Construction risk management approaches include instinctive thinking and actions which rely on personal values, feelings, experiences, cultural beliefs (Slovic *et al*, 2002; Slovic and Peters, 2006), and rationality involving the use of scientific techniques in evaluating the probability of occurrence and impact of an uncertainty to establish an appropriate risk management response (Bowden, 2001; Winch, 2010; Lock, 2003). Recent studies have also revealed the application of fuzzy quantitative analytical systems using *linguistic variables* (Byrne, 1995; Cox, 1999; Zeng *et al*, 2007; Khazaeni *et al*, 2012a; Khazaeni, *et al*, 2012b; Kuo and Lu, 2013). Fuzzy set theory was first introduced by Lotfi A Zadeh in 1965 (Edwards and Bowen, 1998) to facilitate quantitative analysis of relationships where mathematical equations may not be appropriate (Cox, 1999; Jain and Martin, 1998). The application usually involve the use of expert knowledge in the subjective quantification of risk assessment factors, in the form of *linguistic words*, for structured and systematic quantitative analysis using *fuzzy logic controller* (Byrne, 1995; Jain and Martin, 1998). Fuzzy logic thus becomes another rational technique with the difference being *linguistic assessment variables* instead of mathematical equations, which are typical of statistical and probability quantitative analysis.

Empirical evidence from the project case studies where fuzzy logic has been applied reveal some benefits in the areas of improved risk identification on complex projects (Kuo and Lu, 2013), addressing the inherent subjectivities of the traditional risk analysis factors of *risk likelihood* and *risk impact* (Zeng *et al*, 2007), and achieving balanced risk allocation (Khazaeni *et al*, 2012a; Khazaeni, *et al* 2012b). Nevertheless, there appears to be limited application of the concept among construction professionals (Edwards and Bowen, 1998), especially at the post contract stages. This may partly be due to the general criticisms of the unfamiliarity of fuzzy logic tools, and a perception of inherent conceptual errors emanating from the systems fundamental philosophy of imperfections (Cox, 1999), and specifically within the construction industry, the disparities between most of the research project case studies and the general risk management setting, in the areas of risk data availability, competency in rational analytical systems, and risk management decision making approaches.

Construction risk data and reports on the other hand, are commonly expressed qualitatively in the form of statements, narratives, scenario, simulation, and quantitatively using statistical and probability tools (Bowden, 2001; Lock, 2003; Loosemore *et al*, 2006, Winch, 2010).

Inbar *et al* (2010), believe that the prime attributes of a decision task and its setting are what determines the choice of an appropriate decision making methodology.

Hammond *et al*, (1987, cited in Dane *et al*, 2012) have also argued that decision tasks capable of being decomposed into a structured order are most suited for the rational approach, whilst the processing of non-decomposable decision tasks tend to be effective under the instinctive approach. And with construction risk management decision tasks involving exhibits of decomposition (Lock, 2003), the natural expectation would have been the adoption of equal measure of rational and instinctive approaches. The research findings however, reveal otherwise (Akintoye and Macleod, 1997; Lyons and Skitmore, 2003; Kululanga and Kuotcha, 2010).

A questionnaire survey of 100 general contractors and project management practices in the United Kingdom revealed low level of knowledge and application of rational risk management practices (Akintoye and Macleod, 1997). A similar survey of senior management involved in the Queensland engineering industry in Australia also revealed high incidence of instinctive risk analysis practices by analysts with minimal training in rational risk management systems (Lyons and Skitmore, 2003). Another survey of construction companies in Malawi also discovered limited application of rationality among the large companies, with the risk management practices of the small and medium sized companies dominated by instinctive thinking and actions. The findings from the construction industry appears consistent with other studies conducted within the behaviour science disciplines (Shapira, 1986, cited in March and Shapira, 1987).

The reasons expounded for the low application of analytical construction risk management practices include limited availability of construction risk data, limited competency in rational tools and techniques, the size and scope of most construction projects do not provide a benefit-cost justification for investing in rationality, and the lack of appreciation for analytical construction risk management practices (Akintoye and Macleod, 1997; Lyons and Skitmore, 2004; Adams, 2008). Theoretical findings grounded in the behavioural sciences on the other hand, imply that the high incidence of instinctive construction risk management practices may be due to the *spontaneous processing of instinctive thought* (Dane and Pratt, 2007; Betsch, 2008; Betsch and Glockner, 2010; Sinclair, 2010; all cited in Dane *et al*, 2012), which makes for faster responses to complex decision-making, in situations where there is limited structured data (Slovic and Peters, 2006; Bateman *et al*, 2010). Bringing the above together, provides useful insight into the potential benefits of the instinctive approach, in guiding construction organisations in addressing the increasing client and regulatory demands to provide swift and accurate risk management decisions using limited available data (Loosemore *et al*, 2006; Perlow, Okhuysen and Reppenning, 2002 cited in Dane *et al*, 2012).

THEORETICAL FRAMEWORK

The paper adopts a critical theoretical review of concepts and empirical findings from systems thinking and analysis (Checkland, 1999; Bertalanffy, 1968; Carmichael, 2006; Walker, 2007), and behaviour sciences (Slovic and Peters, 2006; Slovic *et al* 2010;

Bateman *et al*, 2010; Tversky and Kahneman, 1982a; 1982b; 1982c; Kahneman, 2011; Epley and Gilovich, 2002; Finucance *et al*, 2003; Chapman and Johnson, 2002) in evaluating the implications of mixing tools and techniques from the different systems of thinking and decision making (Kahneman, 2011). The analysis centres on post-contract project risk management in the housing sector, which by virtue of its comparatively, smaller project sizes and scope, makes it typical of instinctive practices (Akintoye and Macleod, 1997). The principles of general systems theory enables conceptual examination of the effects of mixing objective and subjective risk assessment techniques. The behaviour science theories and concepts nonetheless, facilitates the psychological evaluation of the resulting systematic errors.

Systems thinking and analysis

Systems thinking is a classical investigative approach which evaluates subjects by considering the properties of the collective rather than the individual components (Checkland, 1999). The underlying conceptual ideologies emanated from the biological sciences through the discovery of general systems theory in 1966 (Bertalanffy, 1966). Systems thinking being an exploratory approach (Checkland, 1999) however suggests that, it may have existed prior to its formal discovery, as seen in Paracelsus' investigations in medicine, Leibniz's studies in philosophy (Bertalanffy, 1966), and Apostle Paul's analysis of the mission of the Christian Church (Romans 12: 4- 8; 1 Corinthians 12; 12- 31, cited in Arthur and Pryke, 2013).

The basic tenet of systems thinking, is that every system has an objective (Walker, 2007) that establishes a shared identity among the parts, in terms of their functions and purpose (Blanchard and Fabrycky, 1998). And in order to achieve the desired system's output, the components must collaborate during the transformational phases (Walker, 2007). The influence of external forces sometimes causes changes in the internal structure of systems, leading to modifications in the main system's objectives or the micro objectives of the individual components (Walker, 2007). The presence of multiple divergent objectives, then again makes a system vulnerable to cross purpose working, which could be detrimental to project success.

The psychology of instinctive thinking and decision making

Psychometric research findings suggest that the human mind stores records of life experiences (Bateman *et al*, 2010), in the form of sensory inputs associated with sound, smell, visions, ideas and words (Finucance *et al*, 2003). Each sensory record is marked with a positive or negative *affective* feeling, based on the circumstance in which the event occurred (Slovic and Peters, 2006). Slovic *et al* (2010); Kahneman (2011) have argued a connection between *affect* heuristics responsible for the generation of *affective* feelings, and the *representative*, *availability* and *anchor and adjustment* heuristics. The *representative* heuristics evaluates the possibility of a relationship between an event and its parent population by the degree of similarities between the event and the prime attributes of the parent population (Tversky and Kahneman, 2002). The *availability* heuristics also forecasts the frequency of an event by evaluating how easily a similar past occurrence can be recalled or a possible future scenario can be constructed from the attributes of the event (Kahneman, 2011). The *anchor and adjustment* heuristics estimates future events by applying subjective adjustments to a preliminary given anchored data to achieve the final value (Chapman and Johnson, 2002).

In the process of instinctive thinking and decision making, the human mind scans the mental image library for evidence of previous similar records to influence the modelling of the future decision event in the pattern of the previous occurrence (Benthin *et al*, 1993). A positive previous similar record with the associated positive *affective* feeling tag will inspire a positive feeling and perception of the future decision event as a benefit. A negative previous similar record with the associated negative *affective* feeling label on the other hand, will stimulate a negative feeling and perception of the future decision event as a risk. According to Finucane *et al* (2003), decision modelling in situations of multiple divergent previous comparable records, are determined by factors including the dominant attributes of the different experiences, and the physiological state of the decision maker, being either extrovert or introvert. The reliance on heuristics for instinctive thinking and decision making also suggest that the absence of a similar past record may hinder the modelling of a future decision model (Arthur and Pryke, 2013)

DISCUSSIONS

Against the background of the above theoretical evaluations, let us now proceed to discuss the implications of mixing tools and techniques from the instinctive and rational approaches to construction risk management.

Systems Analysis of Construction Risk Management Decision Making Approaches

Drawing from the principles of systems thinking, we can model the *fast* and *slow* systems of thinking and decision making (Kahneman, 2011) applied within construction risk management (Slovic *et al*, 2010) as depicted in Figure 1 below.

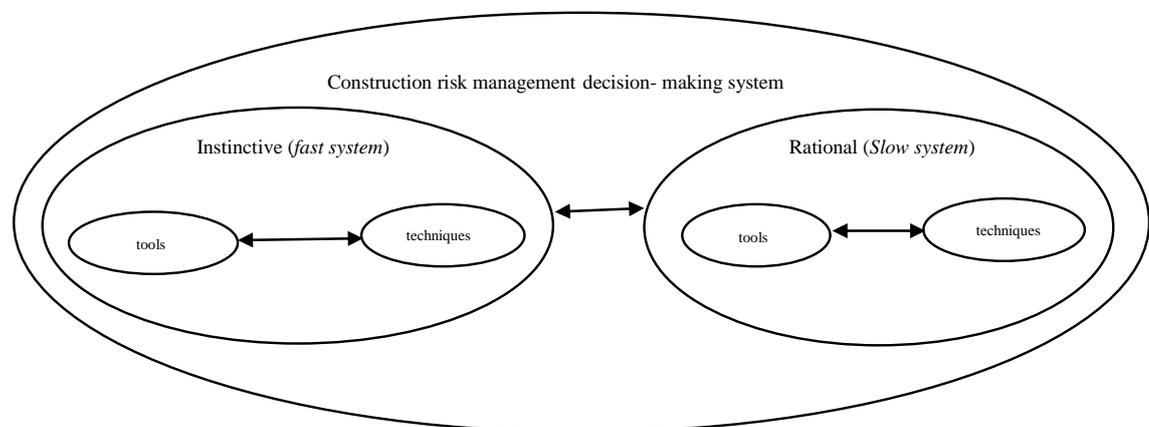


Figure 1: Construction risk management decision-making system. Derived from Walker, 2007:66- 98; Slovic *et al*, 2010:23- 25, Kahneman, 2011:19- 30

The principles of general systems theory suggest that the *instinctive* and *rational* construction risk management approaches will form the components of the main system. The concept of systems decomposition (Carmichael, 2006) which analyses components as subsystems with different micro objectives also suggests that the *instinctive* and *rational* approaches will comprise of parts which are identical within a group but different from those of the other group (Blanchard and Fabrycky, 1998). System transformational processes requiring collaborating working of the parts will also necessitate compatibility between the tools and techniques applied in an approach

(Walker, 2007). The implication being that, mixing an instinctive decision making approach with statistical risk data and quantitative analytical techniques may introduce conflicting objectives which may affect the collaborative processing of the risk management system, and ultimately project success (Pryke and Smyth, 2006).

Instinctive Processing of Statistics and Probability Data

According to Kahneman (2011), a major limitation of the *fast* system of thinking and decision making is its lack of understanding of logic and statistics. Tversky and Kahneman (1982a) also believe that the principles of instinctive decision making which relies on the *representative*, *availability*, and *anchor and adjustment* heuristics, are inconsistent with the principles of probability theory and may be susceptible to errors and biases. Slovic et al (2010) have also argued that, *affective feelings* involved in instinctive decision making impedes the processing of quantitative statistical data (Denes-Raj and Epstein, 1994). Other studies have however revealed instances where experts have relied on their professional experiences to achieve accurate instinctive evaluations (Kahneman, 2011).

Tversky and Kahneman (1982a; 1982b) have suggested the inherent biases in instinctive decision making under the *Representative* heuristics to include, *insensitivity to prior probability predictions* which leads to the error of formulating project risk registers based on typical industry risk events without careful consideration of the specific project environment; *insensitivity to sample size* which gives a false expectation of comparable industry experience on every project; *insensitivity to external influences* which leads to the exclusion of third party impacts from risk analysis; and *insensitivity to the validity of base data* which leads to the error of applying extraneous variables in project risk analysis and decision making. In summary, these factors lead to poor assessment of, and responses to, project risks.

Instinctive judgement under the *Availability* heuristics may also exhibit biases originating from the ease of retrieving past occurrences. This may lead to the error of assigning high probability predictions to occurrences associated with issues in the media, and low probability predictions to occurrences associated with obscure past events (Tversky and Kahneman, 1982a; 1982c). A typical example is the recent media publications on the effects of Japanese knotweed on the structural integrity of residential buildings; this may have accounted for the high attention given to the plant in most project risk management registers, compared to the other less known but equally invasive plants such as aphyllanthes, giant hogweed, Himalayan balsam, mares tail, buddleia, rhododendron (Hodgson, 2014).

The inherent errors of instinctive decision making under the *Anchor and Adjustment* heuristics have been attributed to the inadequacies of adjustments (Epley and Gilovich, 2002), which leads to errors in the final estimations. Inadequacies of adjustment results from the premature termination of the adjustment process, or when a base anchored value is perceived as a *case of suggestion* which should reflect the final estimate (Kahneman, 2011). According to Cohen et al, (1972), cited in Tversky and Kahneman (1982a) the impact of *anchor and adjustment* may account for overestimation of probability predictions involving compound conjunctive events, and underestimation of probability predictions of compound disjunctive events. This may be due to the fact that the sum of probability predictions of compound conjunctive events is less than the values of each of the individual events, whereas the sum of probability predictions for compound disjunctive events is more than the probability predictions of each of the individual events. In the context of construction risk

analysis, the errors from *anchor and adjustment* heuristics may result in unrealistic project programming anchored on optimistic critical path activities, and under estimation of project risk impact anchored on the individual risk events, without careful consideration of the consequential impact from third party events.

Denes-Raj and Epstein (1994) have stated that, most people undertaking instinctive evaluation of statistical data will perceive higher probability values for prospects offering “*more options*” compared to prospects of “*less options*”. An investigation involving undergraduate psychology students who were asked to draw red jelly beans from different sized transparent containers holding different sample sizes, revealed a preference for the container with bigger sample size in spite of the fact that the container with the smaller sample size offered the best probability of chance (Denes-Raj and Epstein, 1994). The implication being that, instinctive construction risk analysis of statistical data may produce variations in the risk quantification and classification depending on the probability scales applied in the base data. The cumulative effect may include erroneous risk analysis and responses.

Slovic *et al* (2010) have argued that, instinctive evaluation of events which evoke strong *affective* memories such as addiction, faith, affection, anger and resentment may be indifferent to quantitative statistical analysis. A research by Loewenstein *et al* (2001) also identified comparable evidence in the form of similar *affective* feelings towards winning the lottery irrespective of the value of probability prediction. In the context of construction risk management, people with sentimental project experiences associated with an innovative construction solution, asbestos contamination deaths, and fire destructions on timber frame construction sites, may form block opinions which may affect the processing of probability prediction of similar future event. Such individuals may become indifferent in their future risk analysis and response of a similar event irrespective of the probability prediction.

The theoretical evidence on the problems associated with mixing tools and techniques from the *fast* and *slow* systems of thinking and decision making probably explains why instinctive construction risk analysis utilising statistical and probability data usually produces projections that are different from the actuals (National Audit Office, 2000; CBI, 2010; Flyvbjerg *et al*, 2003).

CONCLUSIONS

The above discussions have centred on the variances in micro objectives between the different construction risk management subsystems (Walker, 2007, Carmichael, 2006, Slovic *et al*, 2010, Kahneman, 2011, Blanchard and Fabrycky, 1998), the intrinsic biases and errors in instinctive decision making under the *Representative*, *Availability*, and *Anchor and Adjustment* heuristics (Kahneman, 2011; Epley and Gilovich, 2002), the insensitivity of strong *affective stimuli* to quantitative statistical analysis (Slovic, 2010), and the discrepancies between the principles of instinctive decision making, and statistics (Tversky and Kahneman, 1982a; Denes-Raj and Epstein, 1994). Collectively, they provide evidence on the systematic errors inherent in the existing construction risk management practices of applying statistical and probability data within an instinctive decision making approach.

The theoretical evidence on the transformational processes of the different systems of thinking and decision making (Kahneman, 2011), and the need for coordination among system components (Walker, 2007) also suggest that addressing the systematic errors may require careful revision of the existing construction risk management

practices to ensure compatibility between the decision making vehicle, and the data presentation and analytical techniques. This calls for either adopting rational decision making approaches to complement the statistical and probability tools, or on the other hand, applying qualitative risk data formats and subjective techniques which are compatible with instinctive decision making. The existing empirical evidence of low level competency in rational techniques among construction professionals (Akintoye and Macleod, 1996; Lyon and Skitmore, 2003) indicates that adopting the latter option may be more feasible in the present context. There is however the need for further investigations to confirm this. We therefore propose further studies into the level of knowledge and application of statistics and probability within the construction industry, the qualitative data formats and subjective techniques that will be compatible with the existing instinctive practices, and a comparative analysis of the decision making effectiveness of instinctive construction risk analysis which utilises qualitative data, versus the continual use of statistical and probability data.

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EVALUATING RISK MANAGEMENT IN INDEPENDENT WATER AND POWER PLANT PROJECTS IN SAUDI ARABIA

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Worldwide countries are striving to meet demands for water and power, which have been estimated as likely to increase at a rate of 7 percent per annum over the coming decade. Water and power plant projects following the Independent Water and Power Plant (IWPP) approach have typically involved a plethora of risks, as they have been reliant on long-term arrangements to transfer project risks, traditionally borne by the government, to the private sector. Since about 75% of IWPP projects in Saudi Arabia (SA) have failed to meet specified objectives, effective risk management (RM) implementation is key to the success of any public and private project. Practitioners, who are key informants in this subject area, have related their experience about RM in IWPP projects in SA through semi-structured interviews, and analysed these through the grounded theory approach. This study gathers and collates data to present findings in a propositional diagram that is fully grounded, based on practitioners' experiences that extend to the ineffectiveness of implementing RM in water and power projects, specifically in IWPP projects in SA. Findings indicate that IWPP parties have implemented RM in an informal way. In addition, there is a general lack of RM knowledge in the SA water and power industry. The paper concludes with an emergent diagram illustrating major phenomena, categories, and subcategories affecting the implementation of RM in IWPP projects in SA.

Keywords: IWPP, risk, Saudi Arabia, water and power.

INTRODUCTION

With the growing demand for water and power service provision and the tight budgeting by governments, the IWPP approach is a promising option to resolve the twin issues of water and power provision. However, no construction project can be undertaken without an attendant element of risk; thus, RM is an essential consideration in project management when seeking to improve performance and project efficiency (Kelly 1993). To insure success in an IWPP project, the risks associated with the project first need to be clearly identified, evaluated and managed (Hsiao 2000).

This paper aims to support a novel theory, by illuminating a particular phenomenon in the area under study, which aims to identify the elements leading to ineffectiveness when implementing RM in IWPP projects in SA. Three main subjects, namely, RM (RM), water and power plant (WPP) projects and public private partnerships (PPP) in the global context, and SA in particular, are linked together to reflect the contributions

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of each in fully enhancing performance in regard to time, cost and quality in independent water and power plant (IWPP) projects.

LITERATURE REVIEW

Risk management

It is widely accepted that risk attends all construction projects; whilst this can be managed, minimised, shared, transferred or accepted, it cannot be ignored (Dallas 2006). Due to the significant changes witnessed within the construction industry, particularly in terms of procurement methods, as clients allocate greater risks to the private sector, RM has become a necessity, requiring organisations to examine the entire lifecycle of a project. Furthermore, one of the main barriers to the success of such projects is the lack of a formalised approach to RM (Tah and Carr 2000; Ke *et al.* 2010).

It is crucially important for both public and private sector organisations to understand the various risks associated with projects if they are to guarantee long-term success for projects. Furthermore, for each risk it is essential to address the likelihood of risk and the ability of the organisation to reduce the incidence and impact of the risk (Wang *et al.* 2004). Managing risk has two major objectives: to avoid the downsides of risks and to exploit opportunities.

Smith *et al.* (2006) point out that while all projects are subject to risk, unfortunately, many project managers have yet to routinely include project RM as a key process. The management of risk is a continuous process that should span all phases of a project. However, poor project performance will emerge if the procedure for addressing risk is inadequate. Many studies have illustrated that the number of successful projects would be far higher if more organisations had included RM as an integral component of project management (Smith *et al.* 2006).

Current Risk Management Practice in Saudi Arabia

Based on multiple studies into the implementation of RM within the SA construction context, it was found that RM has not been successfully applied uniformly throughout the diverse stages of previous SA construction projects. Falqi (2004) compared the UK and SA in terms of delay to construction project performance, and reported extensive delays affected SA construction projects; typically reported delays which were considerably longer than those in the UK. Poor implementation of RM was found to be one of the most significant reasons for delays. Similarly, Alotaibi (2009) found in his study of SA construction projects that the main reason for failure to meet deadlines and cost targets when executing construction projects is the poor application of RM. Al-Ghafly (1995) identified sixty causes of delays in utility projects in SA, citing poor RM as an important principal factor.

However, the current literature has illustrated that there are an insufficient number of feasibility studies to assess the practice of RM in water and power projects in SA adequately; despite the general research on inadequate observance of RM practices. Combined with this lack, there are also no previous studies regarding the practice of RM in IWPP projects in the SA context. This may be attributable to the short history of IWPP projects in SA. Hence, this research is important when trying to uncover RM practice in IWPP projects in SA.

Water and power plant projects

The majority of the current water and power plant projects in the global context, and in SA in particular have been conducted by the public sector, which finances and operates projects and contracts with the private sector for design and construction. In the USA (the 2nd largest producer of desalinated water), less than 20% of the population is served by the private sector. SA (the world's largest producer of desalinated water), is home to only 3 private projects, whereas there are 33 public projects. The reason for this is that the water sector was one of the most recent sectors to be opened up for privatisation. According to Davis (as cited in Prasad 2007), private sector participation (PSP) in the water sector has been "*late and light*" compared to the privatisation of other sectors such as telecommunications and transport.

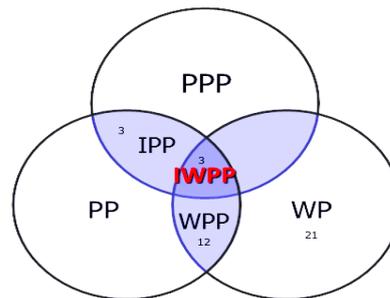


Fig 1: The research concentration areas

The involvement of the private sector has required a partnership between the public sector and the private sector, to support the financing, design, development, construction and operation of water and power projects. In the Middle East, this is called an Independent Water and Power Plant (IWPP), which is one of the various forms of PPP (VTU 2009). Figure 1 displays the relationships between WPP, PPP and IWPP, which is the focus of this study.

In SA, there are 15 water and power plants in operation, only three of which were constructed under the IWPP scheme; the remainder are run under the auspices of public finance and operation (SWCC 2011). However, the World Resources Institute (WRI 2011) stated that in March 2004, SA had announced a plan to launch ten IWPPs by 2016, requiring a total investment of \$16 billion.

This research focuses on the planned IWPP projects and examines a variety of water and power plants and experiences if these, as it is apparent from the literature that this is a relatively new area to the SA construction industry. The first such project was the Shoaiba III project, which came online in 2009 (WEC 2011).

Risks in independent water and power plants

A feature of IWPP projects is that they encounter a plethora of risks during the project lifecycle; some of these risks are unique and specific to the IWPP. This is because it has unique characteristics, which require many organisations to work together over a long period; each with its own policy and culture, and overseeing complex processes. Furthermore, there are a large number of parties from the public and private sectors involved in a typical project, leading to a need for the generation of many documents and agreements to support an IWPP project.

Although some IWPP projects have performed well, many have failed. Completing projects on time and within budget is seen as an indicator of good performance;

however, the project lifecycle of the IWPP approach is subject to many variables and volatility, which derives from many sources. These sources include: the short history of IWPP, a lack of experience of IWPP arrangements between involved parties, complexity in terms of the involvement of various stakeholders, limited competition, a long negotiation and concession period, long term financing, environmental conditions, technology issues, complex interface between water and power, and unpredictable events, which can be classified as risky (Wibowo and Mohamed 2008; Cheung and Chan 2011).

Whereas, in the global context, many researchers have sought to identify the performance level of IWPP projects and identify possible reasons for their failure, and risk factors posing major impediments to success, it is worth noting that in the SA context, little or nothing has been reported on the performance evaluation of IWPP projects. This is due largely to the newness of the scheme in the country, where three projects are only now entering the operational phase.

Furthermore, previous studies have proven that IWPP projects are problematic and result in poor performance in SA and internationally. Studies have shown the failures of these projects could be attributed to improper risk identification, analysis and mitigation. Therefore, paying additional attention to risks should assist industry practitioners to minimise the probability of poor performance (Falqi 2004).

RESEARCH METHODOLOGY

The primary task of this research is to uncover data pertaining to RM in the context of water and power projects in SA, to address the dearth of studies in this area. Fellows and Liu (2008) suggested that questionnaires, as a means of data collection are inadequate tools for acquiring the type of in-depth knowledge required. Therefore, the researchers selected the semi-structured interview method, based on and adapted form of grounded theory, for this study.

Grounded theory derives its name from the fact that the theory is developed from the data, rather than the other way round. Understanding of how complex phenomena occur, and the resulting concepts that emerge from it are grounded in the reality of those phenomena. The data determines the final shape of the theory and this approach is most likely to provide a good fit for the situation detailed in this research. Researchers should also aim to gather field data and discover theory based on a hierarchical structure of categories (Corbin and Strauss 1990).

Rubin and Rubin (1995) suggested that qualitative interviewers need not try to simplify, but should instead aim to capture some of the richness and complexity of their subject matter, and then explain it in a comprehensible way. During the interviews, the participants are to be encouraged to speak using their own terminology as related to the research topic, and are asked to clarify and extend their comments (Fontana and Frey 1994).

Design of the interviews

This research was designed to build a new theory to illuminate the particular phenomenon under study; in this case, this was to discover which elements lead to the ineffectiveness of implementing RM in IWPP projects in SA. A grounded theory methodology does not provide detailed information regarding interview techniques or styles. Therefore, the informal interviews conducted for this research were based on qualitative interviewing techniques, which promoted a flexible outline of topics and

questions (Patton 2002). The factors, taken into consideration for the interview, included strategies for guiding answers from generalised to more specific cases.

Sample and data collection

Grounded theory is often used to investigate complex phenomenon where little understanding exists; hence, the selection of participants is particularly important.

Variations in samplings are often suggested leading to a broad diversity of information-rich participants in the research setting (Patton 2002). Purposeful, variation sampling, by contrast, is used to ensure that there is diversity in the information gathered. For the purpose of this research, the interviewees were chosen on the basis of their experience and knowledge of the phenomenon under study. The essence of the sampling method was to collect data from those interviewees who were best able to answer the questions, rather than sampling a predetermined group of participants or settings (Glaser 1978). The interviewees selected provided a rich source of information on RM in water and power projects in SA.

Seven interviews were conducted; these were with key informants from the organisations who were thoroughly familiar with RM. The focus was on WPP and IWPP approaches; the WPP approach was investigated due to the long experience of this in the public sector has earned. On average, the seven interviewees had eleven years' experience in the construction of IWPP projects. For reasons of confidentiality, the respondents' names are not disclosed. (See table 1).

Round	Interview NO.	Organisation Role	Organisation Name	Participant Position	Experience	Interview duration.
1	Int. 1	Government Official	Saline Water Conversion Corporation (SWCC)	Project Manager	10 Years	49 min
	Int. 2			Follow up & Planning Engineer	11 Years	55.4 min
	Int. 3	Consultant	Fichtner company	Site Engineer	9 Years	39.3 min
	Int. 4	Project Promoter (SPV)	Shuaiba Water and Electricity Company (SWEC)	Project Manager	14 Years	65.5 min
	Int. 5		Shuqaiq water and Electricity Company (SqWEC)	Executive Engineer	9 Years	53 min
	Int. 6	Contractor	Doosan Heavy Industries	Assistant Manager	16 Years	44 min
	Int. 7	Facilities Provider	Marafiq Company	Operational Manager	11 Years	41 min
Total						347.2 Min

Table 1: Interviewees' detail

The above table reports the data from the first round of interviews. More rounds of semi-structured interviews will be considered in ongoing research, until saturation of information is reached. The first round aims to deliver a broad overview of the area under study and to establish the emergent theory; the second, and subsequent rounds, are directed toward critical junctures or significant points and events affecting the targeted subject under study. The interviewees in the case of the first round interviews were identified from the researcher's experience and colleague's recommendations.

FINDINGS AND DISCUSSION

The emergent data is presented in a diagram summarising the emergent theory. Additionally, the researcher supports all phenomena and categories with supporting data acquired from practitioners. The analysis that was carried out explored some initial phenomena found to have affected RM implementation in the water and power

projects in SA. Thus, the following phenomena were explored: lack of awareness, risk factors, and operational and support. The results from the first round of the study provide an initial foundation of theory and a starting point for the research. The entire phenomena and all the features, which emerged from the grounded data analysis, are illustrated in Figure 2.

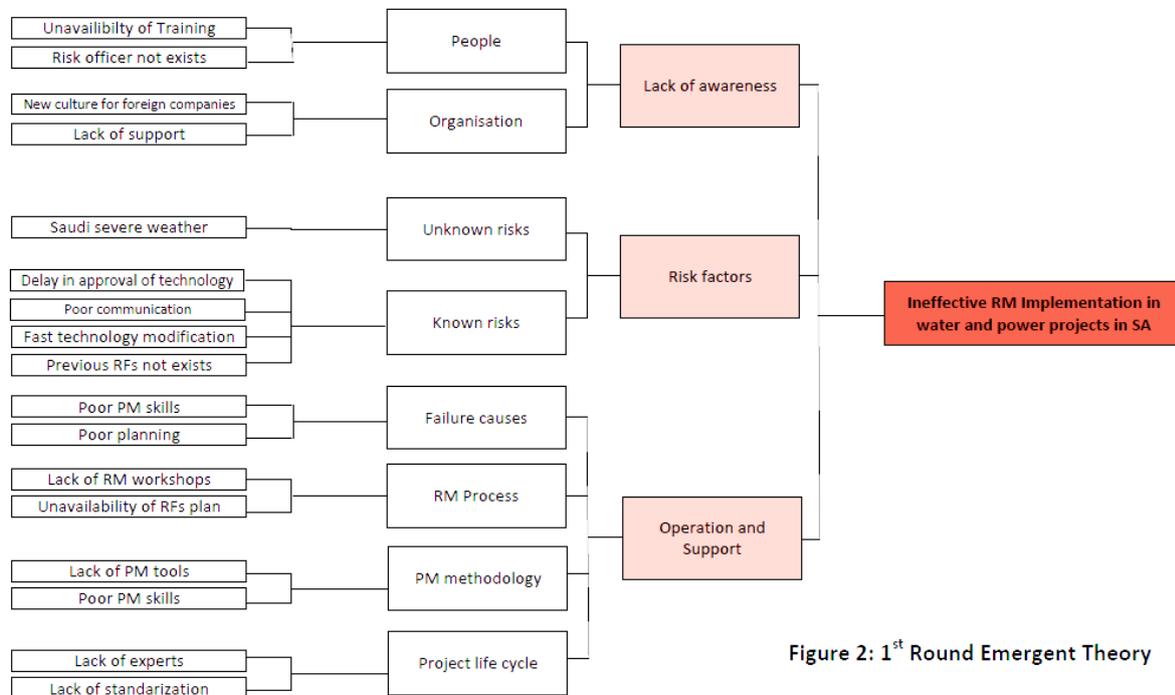


Figure 2: 1st Round Emergent Theory

Each of these phenomena, categories and subcategories is described individually in the table below with quotations from practitioners given to illustrate how the data was grounded.

Table 2: Phenomenon 1: Lack of Awareness

Categories	Subcategories	Clarification & Practitioners' Quotations
People	(a) Training	<p><i>"A lot of effort in increasing staff awareness with regard to risk management should take place at the level of the individual dealing with it."</i></p> <p><i>"I would say that all water and power firms need to set up a strategy to treat the lack of awareness If they can't come up with a clear plan for solving the awareness problem, they may continue to suffer negative results during the project."</i></p>
	(b) Risk officers	
Organisation	(a) Foreign companies	
	(b) Lack of support	

Table 3: Phenomenon 2: Risk Factors

Categories	Subcategories	Clarification & Practitioners' Quotations
Unknown risks	(a) SA severe weather	<i>"Previous WPP and IWPP projects, that have suffered delays or been over budget, based on project output, have shown the reasons behind this failure to be a number of unknown risk factors."</i>
	(a) Delay in approval	
Known risks	(b) Poor communication	<i>"Having known the practical risk factors that the SA water and power plant projects face will help not only to meet the projects objectives, but will also increase the knowledge for related people."</i>
	(c) Fast technology modification	
	(d) Previous risk factors not present	

Table 4: Phenomenon 3: Operation and Support

Categories	Subcategories	Clarification & Practitioners Quotes
Failure Causes	(a) PM skills,	<i>"Indeed, mismanagement in the project often leads to the project taking much longer than planned and costing more than budgeted, and this is due to the poor skills of the project managers."</i>
	(b) Poor planning	
RM Process	(a) Lack of RM workshops	<i>"RM is implemented in an informal way, which means they do not follow the standard process."</i>
	(b) Unavailability of RFs plan	
PM Methodology	(c) Lack of PM tools	<i>"Managing the scope of the project, risks, the work plan, etc. requiring a special procedure in order to attain full control of them."</i>
	(d) Poor PM skills	
Project Lifecycle	(e) Lack of experts	<i>"In the project's life cycle it is necessary to continuously identify causes that may have a detrimental effect on the project and to analyse possible adverse consequences and prepare responses to them."</i>
	(f) Lack of standardisation	

CONCLUSIONS

The data that emerged from the practitioners has been analysed using the grounded theory method. The researcher developed an initial foundation for the theory and a starting point for PhD research. Rich data was collected, providing a clear understanding of the topic. The research began with a general overview then delved more deeply into the topic to uncover the causes of problems, also why previous projects failed to meet their objectives and how they can reach ideal RM implementation based on the opinions of the interview respondents.

The main results emerging from practitioners were:

An initial conceptual theory that emerged from the grounded data analysis, which showed the entire phenomena, categories, and subcategories leading to the ineffectiveness of RM implementation in WPP projects in SA.

This round reported crucial practical risk factors specific to water and power projects, which affect project objectives.

- The current implementation of RM in water and power plant projects in SA is considered informal.
- Practitioners agreed that the effective implementation of RM will be able to resolve the existing water and power projects failures, whereas poor implementation of RM affects project objectives.
- SA suffers from a lack of knowledge and experience in dealing with RM in IWPP projects.
- There is a lack of RM training for staff in all the project parties.
- Providing the appropriate RM resources, training and awareness programs to staff is critical for building an effective organisational culture.
- RM awareness is important for everyone in the project – it is important that everyone is aware of their surroundings and the potential risk they face.

The work undertaken above has defined the boundaries of existing knowledge on RM as pertaining to WPP/IWPP projects in SA, with more focus on WPP, due to its longer history.

Implications for future work

The identification of risk factors called for further work to be undertaken to explore information about the causes of these practical factors, to determine practical factors from more experienced people, and also to confirm these factors from other experts. In addition, practitioners who work in different organisations, each one having their own role, explored the proposed theory; more investigation will confirm or disprove the phenomenon, categories, and subcategories. Furthermore, the researchers need to collect further data through undertaking a second round (and a third if needed) in order to begin to address any unravelling of relationships between the subcategories and categories associated with the selected phenomenon.

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A PILOT-STUDY INVESTIGATING THE ASSESSMENT AND ALLOCATION OF RISKS IN PUBLIC-PRIVATE PARTNERSHIP TRANSPORTATION PROJECTS IN VIETNAM

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Many PPP projects have failed because of risks occurring during operation and earlier studies have demonstrated a need risk assessment and allocation methods for PPPs. Although researchers have been working in this area for years, the amount of empirical work is limited, especially when applied to developing countries. This paper will review previous studies and then describe a pilot study which was carried out in Vietnam. Forty one questionnaires were sent to practitioners working on PPP transportation projects and to officials from government departments. The study attempted to identify key risks in PPPs in Vietnam, and risk allocation perceptions of practitioners in these projects. Also, the pilot study also aimed to test the methods of collecting data, the quality of the questionnaires, and the ability to assess running projects. The purpose of this testing was to carry out a larger study in the fieldwork stage of a PhD program. The findings of the study suggest that ineffective decision-making processes by the public sector, difficulty in obtaining approvals, high inflation, and corruption are the most critical risks in Vietnamese PPPs. For risk allocation, the findings suggest that the government is willing to manage risks relating to political and legal issues. Whereas, private partners are willing to manage risks relating to constructing and operating issues. This may indicate that one of the prime objectives of PPP, the transferring risks to the private sector, has not been achieved. Importantly, the findings have suggested improvement for fieldwork plan. The paper will conclude by proposing a methodology for continuing the study.

Key words: public-private partnership (PPP); risk allocation perception, risk assessment, risk management, Vietnam.

INTRODUCTION

In terms of Public-Private Partnership (PPP) in construction projects, risk management has been attracting researchers because of the distinguishing characteristics of this procurement approach. In practice, the PPP form is used to combine competitive advantages and flexible negotiations, and to apportion risk appropriately with an agreement between the public and private sectors (Li *et al* 2005). However, many PPP projects have failed because of risks such as gaps between public and private sector expectations, lack of clear government objectives and commitment, inadequate legal or regulatory frameworks, poor risk management, and poor transparency (Kwak *et al* 2009). Although they are also construction

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projects, PPP projects have their own unique characteristics. For example, in comparison to conventional construction projects, PPP projects focus not only on delivering assets, but also on specified services. Additionally, a PPP contract lasts much longer than a conventional contract; therefore, managing the relationship between stakeholders during this long period can be more problematic (Chung *et al* 2010).

Vietnam, like other countries in Asia, has experienced rapid economic development in recent years, which has increased the demand for investment in infrastructure systems (Thomas *et al* 2003). Therefore, PPPs are becoming inevitable in this country. PPP transportation projects in Vietnam may have to face many risks associated with the construction industry such as poor infrastructure, underdeveloped management systems, bureaucratic government, and weak competition between public and private enterprises (Luu *et al* 2009). In the future, however, PPP investors in Vietnam would have a better time as the Vietnamese government has been attempting to improve legal and regulatory structures for this type of investment (Dry *et al* 2010).

This study attempted to identify, and evaluate risks in PPP transportation projects in Vietnam. Also, the risk allocation perception of practitioners was also investigated. Besides this, the pilot study aimed to test the methods of collecting data, the quality of the questionnaires, and the ability to assess running projects. Additionally, the way of collecting data, such as sending questionnaires and conducting interviews, was tested to make it more practical, and to ensure that in the main fieldwork sufficient data can be collected.

The paper will first review previous studies, and then research objectives and methodology will be discussed. Finally, findings will be discussed, and development of the future research will be proposed.

LITERATURE REVIEW

Before taking any action to mitigate risks, critical risks need to be identified. Risk identification is the first step of risk management in PPP projects. The purpose of this step is not only to discover events that may go wrong, but also to identify their importance and potential opportunities that arise from these events (Redmill 2002). In this stage, uncertain events are classified based on the objectives of practitioners. Techniques such as check lists, brainstorming, interview and questionnaire, cause-event-effect analyses, Delphi techniques, Brainstorming, Collective Note Book (CNB) and Nominal Group Technique (NGT) have been also used in the area of PPP construction projects (Demirag *et al* 2010). In practice, these techniques have been applied to a number of projects. For example, in order to explore critical risks in “Build Operate Transfer” (BOT) road projects in India, and determine the perception of stakeholders about these key risks, Thomas *et al* (2003) reviewed literature to construct a list of potential risks which are likely to occur, and then participants were required to rate these risks. Participants were also invited to take part in interview to discuss their answers. By using these methods, they discovered that traffic revenue, delay in land acquisition, demand risk, delay in financial closure, cost overrun risk, debt servicing, and political risks are the most critical events in BOT road projects in India. Amongst these risks, traffic revenue risk is the most serious issue. Similarly, a study by Ghosh *et al* (2004) also focused on PPP transportation projects, in this case aimed at identifying risks in rail projects in Thailand. Questionnaires were employed, and they were designed based on a total of 59 key risks located through a comprehensive literature review. Finally nine key risks: financial and economic risk, contractual and legal risk, subcontractors related risk, operational risk, safety and social risk, design risk, force majeure risk, physical risk, delay risk, were identified in

this research. Although Ghosh *et al.* considered that the design of research was reliable and questionnaires were well conducted, the focus of this research focused on only one project (the Chaloeem to Ratchamongkhon rail line), thus the results might not be generalised. However, the advantage of this research is this was a large and complex project, of a type that may be rarely accessed by other researchers; therefore, this study can bring unique outcomes.

Li *et al.* (2012) investigated the PPP context in China. For the risk identification stage, a comprehensive literature review, Delphi technique, and factor analysis were used, followed by a mean score ranking and fuzzy synthetic evaluation in the risk assessment stage. A Delphi questionnaire survey was designed based on a total of thirty four risk factors gathered from the literature review. Li and his colleagues explained state that this technique is the best for research that needs consensus results, and for areas where the historical data is insufficient. Risks then were classified to structure and evaluate the relationship between them. Unlike most of studies, where risks are classified based on their sources (UNIDO, 1996), this research classified risks based on the life cycle perspective since Li *et al.* (2012) argue that risk management process is a continuous process which runs through the whole life of the project, not just at a specific moment. Moreover, Li *et al.* divided projects into a greater number of phases than was commonly the case, specifically: feasibility study, financing, design, construction, operation and transfer phase.

After being identified, risks need to be allocated to the party which is best able to manage them. In fact, risk allocation can be seen as a way to respond to risks. Risk allocation is the core of PPP projects. This allocation is made between public and private sector. Although in conventional construction projects, risk allocation also needs to be implemented, risk allocation in PPP is different. Risk allocation is not an easy task as it depends on many factors, for example, the attitude of managers or their capability to manage risks (Zhang *et al.* 2002). Besides which, the public sector and the private sector may have different points of view about PPP. For the public sector, PPPs are considered as a system to transfer risks to private sector participants, thus they may prefer to transfer many risks to partner parties. According to Chung (Chung 2008), the market competition now is changing the process of risk transfer or risk guarantee from the government to one of “*risk dumping*” from the government. This may mean that the government may attempt to take full advantage of the competitive environment to transfer as much risk as possible to the private partner (Chung *et al.* 2010). On the other hand, for the private sector, they need to obtain a balance between risks and opportunities. This means that they need to acquire gains to balance the potential loss created by risks. The public sector may seek the lowest expenses for taxpayer while the private sector wants to maximize their profits (Innovative Program Delivery 2012). Therefore, if too few risks are allocated to the private sector the value for money, which is the heart of PPPs, can be negatively affected. In contrast, if too many risks are transferred to the private sector, including risks that private sector may not be able to manage; the value for money is also badly influenced. Moreover, this also can reduce the willingness of private sector parties of going further into projects, and if the private sector stops bidding, the final aims of the project can be seriously influenced (Innovative Program Delivery 2012). In addition, risks should be theoretically transferred to the party having the strongest ability to manage them. However, in practice, the capability of each party to manage risk is very complex to evaluate. Hence, this evaluation may be subjective (Lam *et al.* 2007). Academics studying risk allocation in PPPs have usually investigated the risk perception of

stakeholders in practice, in order to form guidelines to help practitioners in the negotiation process (Zayed *et al* 2008, and Chou *et al* 2012).

Although there have been a number of empirical and non-empirical studies carried out in the field of public-private partnerships in construction projects, and through these studies, various techniques have been developed to formally manage risks, almost all of the companies manage risks based on their intuition, and experience rather than formal risk management methods. The lack of time and funds, and the complexity of techniques are the main reasons hindering companies in applying these techniques (Panthi *et al* 2001). Therefore, there is a need to have reliable, objective and practical risk assessment and allocation methods for PPPs. Moreover, the limited research in the Vietnamese construction industry also creates an urgent necessity to carry out the current study.

RESEARCH METHOD

For the purposes of this pilot study, a list of risks was created. These risks were identified from an extensive literature review, considering both the international context and the Vietnamese market, part of which was identified above. A total of 62 risks were gathered. They are categorised in two categories which are “*general risks*” and “*risks in each stage of project*”. There are 24 general risks which refer to the host country’s macro environment, and they are grouped into “*political risk*”, “*legal risk*” and “*commercial risk*”. 38 risks are “*in risk in each stage of project*”, and they are grouped into “*development risk*”, “*construction risk*” and “*operation risk*”. Questionnaire has 3 parts with the first part contains basic information about respondent. In the second part, participants were asked to rate listed risks, and in the final part, participants were asked to give their risk allocation perception for each listed risk. Following this interviews with officers from the PPP department at the Vietnam Ministry of Transport were carried out. These officers were also asked to complete the questionnaire. After that, officers were asked to send questionnaires to other practitioners in the private sector by email. In fact, the questionnaire was not sent to private practitioners directly by the researcher. This method was expected to increase the rate of response, as it can take the advantages from strong relationship between officers and private sector participants. To find the most critical risks, the data was analysed by improving the simple method used by Shen *et al* (2001). More specifically, risks were judged by their frequency of occurrence (Fr), and the degree of impact (Im). Risks were ranked by the equation:

$$R = Fr \times Im$$

In their paper, Shen and his colleagues categorized 3 levels of probability and impact which are 0.1 for “*low*” or “*small*”, 0.5 for “*normal*” or “*neutral*” impact, and 1 for “*high*” or “*large*”. However, after discussing with academic and practitioners, in this paper, 5 levels of probability and impact were used which are 0.9 for “*very high*” and “*very large*”; 0.7 for “*high*” and “*large*”, 0.5 for “*medium*”, and 0.3 for “*low*”, and 0.1 for “*very low*”. This change was expected to create more choices for practitioners in ranking and to make the analysis clearer. Risk score of risk I assessed by respondent j:

$$R_j^i = Fr_j^i \times Im_j^i$$

- Fr_j^i : Frequency of occurrence of risk I assessed by respondent j
- Im_j^i : Degree of impact if risk i assessed by respondent j

Risk score of risk i:

$$R^i = \frac{\sum_{j=1}^n R_j^i}{n}$$

Risks were then ranked according to their risk score (highest being most serious). In order to obtain more data and comments about the research, more interviews were carried out with some participants. These participants for interviews were chosen based on their questionnaire answers. For example, they were people who gave vague answers or significantly different to other people’s answer. The interviews were done with two officers from the government, three private practitioners who have been working in PPPs area, and two academics. Together with analysing by risk score, qualitative analysis was also applied

In terms of risk allocation, each participant was asked about their risk perception for each risk. In other words, each risk was allocated by participants to the party which they considered was best able to manage it. The percentages of respondents who allocated the risk to each party were then calculated for each risk.

FINDINGS AND DISCUSSIONS

Questionnaires were sent to forty one practitioners and thirty three of them were answered and returned. Thus, the rate of respond was about 80%. This is a high rate, and this could be because questionnaires were sent from government officers, not directly from researcher. This method is planned to be used in the fieldwork to bring a high response rate. However, not all of respondents answered all questions. For instance, few participants answered the questions on how to respond to risks and offered risks additional to those in the questionnaire. Some of them said that it would take time to answer such questions. Nevertheless, some of answers for these questions were provided during interviews. Therefore, in the fieldwork, some questions with low response rate will be used in the interviews instead of the survey.

Besides which, although the advantage of the method used in this study is that it can analyse risks both in terms of probability and impact, in reality a risk should be analysed based on additional factors too, such as the probability to lead to other risks. Hence, in the fieldwork, other risk assessment methods would be considered, and one of them may be AHP (Analytic Hierarchy Process) method which has been used in a number of researchers such as, Abdelgawad and Fayek (2010) Li and Zou (2011), Zhang and Zou (2007).

Table 1 shows the distribution of participants by sector. On consideration of these, it was decided that in the final fieldwork, lenders and academics should be invited to take part, both to extend the coverage of viewpoints sampled and increase the experience of respondents and validity of results.

Table 1. Summary of the respondents

Stakeholders	Number	Construction area working
Government	8	Transport
Investor	11	Transport
Contractor	22	Transport

Table 2: Risks ranking for General risks

Po: Political risks; Co: Commercial risks; Le: Legal risks

Type of Risks	Risks	Mean Risk Score	Rank
Po	Ineffective decision making process by public sector	0.512	1
Po	Difficulty in obtaining approvals	0.502	2
Co	Inflation risk	0.467	3
Po	Corruption risk	0.447	4
Co	Interest rate risk	0.392	5
Co	Low convertibility of currency	0.382	6
Le	Difficulty in obtaining compensation	0.382	7
Po	Uncertain policies from the government	0.380	8
Le	Inefficient legal process	0.365	9
Po	Unfair decision in selecting private investors	0.347	10
Co	Small capital market	0.320	11
Le	Change in laws and regulations	0.312	12
Le	Inadequate legal framework	0.285	13
Co	Government restriction on profit and toll decision-making process	0.275	14
Co	Negative economy of the country	0.257	15
Co	Foreign exchange risk	0.255	16
Po	Termination concession by government	0.245	17
Po	Political assistance from the government	0.225	18
Po	Risks relating to tax	0.195	19
Le	Law enforcement risk	0.180	20
Po	Forced buy-out risks	0.157	21
Po	Expropriation/nationalization risks	0.155	22
Po	Insufficient experience of the government in PPPs	0.112	23
Po	The government fails to make payment on time	0.097	24

Table 2 shows the ranking of general risks with the twenty four highest ranking risks as rated by the respondents. As can be seen from the table, amongst top ten risks, the political risks are in the majority. For example, “*ineffective decision making process by public sector*” was ranked as the most serious risk. Practitioners in interviews also stated that they have been faced with difficulty in receiving approval, and the result of the questionnaire also supports this as “*difficulty in obtaining approvals*” stands in the second position, and corruption risk stands at the fourth position. Participants in the interviews also assert that these risks do not only appear in PPPs but also in general construction projects. One of the reasons for this risk, as stated by participants, is that there are many layers in government legal systems, and these layers are sometimes not consistent with each other. Not surprisingly, “*inflation risk, interest risk and low convertibility of currency*” are commercial risks that were considered as key risks. Moreover, legal problems were also pointed out as they can lead to difficulties in running projects. These results are confirming the general conclusions of Wang *et al.* (2000) that in developing countries, political risks are more serious than other risks. However, the table also illustrates that seven other political risks stand at the bottom of the ranking table such as “*expropriation/nationalization risk*”, “*insufficient experience of the government in PPPs*”; “*the government fails to make payment on time*”. This is probably because by the time the survey was performed, there had been a number of improvements in those matters. For example, the experience of the government has been increasing because of the cooperation with other countries. There are now many specialists from other countries working as consultants and advisers for the government in terms of operating PPPs. Besides which, the questionnaires were sent only to PPPs in the transport area, and in this area operational phases are mainly funded through users paying tolls directly to the operator and this might be the reason that private partners do not consider “*the*

government fails to make payment on time” as a serious risk, as it may be in other construction sectors.

Moreover, by saying that the “expropriation/nationalization” is not a serious risk, respondents may be indicating that they do not worry that the projects may, at some future time, be compulsorily purchased by the government. In fact, some specialists expressed the view in the interviews that there are situations when the private sector exploits this possibility. Some projects may have 100 % private capital and the private sector may then submit a high bid price, in the belief that the government thinks that it does not really matter if the price is high (this is an internal matter for the investors as there is no government money in the scheme), as long as the toll is acceptable. Nevertheless, if after the project runs for a period, the government decides to buy back project, they will have to pay the initial bid price. In this case, obviously, the losses fall on the government.

Table 3: Risks ranking for risks in each stage of project

Type of risks	Risks	Mean	Rank
Op	Cost escalation risks	0.875	1
Op	Risks relating to employment	0.625	2
De	Impractical project feasibility report	0.565	3
Op	Inadequate demand	0.523	4
Con	Cost escalation risks	0.515	5
De	Approval risks	0.502	6
De	Bidding risks	0.445	7
Con	Loan risk	0.440	8
Con	Ineffectiveness of supervision of consultants	0.422	9
Con	Poor performance of constructors	0.370	10
De	Delay in planning process	0.337	11
De	Intervention of the government	0.336	12
De	Unavailability of finance	0.327	13
Con	Restriction on import equipment/materials	0.312	14
Con	Supply risk	0.305	15
Con	Government interference	0.250	16
Op	Government interference	0.250	17
De	The government lacks experience in PPPs	0.237	18
Con	Default by concession company	0.235	19
De	Inadequate tendering price	0.227	20
Con	Technical risk	0.195	21
Op	Restriction on repatriation of profits and funds	0.187	22
Op	Supply risk	0.175	23
De	Unclear conditions in the contract	0.165	24
De	Differences in working method and misunderstanding between partners	0.165	25
Con	Poor design	0.157	26
De	Lack of commitment from either partner	0.132	27
Op	Concession company default	0.115	28
De	Unsuitable project location selected	0.112	29
Con	Late design change	0.112	30
Op	Government department default	0.110	31
Con	Contractor default	0.103	32
Con	Protection of geological and historical object	0.080	33
Op	Inability to operate	0.080	34
Con	Environmental damage	0.070	35
Con	Land acquisition and compensation risks	0.068	36
Con	Risk relating to employment	0.065	37
Con	Work conditions differing from contract	0.052	38

Table 3 ranks risks specific to each stage of the project. Amongst the top fifteen risks, the construction risks are in the majority, for example, “*cost escalation risk, loan risk, and ineffectiveness of supervision of consultants*”. Not surprisingly, cost escalation risk was ranked as key risk in both construction stage and operational stage. This could be because the inflation rates in the Vietnamese market in recent years have been significant. For example the annual inflation rate in Vietnam dramatically increased from 6.2 per cent in 2009 to 12.1 per cent and to 21.3 per cent in 2011 and 2012, respectively (World bank, 2014). Although the rate decreased to 10.9 per cent in 2013, this still represents a threat to practitioners in PPPs. “*Impractical project feasibility report*” was also considered a serious risk as it was ranked at the third position. It is highly likely that this correlates strongly with the fourth risk which is “*inadequate demand*”. Indeed, information from interviews shows that feasibility studies at the development stage may not match the reality encountered later. For example, participants in interviews pointed out the situation of Yen Lenh Bridge as an example. The feasibility study of this project did not fully take into account the plan for other roads schemes which were built in the same region. These roads have reduced the demand for the bridge, meaning the demand is insufficient to balance expenditure.

Table 4: Risks allocation for general risks

Type of risk	Risks	Risk allocation (%)		
		Public	Private	Share
Po	The government fails to make payment on time	96.969	0	3.03
Le	Inadequate legal framework	93.939	0	6.06
Po	Political assistance from the government	100	0	0
Po	Uncertain policies from the government	100	0	0
Le	Change in laws and regulations	87.878	0	12.121
Po	Insufficient experience of the government in PPPs	90.625	0	9.375
Po	Corruption risk	84.848	12.121	3.03
Po	Ineffective decision making process by public sector	81.818		18.182
Po	Termination concession by government	78.787	3.03	18.183
Po	Difficulty in obtaining approvals	75.758	3.03	21.212
Le	Inefficient legal process	75.757	0	24.242
Po	Risks relating to tax	72.727	18.181	9.09
Le	Law enforcement risk	60.606	0	39.394
Po	Expropriation/nationalization risks	64.286	7.143	28.571
Le	Difficulty in obtaining compensation	56.667	6.667	36.667
Co	Low convertibility of currency	40.425	59.375	3.25
Co	Inflation risk	36.363	24.242	39.395
Co	Interest rate risk	33.333	51.515	15.151
Po	Unfair decision in selecting private investors	30.303	33.333	36.363
Po	Forced buy-out risks	27.272	12.121	60.606
Co	Foreign exchange risk	18.181	18.181	63.636
Co	Government restriction on profit and toll decisionmaking process	9.09	27.272	63.636
Co	Negative economy of the country	6.06	9.09	84.848
Co	Small capital market	0	0	100

Table 4 shows the respondents’ risk allocation opinions for general project risks. The results indicate that the majority of risks were considered by respondents to be appropriately allocated for management by the public sector. For example, fifteen of twenty four risks on the list were chosen by more than 50% of respondents to be managed by public sector. This result is in line with the conclusion of Ke *et al* (2010) that most risks should be retained by public sector, or be shared by both parties.

Besides, through this pilot study, it is recognized that determining the concession period and toll adjustment mechanism are two of very critical issues in PPPs in

Vietnam. Therefore, in the final fieldwork, two these issues will be investigated further. A model to determine concession period and toll adjustment mechanism could be proposed using a modified “*Net Present Value*” approach to cost and income streams.

As stated above, this pilot study shows some different outcomes in comparison to previous studies in both international contexts and the Vietnamese market. These comparisons will also be re-examined on completion of the final fieldwork and explanations for any differences proposed.

CONCLUSION

This paper reports the outcomes of the pilot study in risk management in PPP transportation projects in Vietnam. This study attempted to identify and rank risks in this area in Vietnam. Moreover, the perceptions of practitioners in the area of risk allocation were also discovered. However, this pilot study also aimed to test research methods such as, the methods of collecting data, the quality of the questionnaires, and the ability to assess running projects.

The findings of the study suggest that ineffective decision-making processes by the public sector, difficulty in obtaining approvals, high inflation, and corruption are the most critical risks in Vietnamese PPPs. For risk allocation, the pilot findings suggest that the government is willing to manage risks relating to political and legal issues such as, risks of failing to make payment on time, inadequate legal framework, and uncertain policies from the government, and difficulty in obtaining approvals.

Whereas, private partners are willing to manage risks relating to constructing and operating issues. Thus, according to the pilot study, the private sector is not willing to solely manage a majority of risks. This may indicate that one of the prime objectives of PPP, the transferring risks to the private sector, has not been achieved. The results are not fully consistent with results from previous studies. The possible explanations for this inconsistency will be considered as the research progresses.

The objective of the study to test the research methodology was achieved. Based on the outcomes of this pilot study, an extended field study is going to be carried out. In this fieldwork, nine selected PPP transportation projects in Vietnam will be accessed. Amongst these projects, six are currently running and three of them have finished. Furthermore, government officers who are working in PPP Department of the Ministry of Transport of Vietnam will be asked to answer questionnaires and have interviews. Also, a number of Vietnamese academics and researchers will be also invited to participate to bring different, and possibly unbiased, points of view. Additionally, other assessment methods such as Analytic Hierarchy Process (AHP) can be used to analyse and evaluate risks in combination with the analysis method used in the pilot study. Two critical issues in Vietnamese PPPs: how to determine concession period and the toll adjustment mechanism will also be researched.

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GOVERNMENT INSTITUTIONS AND INFRASTRUCTURE SKILLS DEVELOPMENT

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The capacity of state institutions is central to the efficient delivery and management of infrastructure. The paper examines two models for improving the skills of managers in central and line agencies of government for infrastructure procurement and management in emerging economies. The first examines the role of the Public Private Partnership (PPP) unit, a specialist agency equipped with the technical capabilities, transactional experience and budget to provide training and assistance to line agencies for the effective delivery of infrastructure projects. Integrated into this model, and used by several nations, is the use of trained relationship managers to manage service contracts including government commissioned build operate transfer (BOT), outsourcing and concession arrangements. This approach uses relationship management principles whereby the regulatory framework of the contract in matters such as price, quality, service standards, and performance measurement is exercised within the contract. The second model is the Gateway approach to infrastructure project analysis and development. Gateway was initially implemented in the United Kingdom and has been widely adopted in OECD countries over the past decade as an alternative governance framework for public projects that require the participation of multiple government agencies, private advisers, several levels of approvals and close liaison between the executive and political arms of government. Gateway imposes new disciplines on the project procurement process, requires central and line agencies to undertake professional development training and imposes new governance standards for large and complex infrastructure procurement projects. Evidence suggests that Gateway is playing a significant role raising the capacity of public agencies to manage large and complex procurement projects, and improving procurement performance.

Keywords: public procurement, skills development, public institutions.

INTRODUCTION

Public private partnerships (PPPs) are a form of specialised infrastructure procurement in use in over 130 countries worldwide. The PPP procurement method is one of several new methods that have appeared in the past 20 years in response to systemic failure in government delivery of public infrastructure (Latham, 1994, Levene, 1995, Department of Trade and Industry, 1998). Technology and skills transfers are most effective when tied to project procurement. This approach is quick and effective if training and technology transfer are a condition of the procurement. When government takes responsibility there is a need to design a formal training program for either a central agency of government or in line agencies of central government. The

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government line agency is a ministry of government responsible for a specific portfolio of government policy and activity. Line agencies are responsible for delivering projects within their portfolios. In countries with federal political structures or autonomous regional governments, the task of standardised training for government managers becomes that much harder. It is also difficult for developing countries to find the funds to invest in training programs across all line agencies.

PAST PRACTICES

The public procurement practices of earlier years included systemic optimism bias, late delivery of projects, poor coordination between state agencies, higher costs, and low stakeholder and user satisfaction levels. As a centrepiece of the reform of public procurement in Britain, PPPs were introduced in 2001 as part of a wider Private Finance Initiative (PFI) policy and were adopted in Australia and other countries shortly afterward. In Australia, the build own transfer (BOT) procurement model was employed by federal, state and local governments from the mid-1990s. It was also employed in several early infrastructure undertakings in Victoria (Citylink) and New South Wales (Sydney Harbour Tunnel). Early transactional evidence suggested private investment in infrastructure improved the rigour of major project procurement, led to greater innovation and new technology, and significantly improved value for money outcomes for government (National Audit Office, 2001, 2003; Fitzgerald, 2004).

In developing countries with a PPP policy, a PPP Unit is often created to implement national PPP policy and ensure consistency of application across the line agencies which are required to deliver projects. The primary role of a PPP unit within a central policy-making agency of state (usually Treasury and Finance or Prime Minister's Department) is to provide early stage financial and technical assistance to line agencies for complex PPP projects.

Most national PPP policies require that all projects above a threshold value or otherwise eligible for procurement as PPPs be selected, evaluated, prepared and commissioned by line agencies. As happens with all governments, often the line agencies simply lack the skills to do this properly, especially in the early years of a PPP program. PPP units also have another important role of providing training to develop the commercial and professional skills necessary to successfully implement these projects. They commonly achieve this with courses and instruction in the following:

- Business case preparation
- Options analysis
- Discounted cash flow methods
- Negotiation skills courses
- Risk-weighted financial forecasting
- Preparation of a public sector comparator
- Conducting a bid process
- Value for money and bidder selection methods.

The PPP Unit employs experienced PPP practitioners, many with international experience, and with the financial support of multilateral agencies such as African Development Bank, World Bank, Asian Development Bank, Economic Research Institute for ASEAN and East Asia (Japan), and Commonwealth Secretariat. The PPP programs employed in the Australian states from 2001 introduced systematic project evaluation, the requirement for detailed business case, the identification, measurement

and transfer of project risks, value for money bid evaluation methods and lifecycle costing. These were significant advances in the process of delivering better infrastructure in the form of improved public goods. The introduction of improved rigour in the procurement process led to improvements in procurement practice which were transferred to traditional government procurement policy with the Gateway programs now employed in the Commonwealth, states and territories. The benefit of these changes has been our improved understanding of major project procurement, significant improvement in procurement outcomes (Regan, *et al*, 2011) and more efficient delivery of public goods and services (National Audit Office, 2005a).

The PPP approval process requires agencies to undertake comprehensive analysis of projects prioritised for PPP delivery. This involves identification of the service needed and preparation of an output specification, cost benefit analysis then preparation of a business case, assembly of the project team, preparation of a procurement plan and timetable, stakeholder consultation, the evaluation of procurement alternatives, construction of a risk-weighted benchmark or public sector comparator selection, agency and ministerial approvals at predetermined steps in the implementation process, the conduct of a competitive bid process requiring pre-qualification in an expression of interest stage, then bidder selection through an invitation to bid process, bidder selection and negotiations for the PPP contract and creation of the *ex post* contract management framework (Partnerships Victoria, 2001, p. 14).

In OECD countries, PPPs are generally managed under policy frameworks that operate independently of traditional procurement laws and policies. In federal constitutions such as Australia, PPP policy is generally administered by the states and territories and its implementation is managed within central policy-making agencies of government such as State Development, Treasury and Finance or Infrastructure and Planning.

PPP units provide assistance to line agencies in the selection, prioritisation, development and implementation of PPP projects. In developing countries where the institutions of government may be less well developed, most PPP policies are given statutory form and a dedicated PPP unit is created to assist the implementation of policy. The PPP unit can provide technical and financial assistance to line agencies to assist project analysis, development and implementation (in World Bank and Public Private Infrastructure Advisory Facility 2007, *Public Private Partnership Units: Lessons for their Design and Use in Infrastructure*, World Bank, Washington).

FUNCTIONS OF THE PPP UNIT

The World Bank defines a PPP unit as any organisation designed to promote and/or improve public private partnerships that has a lasting mandate to manage multiple PPP transactions in response to government failures (poor procurement incentives, lack of coordination, high transaction costs, lack of skills and information) (World Bank-PPIAF, 2007). The PPP unit may control the total number of public private partnership projects and ensure that projects fulfil specific quality criteria, or it may function as an advisory centre and coordinate the responsibility for assisting line agencies with project implementation. Further, the unit's role may include PPP policy and strategy, project identification, analysis, transaction management and contract management, monitoring and oversight. In some jurisdictions, it may have a more formal role as an approval agency for the Gateway development of projects.

Gateway refers to the approval points in the progressive development of a PPP project within government. The PPP process may require agencies to select a project against specified criteria and then conduct a detailed analysis of the project. This is then submitted for Gateway review by the PPP unit before proceeding to the next Gateway stage, which may take the form of a procurement options analysis, the preparation of a life-cycle costed traditional procurement benchmark (the public sector comparator), the bid process and bid evaluation criteria, negotiations with the successful bidder, contract and financial close and then the commissioning of a contract management framework. A Gateway procedure imparts rigour to the procurement process and imposes oversight at key stages in project implementation. The Gateway process (developed in the UK) is now employed widely in OECD countries for alternative procurement methods and is largely responsible for the rapid improvement in government project procurement performance since 2001 (National Audit Office, 2003a, 2003b).

The World Bank generally takes the view that PPP units are designed to compensate for an inability to deliver PPP projects using the existing machinery of government which is largely the case in developing countries (World Bank-PPIAF, 2007, p. 25). However, in OECD countries, PPP units are generally viewed as specialist resource centres designed to build capacity in line agencies and implement PPP projects that meet policy criteria. The independence of a PPP unit is an important instrument of governance that ensures line agencies do not use PPPs to circumvent formal budgetary constraints. PPPs are not an off-balance sheet alternative to traditional procurement and an effective PPP unit will provide fiscal oversight and compliance with the government's overall fiscal policy objectives and management. An independent PPP unit may also serve as a central coordinating agency for infrastructure planning and program management. This is important in avoiding planning delay or "hold up" risk, the major cause of high transaction costs in PPP projects. In Queensland, the location of the PPP project implementation agency within the office of the Coordinator General, Department of Infrastructure and Planning, meets this requirement.

PPP units draw their expertise from personnel in the public and private sectors. In Victoria, private consultants assisted in the drafting of policy guidelines 2001-03 and with the exception of advisory and legal services; most project implementation services are provided in-house. The development of in-house capacity to deliver complex PPP projects is also the preferred approach in South Africa, South Korea, Portugal and the Philippines. A study of PPP units by the OECD identified six core functions of the PPP unit: policy guidance, "green lighting" projects, technical support, capacity building, PPP promotion and PPP investment (OECD, 2010, p. 3).

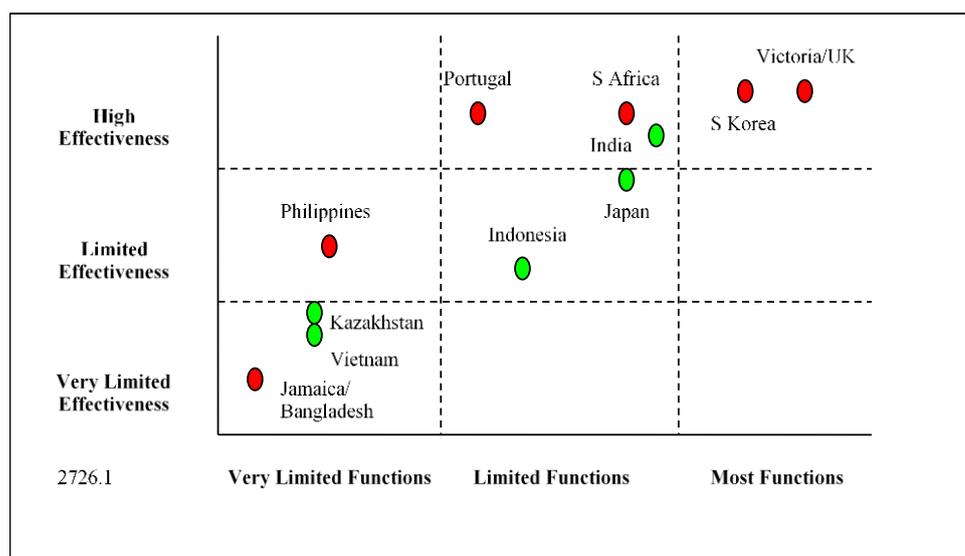
The role of a PPP unit is also that of ensuring that the PPP program is meeting the state's objectives, that transactions are achieving value for money and comply with standards of good governance. The World Bank-PPIAF study (2007) identified a correlation between the scope of functions of the PPP unit and the effectiveness of the national PPP program (see Figure 1).

PPP units are a key component of the PPP project implementation process. In OECD countries, PPP units are designed as resource centres and staffed by practitioners with both infrastructure and PPP project experience. Frequently, senior appointments within the unit are offered to experienced private sector executives with wide transactional experience. As a highly specialised form of project procurement, PPPs

are exempt from conventional procurement laws and policy. The unit offers agencies information, guidance and expertise in matters that may include:

- A sound understanding of policy procedures and methodologies
- Private participation in infrastructure
- Business case development, evaluation and financial modelling
- Risk analysis and risk allocation
- Project finance
- Negotiation skills
- Standardisation of procedures and templates
- Assistance with stakeholder consultation and management
- Financial assistance with early-stage project development and consultants
- Contract management and regulation of long-term contracts
- An executive approval or post-commissioning review role
- A data base of information
- Agency staff professional development and training.

Figure 1: World Bank-PPIAF Study 2007: PPP Unit Scope and Program Effectiveness



PPP units function as the coordinating agency for both policy dissemination and the rollout of projects. Nevertheless, there is no standard specification for a PPP unit and they are mostly designed to fit within the institutional framework of each country. They are most frequently attached to an agency close to the policy-making centre of government although practices vary widely throughout the world. In the United Kingdom, the functions of a PPP unit are provided by three institutions. Partnerships UK provides assistance to line agencies regarding policy application, transactional and project management matters. H.M. Treasury provides policy guidelines, and the Office of Government Commerce provides technical information and training information on matters such as business case analysis, life cycle costing and risk analysis and weighting. The functions of the three agencies overlap.

In the state of Victoria, PPP policy is implemented by the Commercial Division of the Department of Treasury and Finance and projects are selected, developed and managed by line agencies with Departmental oversight. A similar approach is applied

in New South Wales. Prior to April 2012, projects in Queensland were delivered through the Coordinator-General as head of the Department of Infrastructure and Planning, now the Department of State Development, Infrastructure and Planning. Projects in New South Wales and Queensland are selected, evaluated and implemented by line agencies with PPP unit oversight (see Figure 1). At the present time (2014) the global financial crisis together with a number of failed projects has impaired new PPPs in Queensland. The state government is attempting to develop better arrangements for financing and encouraging PPPs in the future working with the federal government.

Similar practices apply nationally and in the other states and territories. In 2008, Australia adopted a national PPP policy which consolidates various policy models operated in the various national, state and territory jurisdictions. However, each jurisdiction has discretion to vary policy to meet specific regional requirements (Infrastructure Australia, 2009, pp. 39-44).

As a general rule, the work performed by a PPP unit is designed to successfully implement a government PPP program. This may include direct participation in policy design and implementation and/or the provision of financial and technical assistance to line agencies to enable them to undertake their own projects or a combination of these roles. The specific activities undertaken by PPP units may include:

- The preparation of policy and procedural guidelines. In some cases, this may include delegated legislative and/or regulatory powers
- Assistance with project selection and analysis to ensure projects meet policy requirements governing value for money, risk transfer and the affordability of future availability payments. This may include an approval role as the project is developed through a number of specified “Gateways” set out in the policy.
- Management of transactions including assistance with contract design, management of the bid process and contract management
- Provision of oversight to ensure agencies and sub-national governments comply with reporting, accounting and governance standards
- Coordination of the PPP project pipeline to avoid tension between the government’s project delivery strategy and the capacity of private bidders to absorb the work flow. Labour market constraints in particular require regular phasing of projects to balance optimal capacity utilisation with skills retention in the market.
- Provision of grants to line agencies and sub-national governments to assist early project development and meet the cost of specialist advisers and consultants
- Creation of a resource centre for the identification of pre-qualified transaction advisers and in developing countries, provision of technical information, introductions to multilateral institutions, international private investors and financiers.

There are three further roles for the PPP unit. Firstly, to assist line agencies and sub-national governments to develop their own in-house capabilities for project implementation over time. Secondly, to provide specialist training to help line agencies acquire greater understanding of the PPP procurement option and acquire specialist skills in areas such as contract negotiation. Thirdly, to conduct post-implementation reviews and build a data base of transactional experience and lessons

learnt to assist further refinement of the policy and assist capacity building at the agency level.

INTERNATIONAL EXPERIENCE

Recent international studies have examined the operation of PPP units in a number of developed and developing countries (World Bank-PPIAF, 2007; Economist Intelligence Unit, 2011; OECD, 2010; Farrugia *et al.*, 2008). See also Sanghi *et al.* (2007). A study by Mahalingham *et al.* (2011) surveyed the performance of PPP coordination agencies in India. The conclusion reached by these studies is that there is no “one size fits all” solution for every nation and PPP units need to be developed to meet the distinctive institutional and policy characteristics of a national government. In some countries, it is necessary for the PPP unit to have executive authority embedded in law to provide the direction and manage policy implementation. In others, the PPP unit has an advisory role within Treasury or another agency of government to provide assistance to line agencies. In others, the PPP unit may provide an intermediate role that includes limited executive powers of approval and the facilitation of projects for line agencies which undertake the “heavy lifting” of project selection, measurement and bidder selection. In Victoria and Western Australia, Treasury and Finance agencies and Treasury Corporations provide dedicated training for line agency staff in areas such as project procurement, risk and contract management.

The World Bank-PPIAF study found a high positive correlation between the success of a country’s PPP program and effective PPP units designed to correct institutional weaknesses of the host government (World Bank-PPIAF, 2007, pp.4, 29-30). Other characteristics linked to the effectiveness of PPP units include:

- Political leadership and support
- Complimentary institutional frameworks including a regulated capital market, public governance and effective measures against corruption
- Friction and dysfunction between government agencies (World Bank-PPIAF 2007, p.8).

Other lessons learnt about the design of PPP units:

- The authority given to the PPP unit must match the expectations placed on the unit
- The unit should be placed in a central decision-making arm of government. In western government experience, this is typically the Department of Treasury and Finance (World Bank-PPIAF, 2007, p.8; Economist Intelligence Unit, 2011, pp.12-14).

A study by the Economist Intelligence Unit (EIU, 2011) examined the institutional frameworks in operation in 16 Asia Pacific countries. Countries that scored highest in the survey were those with strong state institutions and effective PPP units. The study found that new PPP units have been, or are in the process of being established in Japan, Bangladesh, Indonesia, Kazakhstan, Mongolia, Pakistan and Papua New Guinea. The Philippines recently relocated its PPP unit while Indonesia is currently developing a new entity within its Ministry of National Development Planning, Bappenas. Thailand and Vietnam recently launched inter-ministry taskforces to develop the PPP agenda, and India has the powerful ministerial-level Committee on Infrastructure, with the Planning Commission and PPP Unit of the Department of Economic Affairs supporting development and execution of projects (EIU 2011, p. 14). China is distinctive in the Asia Pacific in its lack of PPP-specific institutions with

projects delivered through the same provincial government agencies as traditional procurement (EIU 2011, p. 14).

In OECD countries, PPP policy most often takes the form of a policy with supporting guidance materials. In developing countries, PPP policy frequently has a statutory foundation which includes the establishment of a PPP unit as a division of an existing line agency (The Philippines, Mauritius) or a new agency that assumes responsibility for policy and project implementation (Indonesia). PPP policy is generally put in place by national governments (Britain, Australia, South Africa, Germany and Korea). In Australia, Canada, Japan and China, most PPP projects are delivered by provincial and local government agencies (Economist Intelligence Unit 2011; OECD 2010, 50).

THE GATEWAY PROGRAM

The Gateway program was initially developed in the United Kingdom and employed in 2001 by the Office of Government and Commerce (OGC), in New Zealand in 2006, and adopted by the Government of Victoria in 2003 and the Commonwealth of Australia Government in 2007. Gateway attempts to improve the performance of traditionally procured public projects, reduce cost overruns, late delivery and scope creep by requiring projects to pass through a series of gates at various stages in the project cycle. The gates include justification of the business case, procurement options analysis, the tender procedure, the contract management framework, and post-implementation review. Each Gateway is a review involving a panel of experienced and independent reviewers and all projects above threshold values (in Australia they are AUD10 million for IT, AUD20 million for other projects) are required to undergo the process. Having review gateways for the key stages of projects permits independent assessment and applies an additional governance framework to the development stages of a project to ensure key project performance targets can be continuously monitored and managed. Gateway is designed to improve the procurement process by requiring major or complex projects, including construction to be subject to review at key stages by an independent panel to ensure the project is justified, and that the procurement approach is likely to achieve value for money – a test of quantitative and qualitative project outcomes (National Audit Office, 2005b).

In a relatively brief period, Gateway has delivered significant improvement in traditional procurement performance, delivered knowledge transfer, assisted in building the skills of line agencies, and led to better procurement outcomes (Australian National Audit Office 2012; Sharpe 2005). The building of technical proficiency in line agencies is reflected in the improvement in performance of projects delivered through the process.

Gateway uses three possible results for each review; red denotes immediate remedial action required, yellow indicates conditions apply before the project may proceed to the next review and green, which indicates the project is approved. In the first four years of Gateway in Victoria, an average 18% of projects were graded red and an average 56% graded yellow. In the fifth and six years of the program, all projects were graded yellow. The first 5 years of the program for the Australian Commonwealth Government also achieved a marked reduction in red and yellow grading with 66% of projects receiving a green rating and a significant improvement in project performance. The Australian Audit Office Performance Audit in 2012 (ANAO, 2012) explained the Gateway program as a learning process that provides line agencies with a rigorous project evaluation and process management system and the opportunity to improve technical and project delivery competencies. A series of reviews of New

Zealand's Gateway program in 2011 and 2013 concluded that Gateway was developing skills and experience in line agencies and demonstrating project ownership and leadership from both senior public service employees and government ministers (State Services Commission, 2011, 2013).

CONCLUSION: THE EVIDENCE

The evidence from nearly 20 years of international PPP experience suggests that PPP programs are most effective when they are implemented and managed by a competent PPP unit equipped with the authority, the technical and financial resources to manage both policy rollout and project delivery through an advisory and oversight role with responsible line agencies. The effectiveness of PPP units is positively correlated with the unit's continuing engagement with the project, particularly the development of skills in line agencies and a support role as the project is developed through to implementation. The effectiveness of the PPP unit is also dependant on political support and a regular flow of projects to maintain a skilled and competitive bid market. As a mature PPP market with stable and efficient institutions of state, Australia should be well positioned to operate effective PPP units and deliver "best practice" projects. However, the performance of the commonwealth and state governments in PPP delivery is far from uniform. The stand-out and best performing PPP programs occurred in Victoria and New South Wales, both being recognised internationally as best practice templates. South Australia and the Commonwealth have delivered a small number of challenging and complex projects and in Queensland and Western Australia, the project roll-out as a component of public capital expenditure since 2001 has been negligible. The Gateway project approach integrated into the dedicated PPP units in government agencies offers an emerging and realistic alternative to established PPP units, which often carry too much 'baggage' in bureaucratic administration of these programs. There is evidence that where Gateway has been introduced into the PPP framework, the project implementation is more successful.

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THE COMPARISON OF CONSTRUCTION MANAGEMENT CURRICULA IN UNIVERSITIES BETWEEN THE UK AND JAPAN

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The development of CM education in universities is of significant interest both for academia and practitioners. The comparison of CM education between countries may provide insights into development in different places. The purpose of this research is to consider the contextual differences in construction management (CM) taught education between UK and Japan. Curricula in the two countries were compared. Interviews were carried out in UK universities to learn more about UK CM education. UK curricula were found to be heavily influenced by partnerships with British professional institutions. In contrast, the curricula of Japanese higher education institutions are restricted by the Ministry's requirement in relation to professional licenses. This raises interesting questions about how each institutional context influenced the development of different kinds of skill. The self-regulation of the professions in the UK seems to make British higher education for the professions more responsive to contemporary industry needs. In contrast, Japanese government's control over the curricula is aimed at developing wider architectural and engineering skills. The intention of this paper is to promote dialogue between British and Japanese institutions for the wider development of CM education.

Keywords: curriculum, education, employment, institutional force, professional license.

INTRODUCTION

Construction management (CM) education has developed in different ways in different countries. Since the curricula differ, it may be possible to transfer learning between countries about how CM education is defined and constituted in different places. Such a task requires prudence, taking into account the major differences in the way that construction is organized in the two nations. The purpose of this paper is to consider the differences in CM curricula between two countries, to ascertain the extent of these differences and the reasons for such differences. The premise of this research is that various industrial contexts are connected to systematic issues about how curricula are designed and controlled. For example, differences between CM programmes in higher education in Japan and UK may variously be related to contextual industry practice, to professional infrastructures or to the way that universities are regulated and managed. The broader aim of this research is to develop a conversation between British and Japanese academics, professional institutions and

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civil servants about what constitutes CM and how it may be developed in both countries, while respecting the crucial contextual differences in each country.

LITERATURE REVIEW

Some scholars advocate that higher education (HE) CM curricula need to reflect practical knowledge of the industry. For example, Sher and Walker (2013) studied the development of students' management skills through a computer-based simulation of operating a hypothetical construction company. They reported that simulations modelled on practical cases helped to engage students. Students were able to understand financial management in a practical sense, in a way that can be difficult to deliver through traditional teaching approaches. Sloan (1995) suggested that there are various ways of using computer-assisted learning (CAL). He advocated that universities might use CAL strategically to develop competitive advantage. More specifically, universities are being asked to provide for the needs of their "customers" including students, government and industry. Although his focus was on the use of CAL, his attention to meeting the needs of the wider context of higher education is worthy of attention in considering the broader context of education.

Attention has also been paid more generally to the design of HE programmes. Arditi (1984) reviewed graduate construction management programmes offered by departments of civil engineering in the USA. He found that programmes differed in terms of the concentration and emphasis of each subject category, such as construction technology and general management. However, he did not further explore why the programmes differed from each other. In contrast, Devaney and Roberts (2012) extended the study of CM programmes with regard to graduate employability. They questioned how the different types of qualification affect the employability of property and construction graduates. Their results suggested that a postgraduate degree in land and property management increased the probability of graduate level employment, which was not seen in the cases of construction, quantity surveying or building surveying. They implied that a wider context, such as economic downturn and industry's needs, has to be taken in to account in the provision of programmes. As a means to raise graduate employability, Mullin *et al.* (2010) especially focused on how to accommodate industry's demands into educational programmes. They analysed the gap between graduate skills gained from CM programmes and industry's demands for graduates in the workplace. With a specific focus on soft skills, including team working and leadership, they conducted questionnaire surveys to investigate the views of academics, senior practitioners and recent graduates. They identified certain soft skills that seemed to be needed in the curriculum. However, they did not propose specific ways of improving actual curriculum design according to such industry needs in practice.

One way to tackle this problem is to seek to bridge the gap between HE and industry. Some articles suggest that this might be beneficial for both constituencies. Gann (2001) studied construction firms' capabilities to take up and implement the outcome of academic research from UK universities. He found that professional institutions play a major role as repositories of knowledge. He also noted the role of government as a sponsor of academic research, particularly the low level of investment in R&D in the construction sector. This implies that the institutional contexts that influence academic practice are different in each country. For example, the influence of the government is much stronger in Japan than in the UK. Significantly, Cieszyński *et al.* (2006) studied graduate CM programmes offered by the UK HE institutions to provide

insights into the required qualification in Poland. They noted the importance of the role of accreditation bodies in the UK, which have a big influence on the design of CM programmes. They developed a matrix-categorization of the various disciplines of knowledge required in CM in order to provide insights into the development of CM programmes in Poland. However, they did not further explore professional bodies' influence on the HE institutions' programmes.

In the UK, there seems to be a clear understanding about how to constitute a CM programme. This includes factors such as the needs of students in relation to their employability, the needs of government as a sponsor of academic research and the needs of the industry such as the development of soft skills. In the UK, such programmes have evolved over decades of interaction between industry, professions and both further education and HE establishments. In the absence of such a history, countries like Japan have been seeking how to develop CM programmes that are contextually appropriate. For the purpose of providing insights into the potential for CM education in Japan, a first step is to understand such contextual differences. The specific focus of this research is on educational institutions' concerns about the wider context that influences their design of the CM curriculum in UK and Japan.

METHODS

This paper builds on previous research that involved analysing and summarizing Japanese HE curricula (Mihara *et al.* 2013). To develop an overview of UK universities' approaches, their curricula were studied and interviews were conducted with academic staff in September 2013. Based on our discussions, as experienced UK and Japanese academics, interview questions were developed and sent to interviewees prior to the interviews. The questions included the following: (1) types of CM programmes offered, (2) distinct features of the university's programmes, (3) constraints and requirements of curriculum design, (4) industry's involvement in curriculum design, (5) graduate destinations and (6) contents of subjects provided. Each interview lasted from one to two hours. In parallel with the interviews, the curricula and the aims of the programme were collected from the universities' websites and brochures, as well as through direct contact with university administrators.

Four universities were targeted due to their reputation in the CM area, which have been anonymized and are referred to as A, B, C and D. Interviewees were selected from those who were engaged in the design of CM programmes. The access to these interviewees was gained through personal contacts. Due to the availability of interviewees during the first author's visit in the UK, the positions and numbers of the interviewees vary in each university. In University A, the interviewee was in charge of designing MSc programme as well as teaching undergraduate students. In University B, the interview was conducted with three personnel; the Director of Research, a BSc programme leader and a Higher National Certificate (HNC) programme² leader. In University C, the interview was conducted with the Head of School, who provided answers with regard to the operation of the school. In University D, the interviewee was involved in curriculum development as well as teaching undergraduate students.

The interview data was analysed to explore participants' major concerns in relation to the curriculum design. The specific analytical method was to code interview

² HNC is a qualification that is roughly equivalent to one year of university. Typically, those who are in employment take this course in order to get into an undergraduate course. After successfully completing the HNC, such students can gain a degree with one further year of full-time study.

transcripts to seek common themes. The themes sought were those that would help to understand the wider context that influences their design of the CM curriculum. Following the analysis of the UK universities, the curricula of three higher education institutions in Japan were compared with what was learned in the UK. The three Japanese institutions were selected as their curricula had previously been collected and reported (Mihara *et al.* 2013). Specifically, the inclusion and emphasis of each subject was compared between Japanese and UK curricula. Finally, additional clarifications were sought through questionnaires distributed to academic staff in Japanese institutions through email. The comments gained from these questionnaires are used to discuss the future development of CM education in Japan. The selected Japanese academic staff were all in charge of curriculum design.

The reason for the different methods used in UK and Japan is that the field-work was carried out by the first author, whose first language is Japanese. Interview transcripts of UK participants were needed to ensure adequate translation of the responses to questions. There was also the need to understand the institutional context. Simple written responses were adequate for communicating with Japanese participants.

FINDINGS

CM education in the UK

The interviewees' answers varied depending on their roles in curriculum development and the scales of the university. For example, University B's answers mainly focused on the differences between programmes (HNC, BSc and MSc) as the three staff were interested in discussed these differences with each other during the interview. In University B, the detailed content of subjects was not explained as the interviewee was in charge of overall programme design. In contrast, University D's answers were mainly related to how to teach students as the staff had a close relationship with a small number of undergraduate students in a teaching process.

Also, it was discovered that CM courses may or may not be separated from other courses such as Quantity Surveying, Building Surveying and Property Management. This is because the distinctiveness of these courses and their titles varied between universities. CM courses at undergraduate and MSc level were particularly focused. For example, University C offered so many different courses, all of which could not be explained during the time of the interview. These unexpected difficulties with regards to the difference in interviewees' perspectives and that in the distinctiveness of course names led to the collection of relatively inconsistent information between universities. However, this is seen as acceptable as the main purpose of this study was to explore and broadly understand the range of different perceptions with regard to the context of CM education in UK universities.

The analysis of the interview data gained from the UK resulted in the identification of UK universities' main concerns about the industrial context. First, there were concerns about the relationship with professional bodies such as Royal Institution of Chartered Surveyors (RICS) and Chartered Institute of Building (CIOB). Second was their concern about graduates' employability. The close relation between these two concerns marks the distinctive features and aims of curriculum design. This is because the accreditation of these professional bodies (e.g. RICS, RIBA) is significant in recruiting students who have certain vocations in mind (e.g. quantity surveyors, architects). Graduates who have taken accredited courses are exempt from further professional exams for membership of professional institutions, which is often a

requirement for employability. In order to gain and retain accreditation, professional bodies visit accredited HE institutions every five years to check that their curriculum conforms with contemporary professional needs.

Other themes were identified from the interview transcripts, including the balance between teaching of hard and soft skills, the regular meetings between academic staff, professional bodies and industrial professionals and the involvement of professionals in teaching. These are seen as specific means of meeting major concerns about professional bodies and graduate employment. In Table 1, these two major concerns in each university are summarized.

Table 1: Features of the UK Universities' CM education

	University A	University B	University C	University D
Identified features of the design of CM programme	Integration of broad areas of construction management	Distinction between programmes in relation to the balance of theory and practice	Two masters courses aimed for domestic and international markets	Emphasis on construction techniques
Partnership with professional bodies	CIOB/RICS	CIOB/RICS	CIOB/RICS	CIOB/ABE
Entry requirement	360 UCAS points	320 UCAS points	260-300 UCAS points	240 UCAS points
Graduate employment	Consultancy, construction companies	Consultancy, construction companies	Consultancy, construction companies, subcontractors	Regional construction companies, subcontractors

In University A, the broad range of subjects is provided in an integrated way. The curriculum includes the management of property, construction procurement and construction operations. Not only management skills, but students' technical skills are also developed, especially in relation to building surveying and the maintenance and repair of buildings. Building information modelling (BIM) was recently incorporated into the curriculum as providing opportunities to develop the students' capability to integrate technical knowledge and management skills. The aim of this university's curriculum is to prepare graduates for a career leading to a senior management position in related vocational disciplines. The majority of graduates become consultants. With the support of RICS and CIOB, as well as building surveying and property management companies, industrial placements are provided as a career development module.

In University B, the curricula were distinctive in each programme (HNC, BSc and MSc) in relation to the kinds of knowledge and skills the students need to develop. In the undergraduate course, cost management occupies a significant proportion. This is in response to the requirement for the accreditation of RICS. The accredited programmes are followed by students who aim to become quantity surveyors. In contrast, the curriculum of MSc courses emphasizes the development of skills for managing people. This is related to the strength of research area in this university. In the HNC programme, the science of construction is central, including the use of BIM. One of their challenges is to balance theory and practice in the curriculum. The University employs some academic staff who have rich work experience. Also, they regularly hold an employers' forum to seek their opinions about the curriculum. In

response to industry's needs, soft skills including communication skills and leadership were considered to be increasingly important compared with hard skills.

University C has two CM-related, MSc programmes; one is for students who aim to work in the domestic market whereas another is for students who aim to work in the international market. The university is proud of the large number of students and their variety of graduate destinations from consultancy to subcontractor companies.

Through the partnership with RICS and CIOB, professional opinions are incorporated into the curriculum with different emphasis. Some subjects reflect the wishes of RICS, while others reflect the wishes of CIOB. Regular meetings are held between academic staff, practitioners and students. Also, lectures from practitioners and from doctoral students are encouraged as a way to integrate practice, teaching and academic research.

University D's CM education reflects its history. The university used to be a technical institute catering to the local industry. Its particular emphasis on the development of industry-relevant, practical skills led to the recruitment of students with various backgrounds including construction operatives. The programmes are accredited by CIOB and Association of Building Engineering (ABE), but not RICS. This is because the minimum level of entry requirement dictated by RICS is above the level that that University can recruit. Due to this restriction, students who aim to become quantity surveyors do not normally come to this university. Instead, some graduates become building control officers as the accreditation of ABE is suitable for this profession. Active partnerships with local employers enable some graduates to be employed by regional contractors, as well as by subcontractors. The university has an industry advisory board in which people from local industry advise on programme content.

CM education in Japan

The curricula of Japanese HE CM education reveal marked differences from the UK. The study of these curricula was augmented with an emailed questionnaire sent to the participating universities for clarification of specific points. The three participating institutions have been anonymized and are referred to as E, F and G. The questions included: (1) particular features of CM education, (2) industry needs and (3) partnerships with industry.

The institutions encompass CM curricula in the Department of Architecture. This is because there is no HE education in CM outside of architecture schools. In Japanese, the term, *Kenchiku*, has an approximate translation as architecture. However, the term is much wider than this translation would imply, as it infers the whole non-civil engineering sector, including the process of building. This can lead to much confusion in making detailed comparisons.

The *kenchiku* curriculum is mainly designed under the influence of the Ministry of Education, Culture, Sports, Science and Technology (MECSST). Significantly, the Ministry sets the requirements for the curriculum in HE as eligibility requirements in relation to examinations for attaining a professional licenses include first class architect (*kenchikushi*) license and Engineering Operation Management Engineer certificate. Students mainly aim to attain the license of first-class *kenchikushi*, which is of significant importance for career development.

The selected institutions have particular features in terms of CM education. Based on the study of UK universities, Table 2 summarizes the features of Japanese HE institutions in relation to the background institutions and graduate employment.

Table 2: Features of Japanese higher education institutions' CM education

	University E	University F	Institute G
Emphasis of the programme	Large proportion of management and planning	Architecture	Construction techniques
Background institution	MECSST	MECSST	MECSST
Graduate employment	Construction, housing, architecture, real estate	Construction, housing, architecture, real estate	Construction, builder architecture, real estate

University E included a relatively large proportion of management and planning subjects in the curriculum compared with other universities. CM subjects include construction methods, construction process, building economics, building industry, housing process planning and urban design. The academic correspondent in this case stated that the Ministry's requirements for a first-class *kenchikushi* license have a major impact on curriculum design. He wrote that the curriculum benefits in developing broad architectural engineering skills including structural and services engineering as well as construction methods. He pointed out that current CM education may need to respond to a problem in the industry that architects and contractors lack a clear sense of roles and responsibilities. In terms of the partnership with the industry, he asserted that construction companies are not motivated to establish partnerships as they do not expect universities to develop students' practical skills. The companies are willing to train new employees because there is a common expectation for lifetime employment or, at least, employment for a long duration.

In University F, management subjects are not particularly emphasized in the curriculum. However, some of the academic staff carry out research in construction management. CM subjects include building economics, facilities management and process planning. These are optional subjects and not required for graduation. In response to our questions, the participants suggested that the University may be too focused on how to meet industry's needs. The partnership with industry is seen in internship schemes for students and cooperation in academic research. Our correspondent mentioned that maybe either academia or industry had not made much effort in developing the partnership because the partnership is not a necessity in Japan. He also mentioned that the requirements for a first-class architect license have a major impact on designing the curriculum.

Institute G emphasizes much more on the development of technical and practical skills. Management skills are gained from practical experience which is incorporated into the curriculum, including mock-ups of real construction processes. Internship is a required subject for graduation. A particular aim is to develop students' practical skills that will be immediately applicable in the industry upon graduation. Graduate destinations vary from builders to real estate companies. The correspondent felt that there is a lack of knowledge and skills of graduates in the Japanese construction industry. He strongly stated that, in the partnership between HE and industry, there is an urgent need to solve the problems confronting the industry.

Comparison between Japanese and British curricula

CM subjects were compared between Japanese and British curricula. Broader categories of the subjects were developed by authors to make comparison easier, interpreting curricula. As a result, the differences in inclusion or emphasis of subjects

were identified. This was analysed based on the names of subjects shown in the syllabus. The interview data and the frequency with which subjects were mentioned in each category were used to understand the difference in the emphasis of subjects between Japan and the UK. It is acknowledged that the names of subjects may not precisely indicate the content of the curriculum. For example, 'architectural design practice' may be partly included in the subject of 'project' in CM education in the UK, which does not appear as a topic in the curriculum. Also, 'industrial context' may be taught in Japanese universities depending on the research area of academic staff. Despite this limitation, the analysis still provides a basic picture of where the emphasis differs in the two countries (see Table 3).

Table 3: Comparison of curricula between UK and Japan

Categories	UK	Japan	Topics	UK	Japan
Technology	○	●	Construction technology	○	●
			BIM	●	△
			Environmental services engineering	△	●
			Construction material	○	●
Management	●	×	Construction process	●	△
			Human resource management	●	×
			Project	●	×
Design	×	○	Planning ¹	×	○
			Design ²	×	●
Basic principles	○	○	Industrial and professional context	○	△
			Engineering	○	○
			Economics	○	△
			Law	○	△
			Maths, physics, chemistry, biology, geotechnics	△	●

Key: × – Not included, △ – Mentioned, ○ – Included, ● – Emphasized

The result of the comparison provided some insights about the difference in CM education between two countries. First, management is not central in Japan compared with UK. Broader knowledge about the construction industry and human resource management are not taught in Japanese programmes. Also, construction economics and law do not figure highly in Japan. These may be considered as important subjects for graduates who are to become leaders in the UK construction industry. Second, contemporary industry needs, such as BIM, are not often seen in Japan. This is because there is not so much motivation to update the curriculum based on industry's current needs both for universities and practitioners. Third, the main subjects in a kenchiku department in Japan include architectural, structural and services engineering planning and design. This is related to the skills required for kenchikushi professions in Japan. Finally, subjects related to general science such as mathematics, physics and chemistry are included as requirements by the government in Japan. These subjects are a useful basis for learning structural and services engineering.

DISCUSSION

Difference in the background institution

It was found that the professional bodies and graduate destinations play a major role in the way that universities design their programmes. The key difference between the two nations is related to requirements for entering a professional career. The direct government control of the relevant profession is seen in Japan, by comparison with self-regulation of UK professions.

In Japan, the development of the CM curricula is restrained by the requirements for the professional *kenchikushi* license set by the Ministry. Although the number of subjects related to the management area has been increasing in a few HE institutions, these subjects are merely optional. The development of the professional skills of architects is seen as more important. Construction companies employ graduates without practical skills as they educate new employees in their own systems (interview with University E). Therefore, there is not so much motivation for both the academia and industry to develop the partnership (interview with University F). Clearly, this background context does not motivate the development of CM education.

The accreditation of professional bodies is significant in influencing the curriculum in the UK. Students aim to attain membership of the professional bodies as a result of their education in the Universities. The professional institutions tend to restrict entry to the professions to suitably qualified graduates. The particular benefit of this partnership is that this allows the curriculum to be updated according to contemporary industry needs (interview with University B). This is mutually beneficial for HE institutions and practitioners, as the industry is left to the market in the UK (interview with University C). The lack of motivation for the partnership as well as government control over the curriculum makes this updating mechanism difficult to develop in Japan.

Towards the development of CM education in a Japanese industry context

The main general contractors have been proud of managing all aspects of construction projects in Japan for decades, from safety and quality through to process management. However, the management area has been gaining recognition both in academia and industry. The role of professional institutions in influencing the curriculum in the UK may provide insights into the way that CM education might take root in Japan. It is hoped that this paper is the beginning of a more involved conversation between the CM communities in both countries.

CONCLUSION

In this research, the concerns of UK academics in designing CM curricula were investigated. Their main concerns about the partnership with professional bodies and graduate employment were found to have a huge influence on the design of the curriculum. The inclusion and emphasis of subjects were compared between Japan and the UK in relation to these concerns. The relation between HE institutions and professional institutions was found to contribute to the design of CM curricula around meeting contemporary industry needs in the UK. In contrast, the relationship between Japanese higher education institutions and the Ministry was found to develop architects' broader skills as well as restrict the development of CM education in Japan. The key finding is that, in both countries, those who regulate admission to a

professional career are the most significant in terms of the impact on the content of curricula.

This research provides insights into the study of curriculum design in relation to the institutional context. Previous research typically focused on either specific subjects in curriculum or on market needs. This study suggests that it is useful to relate the institutional context to specific subjects, in order to develop a better understanding of the academic-industrial partnership. Also, this study can be applied to investigate CM education in other countries. As a future direction of this research, the way that professional bodies influence curriculum design in the UK will be further investigated. This is expected to benefit the discussion on how to develop CM education in Japanese higher education institutions.

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CHANGING INSTITUTIONS OF KNOWING – CLIMATE MITIGATION, CRAFT COMPETENCES AND VOCATIONAL TRAINING IN DENMARK

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In order to reach the EU 2020 goals for the climate, Danish vocational training units are currently in a process of institutional change triggered by the need of providing energy, and new process competences for the skilled and semiskilled workforce active in construction. The aim of the present paper is to analyze enablers and barriers for this institutional change. The vocational education system in Denmark is strongly institutionalised with unions, employer's associations and the schools in central roles. Drawing on institutional theory contributions on labour market -, educational - and professional institutions, the paper presents a study of institutional work inside and across schools and craft disciplines working in SMEs involved in new building and renovation with an energy aspect. Collaboration between four education committees for carpenters, masons, electricians and plumbers and interviews with seven companies come to focus on competences of interdisciplinary collaboration and sustainable innovation in SME. The anticipation of future building regulation of 2015 and 2020 creates an institutional pressure in education for change including handling differentiated demands of customers and contractors, not always just following regulation but occasionally ahead of it. At a time this needs to be balanced with customer needs with a comfort orientation and issues of cost and financing. The committees act in a contradictory, sometimes conservative manner in this change of institutions of knowing. In the future specialization will be supplemented by horizontal and vertical interdisciplinary and innovative competences integrating the complex process industrialized construction sector. Schools, teachers and digital teaching materials need be developed to support this change supported by front running companies and results from innovative building projects. The education committees in Denmark can have a leading role in this development and set high and motivational standards for the improvements. The analysis sees however a lot more barriers than enablers.

Keywords: competences, craft, vocational training, energy, climate, industrialization.

INTRODUCTION

The societal task of renovating the existing building stock in Europe to meet the commissions climate targets for 2020 is tantamount (Næss-Schmidt *et al.*, 2012) and it is recognized that the development requires not only financial investment and technology, but also competences (Forsingdal *et al* 2012). In August 2013 the Danish government decided to reduce emissions of greenhouse gases by 40 % from 1990 to

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2020. The government expects this ambitious Danish climate plan can be combined with successful economic development and a conducive framework for industry. For new buildings The Danish Building Regulative 2020 will require maximum gross energy consumption at 20-25 kWh/m² per year (an implementation of the EU near zero carbon directive). One of the energy renovation initiatives is conversion of oil and natural gas boilers in existing buildings to renewable energy. Another is to reduce energy consumption in the building stock. Forsingdal *et al* (2012) calculate the need for labour to meet these new demands at 6-13,000 workers compared to the total employment in construction at around 150,000. Moreover Bertelsen *et al* (2013) pointed at the need to meet the requirement from new process industrialization changing the construction process in Denmark.

The aim of the present paper is to analyze enablers and barriers for this institutional change of energy and new process industrialization. Two main institutional processes are discerned; from within the vocational training system itself and from the companies working in the emerging energy renovation market.

The vocational education system in Denmark is strongly institutionalised with unions, employer's associations and the schools in central roles (Koch 2013). Drawing on institutional theory contributions on labour market -, educational - and professional institutions the paper presents a study of institutional work (Lawrence *et al* 2009) inside and across schools and craft disciplines as well as in energy oriented craft. Interviews with seven companies performed by the four committees for carpenters, masons, electricians and plumbers come to focus on competences of specialization, interdisciplinary collaboration and of doing sustainable innovation.

The paper is structured as follows. It opens with an overall method, followed by a framework of understanding of the institutional dynamics. The general description of the Danish vocational education and training system, followed by the empirical material first focusing on four selected education committees and second on seven selected enterprises. This is then analysed in the discussion section followed by a conclusion.

METHOD

The overall research approach is interpretive sociology, drawing on institutional theory and method (Suddaby and Greenwood 2009). The paper built on the report on the project 'Analyses of the development of new or changed energy education in cooperation between construction and installation sector' (Bertelsen *et al* 2013). The data material and analysis of this project is subsequent revisited in a sequential manner for reinterpretation (Lewis and Grimes 1999) as (micro)processes of institutional work (Lawrence *et al* 2009).

The original project was carried out in close dialog with the four main Danish education committees for carpenters, masons, electricians and plumbers. There was also an element of action research in project, as the committees supported by the author were trained to perform the analyze themselves in the following four steps: A desk research on needed competences, interviews of seven growth companies on experiences and opportunities, cooperation between the four committees on interdisciplinary competences and last how to formulate recommendations for future developments. This can thus be seen as a part of the institutional change (Dover and Lawrence 2010)

To enable and conceptualise the development process a framework of understanding of competences was presented in the beginning, drawing on the authors previous work on autonomy and innovation in construction teams in Denmark (Bertelsen 2007) and on development of construction processes in an industrialized perspective (Bertelsen *et al* 2014). The works show needs for energy specialization and new interdisciplinary and innovative competences in process industrialization, related to prefabrication. Interviews were executed with seven companies operating in the energy construction and renovation market. The interviews are executed by the four education committees guided by the author. The seven companies encompasses two carpenter's companies with around ten employees, one masons company with twenty employees, two electricians companies with 95 and 65 employees respectively and two plumbers enterprises with 62 and 85 employees. Below is selected one company for each category only. Common for the internal discussions between the four committees and the seven interviews of growth companies were applied an open questionnaire on:

- Professional competence and specialization in energy performance
- Interdisciplinary competence in horizontal cooperation and vertical controlling
- Innovation, learning and evaluation competences
- Teachers' competences, education materials and the education system as such
- Development directions on energy and industrialization trends in the market.

The limitations of the research are related to its character as action research, where the author tried to bring the four education committees in interdisciplinary interaction to inspire schools, pupils and enterprises. This involving close encounters with labour market organisation representatives, for whom the project was a political instrument.

THEORETICAL FRAMEWORK

Institutional theory is a contemporary grand theory (Thornton *et al* 2012, Lawrence *et al* 2009, Lounsbury and Boxenbaum 2013a and 2013b). Thornton *et al* (2012) is thus outlining how society from micro processes to macro structures can understood through series of interlinked institutions and institutional logics, labelled an institutional system. Here we are especially interested in contributions on labour market -, educational - and professional institutions (Cort 2011, Lieshout 2008, Koch 2013).

Institutionalist theory advocates non-rational, cultural socially constructed explanations of societal order and change. Scott (2001: 48) defines institutions as: "Social structures that have attained a high degree of resilience... [institutions] provide stability and meaning to social life... Institutions are transmitted by various types of carriers, including symbolic systems, relational systems, routines, and artifacts. Institutions operate at different levels of jurisdiction, from the world system to localized interpersonal relationships. Institutions by definition connote stability but are subject to change processes, both incremental and discontinuous..." Scott (2001) and Thornton *et al.* (2012) conceptualise institutions as consisting of three types of elements: cultural cognitive, normative, and regulative. Recent institutionalist theory departs from explaining organisational homogeneity and stability (DiMaggio 1983), and most recent contributions are interested in institutional change, and complexity understood as relations between multiple institutions. Central concepts are institutional work (Lawrence *et al* 2009, institutional logics (Thornton *et al* 2012) and institutional complexity (Greenwood *et al* 2011).

Education of skilled workers can be understood in several ways reflecting different basic institutions. Education can be viewed as a societal task and part of the basic rights of a citizen (Cort 2011). And/or it can be seen as a market demand for human

resources. Historically, education and apprenticeship was even part of a social order of the crafts, the guilds. Over the last 150 years the education of skilled workers/craftsmen has been institutionalised in multiple ways (Cort 2011, Lieshout 2008). Lieshout finds several different ways in which vocational training can be institutionalised. He points to instances of market driven training, of school driven and of "associational governance" driven pointing to a close alliance between the state, the unions, and the companies. As a particular case in point of associational governance the Scandinavian setting sees the institutionalist set up evolved into a mature field with very close and tight collaboration between the state and the labour market parties, known as corporatism (Cort 2011, Koch 2013). In these context institutions of knowing involves education system actors, craftsmen, apprentices, crafts companies and more. Institutions of knowing involve formal and informal forms of knowledge and competences within and across crafts. Koch (2013) suggests that these labour market institutions in Scandinavia have been remarkably resilient to continual undermining by US and global management and production concepts tainted by liberal and individual institutions of production and knowledge.

The vocational education and training institutions (VET) have not only survived but maintained their position seen over long time spans even if operating in a complex and multiple institutional contexts. Lieshout (2008) on the other hand suggests that these labour market institutions risk stagnation if not continually renewed in a manner responding to the contradictory demands of state (EU), building industry, citizens, youngsters and other interests. Koch (2013) posits that part of the institutions resilience lies with their ability to span from micro to macro in the labour market set up. Lieshout (2008) similarly explains the German and Dutch system like that, yet point out at the state of Wisconsin is an exception as a vocational education system has been maintained and developed over long time without the macro governance frame provided in Scandinavia, Germany and Holland.

There is therefore a resonance between the challenges of the institutional set up of VET and the development of institutional theory and the change in activities and performance in the construction industry. Here we are in particular interested in the interplay between bottom up and top down dynamics, which usually keeps the institutions of knowing together and also put them under pressure. More specifically the institutional work approach (Lawrence *et al* 2009) have proposed to appreciate the micro processes of maintaining, destabilising, developing new institutions, which here lead to looking at how small enterprise development might contribute to the development of VET or differs from larger enterprises in development strategy.

INSTITUTIONAL WORK IN VOCATIONAL TRAINING

The vocational education system in Denmark is as mentioned a mature field, strongly institutionalised with unions, employer's associations and the schools in central roles (Koch 2013). The Danish continuing vocational education (C-VET) (in Danish "AMU") are well-functioning systems serving a triple purpose according to the Ministry of Education:

- To improve competence according with the needs of the labour market
 - To contribute to solving market restructuring problems in short- and long-term
- To give adults the possibility to upgrade competences for the labour market.

The C-VET programme in Denmark is funded almost entirely by the state. As indication at present the Danish building sector employs some 92,000 skilled workers educated in the C-VET system and 41,000 unskilled workers compared to the total

employment at 157,000 (Forsingdal *et al* 2012). There are at present 11 educations within building and construction, encompassing plumbing, masonry, carpenters, electricians and more. In-company training in Denmark takes up 60-75 percent of the training period, compared with only 15 percent in Sweden (Cort 2011). Moreover when it comes to vocational training for employees, the enterprises get a wage refund as a participation incentive from both state funds and competence funds financed from the labour market agreements. Hence there should be the best circumstances for C-VET in the building industry. Despite this - the building industry does not use the system sufficiently bearing in mind the needed energy skills and future market demands. Especially the industries occupied with insulation and building envelope lack participation whereas plumbers and electricians have more enrolment in C-VET due to certification requirements. Furthermore it is a basic assumption in the recent 'Status Quo 2012' (Forsingdal *et al* 2012) that the Danish C-VET needs modernization, if competencies in the building sector are to fill the necessary role with regard to the individual specialist workers and craftsman and the performance of the system itself. In relation to the growing specialization of the workforce and the quantity of prefabricated building parts the need of interdisciplinary competence is growing. If this modernization fails it will constitute a fatal barrier to fulfilment of the Danish 2020 climate plan. Forsingdal *et al* (2012) highlights central points of weakness:

- There is a lack of cross sectorial understanding between the different specialist areas
- The contractors have a tendency to approach building projects in a fragmented way and not in a holistic way as clients and users typically do
- There is often a lack of understanding between architects, engineering consultants and contractors, and this compromise the expected energy savings.

Education institutions and labour market parties

Despite Forsingdal *et al* (2012)'s well-placed problematization of the VET system, their result also shows that there is more focus on energy efficiency in the courses of the vocational training institutions than previously, reflecting a gradual reform from within the system (Bertelsen *et al* 2013). Also training of craftsmen in occupation has evolved in this direction. The competence framework of understanding by Bertelsen *et al* (2013) encompasses professional competences (growing specialization), interdisciplinary -horizontal and vertical- competences, innovation competences, teachers' competences and understanding of building cultures, sustainability and industrial building. The analysis involved co-contributions and dialogues with representatives from the education committees set up nationally to enable the associative governance (Lieshout 2008). Below the position taken by each committee is summarized following the competence typology.

Carpenters committee

Carpenters' professional competences will in the future probably need to have more focus on building physics and knowledge on materials and their interplay. It is likely that the craftsmen need interdisciplinary competences but increased cooperation could also be realised through management. Leading carpenter enterprises are today able to build according to the energy demands for 2020 and handle the changed processes that it involves. Innovation competences should therefore support that. The vocational school should prepare for new types of cooperation and processes and the teachers' competences need continual development.

Masons committee

The masons' education committee found that the masonry craft already possessed the professional competences. Moreover the committee found that interdisciplinary competences would be very dependent of other crafts conservatism. The innovation competences were understood as more of a need for the common institutions put in place such as information councils, to be better at communicating. Teachers' competences would need the schools management to act in a sanctioning manner, as teaching material on energy renovation within masonry is already in place. The understanding of building cultures tend to be a nostalgic notion on the previously more important role of brick wall, yet new regulation actually enables a new way of making brick walls.

Electricians committee

Electricians' professional competences are today specialised over a wide set of topics, while at a time there is a new tendency to group contracts on related areas into bulk contracts. This might lead to new demands for interdisciplinary competences. The electricians' education committee found that innovation competences should be built at the vocational schools, and that teachers competences should be develop to support that. Indirectly that approach disregards the innovation challenges electricity contracting enterprises face also related to issues of sustainability and new industrialization.

Plumbers committee

Like the electricians' the plumbers' education is today split in a larger number of specializations also in the plumbers areas one can witness large HVAC companies doing broader contracts leading to new kinds of coordination. This could lead to demands for new interdisciplinary competences. The plumbers committee is in line with the electricians in their view on innovation and teachers competences etc.

Energy renovation growth enterprises

The other central institutional dynamic is the market development of new energy renovation solutions and services. These generate demands for new competences which in a Danish context should be articulated as demands for education and training in the VET run by the state and given the institutional logic that education is a right for the citizen. Small and medium sized companies are very important parts of the Danish building sector, which is much more fragmented than for example the Swedish. Below is given illustrative examples from the interviews of the seven companies. We do not cover all dimensions of competences i.e. professional competences, interdisciplinary competences, innovation competences, teachers' competences and understanding of building cultures, sustainability and industrial building.

Carpenters

Enterprise no 1 has recently shifted main emphasis from new built to renovation, which in 2013 was roughly 70 % of their turnover. They sense ambivalence among the customer and act accordingly.

"We typically built according to the 2015 regulatory demands but off course we have begun looking forward towards 2020. But this is not part of running operations. We know 2020 is coming and that one should be ready. But it is at present not what we strive at with regards to generating turnover. This is also based on our experiences with what the customers will pay for at present. Our experience is that the customers' intentions are really, really good and everybody asks in detail about it. Two years ago

we did not hear the word energy in the same way, as we do now. When the customers' comes to us today, then we hear the word energy every other time. But when the offer comes.... Then there is a tendency that people decline... they have to invest a lot of money now. In some areas it is not only 7-10 years of pay back but considerably longer. So it is an act of balance." (Bertelsen *et al* 2013)

In terms of innovation they see themselves as "not inventing the wheel." Again a middle of the road positioning, with not too radical insulations demands, education and training of employees are an internal process, and they do not draw on the C-VET system. As the interviewee comments: "I wouldn't even call it courses." (Bertelsen *et al* 2013)

Masons

Enterprise no 3 a masonry company interviewed are repudiated as being innovative and growing. At present they have sixteen employees. They cannot at present compete with prefabricated detached houses, which are considered lower prices (and can be low energy consumption compliant). On the local energy renovation market of detached houses the company has been able to sell a series of outer add on insulation with cladding. The company is participating in several projects on energy renovation, but is not using the VET system for competence development.

Plumbers

Enterprise no 4 put emphasis on a joint identity. To develop that they use a particular organisation of groups "around" a first line manager. Internal training is used to support the development of common identity. Energy renovation and other innovation do not play a large role in this company. When competence needs emerge, they would usually turn to the supplier, for example in the case of heat pumps. Moreover C-VET courses are used to a limited extent.

Electricians

Enterprise no 7 has been able recently to sell systems for monitoring of energy to their regular customers, on which their business is completely based. Enterprise no 7 views themselves as relatively connected to tradition, *yet also* have expertise in KNX, IHC and LON (standards for communication). They also emphasise interdisciplinary skills. Use of C-VET does not get mentioned at the interview.

DISCUSSION

The process of setting the institutions of knowing in motion is complex and feature institutional work in a kind of top down - bottom up fashion as one main axis. The top down institutional process involves inside and across schools and representatives of craft disciplines whereas the bottom up derives from energy oriented craft based SMEs involved in new building and renovation with an energy aspect. The top down element occurred through the education committees' position in the issues of energy competences. It is interesting to note that even within the committees put in place to enable a continual reform of the vocational training, there is clear examples of conservatism. In this case it is played out especially with the electricians and plumbers committee, but the other committees' also encompasses elements of preservative forces contributing to maintaining the existing institution. Moreover the proposals appear routine like and does not reflect much incorporation of contemporary trends in the building sector. The interviews with the SME companies show that they operate pragmatically within and outside the energy renovation market. The anticipation of future regulation of 2015, 2020 creates an institutional pressure (and legitimation) in

education for change on the company which they clearly sense. This includes handling differentiated demands of customers, not always just following regulation but occasionally ahead of it. At a time this needs to be balanced with customer needs of comfort, convenience cost control and financing. Moreover technical aspects such as airtightness are also proliferated, pointing at orchestrated competences rather than merely isolated innovation, commercial or technical competences. The direction of this institutional work is therefore ambiguous and used in a political manner both for advocating change/disruptions of the institutions of knowing and for maintaining them.

Table 1: The education committees' evaluation of needed competences

Competences:	Committees:			
	Carpenter	Mason	Plumbers	Electricity
Professional competences:				
1. Knowledge of building physics, materials and the interaction	+			
2. Sustainable construction, energy efficiency and renewable energy			+	+
3. Competitive construction methods and new energy solutions	+	+	+	
4. Competence in integrated and total construction solutions			+	+
Interdisciplinary competences:				
5. Horizontal cooperation and responsibility for the final building	+	+		
6. Energy solutions guided by customer needs and open boundaries			+	+
Innovation competences:				
7. Information on innovative and use of digital teaching materials		+		
8. Develop new and more effective processes and constructions	+			
9. Innovation a central part of the pedagogical model and education			+	+
10. Competence in optimization, resource reduction and efficiencies			+	+
Teachers competence and teaching materials:				
11. Teaching in interdisciplinary competences and development	+			
12. Teaching in new energy competence in progress but too slow		+		
13. Problem-based learning and complex innovative solutions			+	+
Competences in new process industrialization:				
14. Sustainable building requires reinvented skills and educations	+			
15. Total energy reduction, architecture and producer cooperation		+		
16. More fitting, smart houses and consumer linked via Smart Grid			+	+

The findings thus come to focus on competences of cross disciplinary collaboration (point 5, 11) and of doing sustainable innovation (point 2, 3, 6, 10, 14). Even if considered as growth companies the interviewed SMEs also run into barriers. Renovation tasks by customers might be "convenience renovation", meaning punctual renovation, only initiated by the owner or real estate administrator where absolutely needed (Koch *et al* 2014). Moreover many craft enterprises appear to prefer status quo in their way of operating, which is surfacing in other investigations (Koch and Buser 2009). It appears that both the vocational training system and the enterprises are

exercising a type of combined ambivalent supplication (Parkin 2010). Parkin (2010) in her conceptualisation of business and organisational sustainable leadership describes a point of departure for companies from traditional ways of doing business, which continues observing sustainability in a very reactive manner, exercising “ambivalent supplication” where sustainability is still an external factor that has to be justified and different from core business strategy (Parkin 2010). Here neither the enterprises nor the vocational training system are entering revolutionary change. Rather the two processes of institutional work largely resonate with each other in a slow precarious reform moving the institutions of knowing into sharing the supplication.

This leads to the observation that there is a risk of vocational education institutions stagnation if they are not able to respond appropriately to the new competence demands of the energy renovation transformation and new industrialization of construction processes. As the multinational companies such as Schneider Electric by now operate business models on energy renovation making alliances and networks with SME electricians that encompass energy training and competence development it is not unlikely to envisage a fundamental jolt of the corporative vocational training system. It is a composite set of institutional logics that is in play impacting on the development of the vocational training, encompassing the state (EU), building industry, citizens, youngsters and other interests. Daudigeos *et al* (2013) finds an equal composite picture of institutional logics at health and safety in construction, also leading to a near deadlock.

CONCLUSIONS

This paper set out to discuss enablers and barriers for an institutional development of the vocational training system in Denmark responding to the need for competences in energy renovation of the existing building stock. Even if renewal of courses and educations do occur from inside the vocational education and training system, an institutional maintenance seems to be the main agenda for the education committees. They are reluctant in their engagement with the energy question. Similarly the enterprises operating in energy renovation do this in a pragmatic and relatively slow fashion. Together these top down and bottom up institutional work processes that the education committee, the crafts and the enterprises engage in appear to practice ambivalent supplication to the future zero energy regimes, thus largely maintaining the institutions of knowing. We interpreted this status as risky and possibly leading to stagnation of the vocational education and training system. A series of initiatives within the institutions in the future might mitigate this risk.

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THE CONSTRUCTION SMES DEVELOPMENT DEBATE IN SOUTH AFRICA: CONTRIBUTIONS FROM FET COLLEGES

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The why, when, and how to engender contractor development in South Africa has been interrogated in recent years. Various authors have proposed one panacea or the other without considering the possible contributions of Further Education and Training (FET) colleges in the country. The research identifies key factors that influence how FET colleges are able to facilitate the development of successful construction small and medium size enterprises (SMEs) in South Africa. A survey of the literature was followed by an empirical study, which generated the primary data. A survey was initially conducted among registered construction SMEs, and then interviews were conducted with academics who are employed at FET colleges. The findings indicate that FET colleges serve a multidimensional purpose by producing qualified artisans, who produce quality workmanship in their specific trades and who are capable of establishing successful businesses. Based upon the findings, it can be concluded that FET college structures can provide the foundation for SME development programmes in South Africa. It is therefore recommended that the syllabi for contractor development programmes (CDP) and construction programmes in FET colleges should align with one another in order to develop a specific programme for construction SME development.

Keywords: contractor development, education and training, South Africa.

INTRODUCTION

According to Ranjit, Mwanaumo and Nkado (2011), the South African construction industry is still in a transitional state of change. This is evident due to the fact that the construction SME sector needs to be assisted in terms of capacity building, training and business advice monitoring and counselling. In light of this, Contractor Development Programmes (CDPs) have been adopted and introduced in the South African construction industry. The adoption has been promoted to identify and remove the constraints affecting the development and performance of construction SMEs (Construction Industry Development Board (cidb), 2011a). This paper recognises the challenges that are faced by the current model, which drives contractor development and introduces FET colleges as a possible contributor thereto. The data that has been

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analysed was obtained from the literature, questionnaires, and transcribed interviews. The results emanating from the analyses suggest that FET colleges should be considered as possible contributors in the training and education of contractors in South Africa.

Overview of CDPS IN SOUTH AFRICA

According to the cidb (2010; 2011b), the National Department of Public Works (NDPW) has provided leadership in contractor development since the inception of the democratic government in 1994. Initially, the NDPW established the Emerging Contractor Development Programme (ECDP) to advance entry for primarily black contractors into the construction industry through direct government contracting (cidb, 2010; cidb, 2011c). The ECDP was conceptualised by the government of South Africa to improve job creation in the public sector. The ECDP thus gave government the opportunity to enhance contractor development initiatives through the Vu'kuphile Programme.

However, the ECDP and Vu'kuphile Programmes are primarily skills development based and were implemented through a learnership programme (cidb, 2010; 2011c). The cidb (2010; 2011c) further postulates that the NDPW initiated the Contractor Incubator Programme (CIP) in order to shift the contractor development focus from small contracts to more substantial contracts and to higher levels of contracting. The conceptualisation of the CIP by the NDPW was based on principles of advanced enterprise development. The principal motive is to improve the overall performance of contractors in their regional bases; to improve the ability of local contractors to compete with international construction firms; and to promote and improve the use of efficient labour intensive methods (cidb, 2011a: iv).

Apart from the programmes which have been mentioned, several other government departments and construction industry role players / stakeholders have also developed CDPs, which include, inter-alia:

- Vukuzakhe Contractor Development Programme;
- Sakhasonke - Limpopo and Eastern Cape DPW;
- Stepping Stone - Western Cape DRTPW;
- The Mpumalanga Department of Public Works, Roads and Transport Programme (Sakha'bakhi Contractor Development Programme);
- Kubakhi- Gauteng DPTRW;
- Integrated Emerging Contractor Development Model: IECDM - Eastern Cape Development Corporation;
- Contractor Development - Royal Bafokeng Economic Board;
- Masakhe Contractor Development Programme (KwaZulu-Natal Department of Public Works);
- The Small Enterprise Development Agency (SEDA) Construction Incubator (SCI) Programme;
- The Polokwane Local Municipality Contractor Development Programme;
- The Free State Department of Public Works and Rural Development Programme;
- The Free State Department of Police, Roads and Transport Contractor Development Programme;
- Western Cape Department of Transport and Public Works Siyanyuka Contractor Enhancement Programme, and

- Northern Cape Department of Roads and Public Works Contractor Development Programme.

In addition, the cidb (2011c) mentions that these CDPs were implemented with the model indicated in Figure 1, which is explained in terms of:

- Programme Strategy and Targeting: this section of the model deals with the establishment of targets for contractor development, criteria for inclusion, exit strategy and the criteria for graduating from the programme;
- Contractor Assessment: this section of the model deals with the screening of incoming contractors against a criterion in order to evaluate the prospective contractors current skills and development level;
- Work Opportunities: this section of the model deals with providing the contractor with sustainable work, through appropriate procurement strategies;
- Training and Mentorship: this section of the model is responsible for providing the contractor with theoretical and practical training, mentoring, and an enabling environment;
- Evaluating and Exiting of Contractors: this section of the model is responsible for continuously evaluating the contractors' achievements against the predefined performance standards, and
- Monitoring and Evaluating of Programme: this section of the model is responsible for evaluating and exiting the contractor from the programme based on the graduation criteria achieved, which relates to skills / qualifications and certifications.

Generic Model for Contractor Development

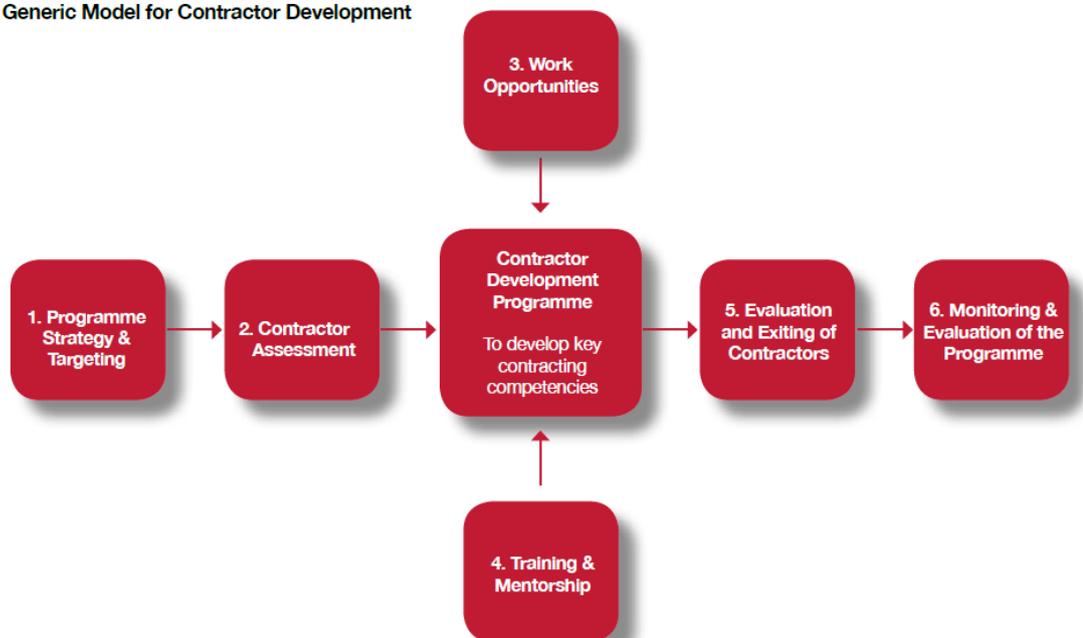


Figure 1 Generic Model for Contractor Development (Source: cidb, 2011c: 15)

Implementation challenges of CDPs in South Africa

With the development and implementation of CDPs, the cidb (2011a) has highlighted a number of challenges which have impeded their success rate. These challenges include:

- The rationale for the programme: most CDPs do not have a clear rationale for initiating the programme, which inevitably leads to poor implementation and outcomes. The lack of clearly defined objectives translates to poor implementation, monitoring and evaluation;
- Absorptive capacity of the programme: CDPs do not effectively match the number of contractors on the programmes with the available resources;
- Contractor selection: for most CDPs, the selection process of participating contractors are open and transparent, however many CDPs do not have selection criteria that enables the identification and selection of the contractors that demonstrate the most potential to be developed. According to the cidb (2011a), this is the most cited reason for the apparent lack of success of many contractors that exit the programme;
- Funding for the programme: funding for many CDPs is not prioritised during the conceptualisation and planning phase, but only addressed at the implementation phase of the programme which is often too late;
- Human resources: the majority of CDPs do not have sufficient staff with the required skills for contractor development units. Programmes are often overstaffed with inappropriate staff or understaffed;
- Monitoring and evaluation of contractors: the majority of CDPs do not implement progress monitoring and evaluation of the contractors or use contractor assessment tools to gauge their development. This makes it difficult to evaluate contractors' progression or to prepare for their exit from the programme;
- Training and skills development: most CDPs struggle to put in place properly structured training and skills development initiatives. This is due to the lack of funding or unskilled personnel for training, and
- Mentorship: most CDPs acknowledge the need and importance of mentors; however they struggle to implement it due to a lack of sufficient funding, few mentors, qualified mentors, and the high mentor to learner contractor ratios.

These challenges pose a pertinent question to stakeholders in South African construction. The question is 'Can FET colleges produce employable contractors through CDP programmes for clients in South Africa?' The response to this question would underline the role of FET colleges with regard to CDP programmes in South Africa.

FET college contribution to contractor development in South Africa

According to Maharaswa (2013), technical colleges were established in the industrialisation era (1920s) to deliver apprenticeship programmes in order to produce artisans. However, in the 1980s the world oil crisis as well as globalisation affected the college sector. The resultant effect of the crisis is a decrease of apprenticeship and training opportunities. These events brought about increased interest in South Africa for trading purposes and exerted pressure on the government as shown in the following changes:

- The Manpower Training Act 1981 was established and facilitated racially inclusive access to skill opportunities related to artisanship, and
- More technical colleges were subsequently established in the rural and peri-urban areas of the country.

According to Maharaswa (2013) and Makole (2010), transformation of the college sector came about post 1994. This was endorsed by the White Paper 4, which was

titled: A programme for the transformation of FET. Thereafter, the FET Act 98 of 1998 was enacted to be replaced by the FET College Act 16 of 2006, which has subsequently been amended to transfer the FET College functions from Provincial competence to the Department of Higher Education and Training (DHET) in 2009 (Maharaswa, 2013). Between 2001 and 2003, 152 technical colleges in South Africa merged to form 50 mega FET Colleges in pursuance of efficiency and improved access to intermediate skill and learning opportunities. Makole (2010) says that FET Colleges all over South Africa offer three distinct training programmes, which include:

- The National Technical Education Diploma (NATED) programme;
- The National Certificate Vocational programme; but more importantly, and
- The occupationally directed Learnership programme that lends itself to the development of artisans.

The learnership programme

According to the Skills Development Act No. 97 (Republic of South Africa, 1998), a learnership is an alternative form of training, which consists of a structured learning component and practical work experience of a specific nature (bricklaying, plastering, and plumbing) and duration and culminates in a full qualification registered with the South African Qualifications Authority (SAQA). It targets learners who are already employed as well as learners who would like to enter the workplace. In light of this, the programme has been designed in a unique way to form a contractual agreement between three parties (Republic of South Africa, 1998). The agreement is illustrated in Figure 2.

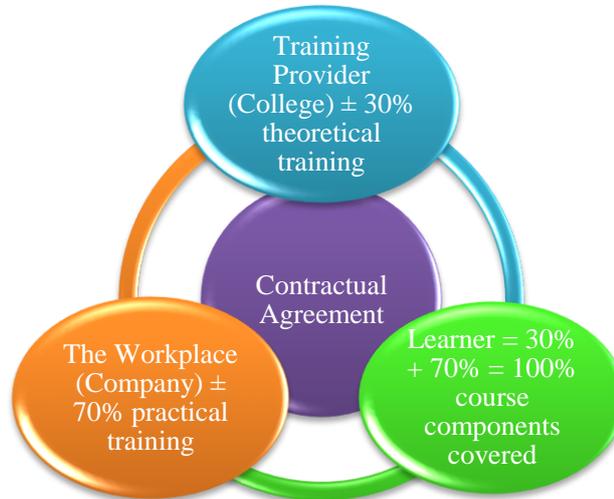


Figure 2 Contractual Agreement between the Parties involved in a Learnership Programme (Source: Republic of South Africa, 1998: 11)

In order for the learner to successfully exit the programme, it is imperative that he / she attends the programme, and adheres to all contractual arrangements agreed on in Figure 2, which also demonstrates the programme structure. On completion of the learnership, with an additional eighteen months of practical training in a specific trade, the learner will automatically qualify for an artisan trade test or could progress to professional and other qualifications (Republic of South Africa, 1998).

With the contractual agreement and the programme structure illustrated and explained above, Lensing (2014) is of the opinion that learnership programmes offered at FET colleges and the model that guides its implementation, seen in Figure 3, bears great resemblance to the generic model for contractor development. Lensing (2014) further suggests that learnership programmes are not focused directly on contractor development, although FET colleges have the necessary infrastructure, facilities, and budget that could cater for the development of construction SMEs. In other words, the challenges of CDPs can be addressed when they are offered by FET colleges.

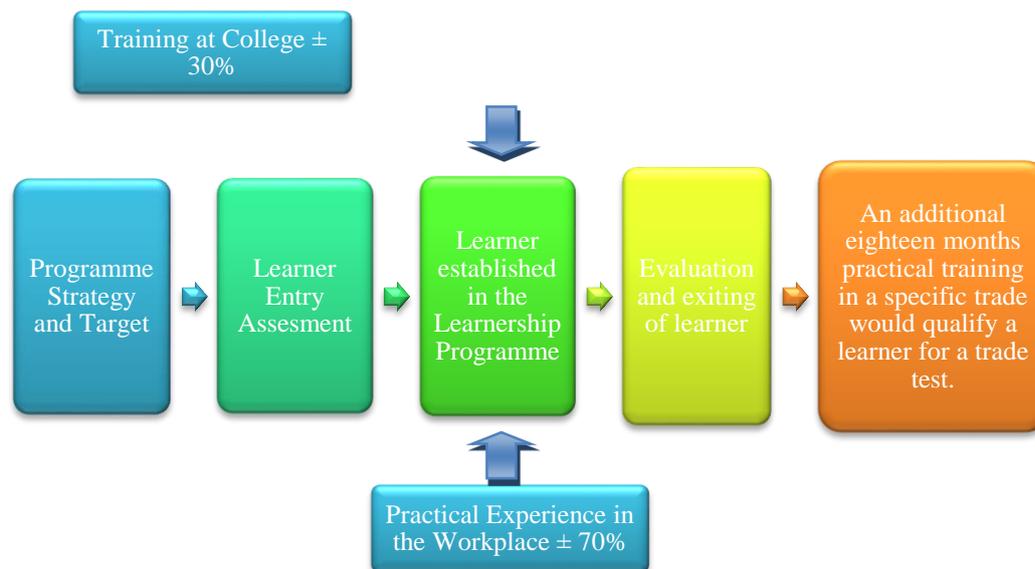


Figure 3 Learnership Programme Implementation Model (Source: Lensing, 2014)

Khan and Lootz (2014) further support this argument by suggesting that CDPs will be well housed in the FET sector as the sector forms a collaborative partnership with higher education institutions, Adult Education and Training and the Skills Development Sector. These sectors currently form one band under the DHET and provide a powerful basis for addressing education and training in an integrated way.

RESEARCH METHOD

The mixed method used open-ended questionnaire surveys and interviews as research tools. By utilising open-ended questionnaire surveys and interviews as research tools for this study, the researcher was able to identify subtle nuances and avoid inducing responses, which may occur when using predominantly close-ended questionnaires (Greenfield, 2002).

Questionnaire administration

An initial questionnaire survey was administered among construction SMEs to investigate if they had ever attended CDPs and if 'Yes', to further investigate if there were any shortcomings with regards to the CDPs that they had attended. The data for the survey were collected from 50 registered construction SMEs, based in Cape Town. The semi-structured questionnaire had six questions, which pertain to specific CDP elements. A mix of closed and open-ended questions was utilised. The administration of the questionnaire was based on a purposive sample. A total of 50 questionnaires were administered of which all 50 were useable, which equates to a 100% response rate.

Interviews

Thirty academics that are employed at FET Colleges were interviewed in the study. The main objective of the interviews was to sample the opinions concerning if FET Colleges should host and implement CDPs in South Africa. A combination of semi-structured and unstructured interview methods were employed to enable maximum input from the interviewees while allowing data to be collected uniformly (Bloor and Wood, 2006). The interviews gave the researcher the opportunity to develop and analyse the parts of the project that needed to be considered in a more detailed way. In the first part of the semi-structured interview, the interviewer went through a set of questions (pro-forma) through which the necessary data were collected. During this process, the interviewee gained a better understanding of the research undertaken and developed a rapport / trust which was essential for the second part of the interview (Hesse-Biber and Leavy, 2006). During the second phase, the interviews were unstructured, thus catering for an in-depth discussion over an area, which during the first phase was identified as of additional value to the research. It should however be noted that the interview participants were also purposively selected.

Data collection challenges

It should be noted that there were some challenges with regards to the questionnaire survey. This was due to minor interpretation issues, which were made evident by certain respondents. This dilemma did not pose a real threat to the research study as questions were clarified and eventually answered. However, a small delay in terms of the data collection was observed. The interviews had no challenges as questions were asked and answered uniformly.

DATA ANALYSIS AND FINDINGS

Questionnaires

The data obtained from the questionnaire is presented using simple interpretive and descriptive methods. Table 1 provides the summary of responses to the questionnaire survey questions. Table 1 indicates that all the respondents have attended some sort of CDP. This is evident due to 100% of the respondents answering “yes” to the question. In response to second question, 65% of the respondents said that there was no entrance criteria for the CDPs that they have attended, although 35% were unsure with regards to this question. In terms of CDP staff competency levels, 50% of the respondents were of the opinion that staff employed to facilitate CDPs are incompetent, 30% said they were competent and 20% not unsure if the facilitators were either competent or not. With regards to the monitoring and evaluating processes that should take place during CDPs, 80% of the respondents were of the opinion that this key aspect was never implemented. Only 20% agreed that these processes were in place. When asked the question, if CDPs were adequately structured, 60% said no, 25% said yes and 15% were unsure. The last question asked respondents if there was any mentor assigned to them during and after the programme, 80% said no and 20% said yes.

Table 1: Summary of responses to the questionnaire survey questions

Question	Response (%)		
	Yes	No	Unsure
1.1 Have you attended any CDPs?	100	0	0
1.2 Were there any entrance criteria for the CDP which you attended?	0	65	35
1.3 In your opinion, was the staff that facilitated the CDP competent?	30	50	20
1.4 Were you ever monitored or evaluated during the CDP?	20	80	0
1.5 In your opinion, was the CDP adequately structured?	25	60	15
1.6 Were there any mentors assigned to you during and after the CDP?	20	80	0

Interview responses and findings

In response to the questions, which examine if the interviewee knew what the term ‘CDP’ stood for in the South African construction context, all the academics that were interviewed knew what CDPs were and gave significant feedback with regards to the challenges, which are currently faced by CDPs in South Africa. The majority of the academics were of the opinion that CDPs tend to suffer in certain areas, which are unlimited to:

- The rationale for the programme;
- Curriculum development;
- Skilled personnel;
- Monitoring and evaluation of contractors after the programme has ended;
- Mentorship during the programme;
- Proper infrastructure, and
- Funding which could be caused due to one of two things: lack of prioritising funding during the conceptual stage, and corruption.

In addition, most of the interviewees concurred that the main reason for the challenges is due to the lack of recognition by government that CDPs form part of an educational compliment, which in essence should be conducted at educational institutions, such as FET colleges. Most of the interviewees further mentioned that it would be ideal to train and develop construction SMEs through CDPs hosted at, and integrated in FET Colleges. The interviewees justify their opinion by stipulating that currently FET Colleges across South Africa offer a number of programmes, some of which are practical, and others which are more theoretical in nature. One of the programmes is the building and civil engineering learnership programme, which is mandated by national government and the DHET to produce more skilled workers to practice as plumbers, bricklayers, and plasterers. It is from this proposition that the interviewees are convinced of the potential of FET Colleges to contribute to contractor development in South Africa. This is underscored by the FETs having the necessary infrastructure, budgets, and systems, as well as the ability to create opportunity with regards to industry stakeholders and statutory bodies which will support the

development of construction SMEs. Furthermore, the interviewees are of the opinion that by utilising FET Colleges to house CDPs, more structured learning, training and development will take place.

DISCUSSION

The findings with regards to the questionnaire survey as well as the interviews clearly manifest the implementation challenges experienced by CDPs in South Africa, which in essence are highlighted by the cidb (2011a) in the literature review. Based on the findings, these challenges clearly amplify that CDPs, which are currently being implemented by industry stakeholders and statutory bodies are clearly not well structured and organised.

As the findings postulate, this is due to government's inability to recognise that CDPs form part of an educational compliment, which in essence support the argument of Lensing (2014) and Khan and Lootz (2014) that CDPs should be promoted within the FET sector as it has the necessary infrastructure, budgets and systems as well as the ability to create opportunity with regards to industry stakeholders and statutory bodies which will support the development of construction SMEs.

As an overview to the research findings Makolo (2010) is of the opinion that FET colleges should be considered as a key driver to the development of the South African construction industry, through the graduation of competent construction SMEs.

CONCLUSIONS

The study has shown that it is evident that current CDPs are experiencing a number of critical challenges in South Africa. These challenges directly affect construction SME development as they are the ones attending the programmes. This raises the debate in terms of the dismal failure rate experienced by many construction SMEs and their business development. It is with this concern that FET Colleges are considered as a potential significant contributor to contractor development. From the research findings, it is evident that FET Colleges have the necessary infrastructure to house and present CDPs. However, it should be noted that the research study reported on is in its initial phase and the findings are best described as 'exploratory', as future studies should realise more conclusive results.

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LESSONS LEARNED FROM BUILDING THE EDUCATION REVOLUTION (BER) PROGRAM BY THE SOUTH AUSTRALIA CONSTRUCTION FIRMS

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In response to the global financial crisis (GFC) in 2009, Australia undertook to mitigate the crises through the development of the National Building and Jobs Plan. Part of this plan for the construction industry was the commencement of Building Education the Revolution (BER) projects which comprised over one per cent of Australia's Gross Domestic Product (GDP), a massive outlay of expenditure to be delivered over a rapid time frame by a number of construction organisations. Despite the crisis, there have been limited studies conducted to document the effects of BER, and how construction organisations responded to the challenges. This paper aims to explore the lessons learnt from the strategies implemented by the construction organisations during that BER period. A mixed method approach was employed for the study. Data was collected from of 48 organisations using questionnaires, and two interviews were conducted to validate the findings. The following five lessons learned were identified: (i) the potential for high profits existed which brought about an increased requirement for careful resource management; (ii) the preservation of existing client base is crucial for post stimulus survival; (iii) threats and risks are brought about by stimulus and require consideration and planning; (iv) stimulus in the construction provides an opportunity to build an organisation's reputation; and (v) learning from the changes in competitor behaviour should be undertaken throughout stimulus; and by undertaking further research into strategic management, a sixth lesson was identified: (vi) organisations must re-address their business strategies post stimulus to adjust to their new external environment conditions. Given that there have been few stimulus implementations in the South Australian construction industry; the identified successful strategies based on the lessons learnt from the BER could assist construction organisations in undertaking and maintaining work post stimulus, despite the cyclic nature of the industry. The research was localised to the South Australian construction industry.

Keywords: South Australia, organisational learning, global financial crisis, stimulus package.

INTRODUCTION

The Building the Education Revolution (BER) program comprised over one per cent of Australia's Gross Domestic Product (GDP), a massive outlay of expenditure to be delivered over a rapid time frame. According to Althaus (2012), some 10,500 building projects were approved for 7,900 schools within seven months of the Australian

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government's decision to establish the program. The same study by Althaus (2012) established that this rapid injection of money through school building development was an intentional approach implemented through the lessons learnt from the 1990 recession stimulus.

As the BER projects consisted of simple projects ranging from \$0.25m to \$3.0m in size, a large proportion of these projects with few exceptions, were undertaken by Tier 2, 3 and 4 builders as stated in the BER Task Force Interim Report 2010. Therefore it can be concluded that the BER program was specifically aimed at construction companies operating in the Tier 2, 3 and 4 levels of the Construction Industry throughout Australia. However in 2013 the most of, if not all the BER projects had been completed and, according to the Australian Construction Industry Forum (2013), those sectors exposed to the BER scheme would experience a decline in output. For example, it was envisaged that in South Australia's non-residential construction sector, the current slump would continue into the next decade with little change. This had left the sector in a position where work was scarce and tendering became highly competitive. The upshot of this scenario and forecasted by the Australian Construction Industry Forum, (2013), was that there was never been a more important time for business involved in the construction industry to understand and forecast work over the next 10 years.

While the Australian government should be commended for measures undertaken during the global financial crisis (GFC) in 2009, such as the development of the National Building and Jobs Plan, the short term fix of fiscal stimulus aimed at construction industries posed great risk to contractor's inexperience in dealing with the associated problems and follow on effects. As observed by a recent study conducted by WT Partnerships (2013), within the context of South Australia, there continues to be relatively few public sectors projects as compared to the pre-BER period and the financial problems of the State Government are regularly aired in the media (WT Partnerships (2013, pg. 8). The observation above calls for further exploration and determination of the success of the BER and its effects on the wider economy. While previous research has been undertaken to establish the effects of the BER across a number of Australian states (Australian Government, 2010), the shortcomings associated with those studies were that the research was conducted either during the BER or soon after the completion of the BER project. This approach had its limitations as the full extent of these effects was not known although it's acknowledged that the end of a project is consequently the end of collectively learning (Schindler and Epper, 2003 pg. 220). Secondly, the studies failed to investigate the effects of the BER on construction organisations other head contractors. It should be noted that the construction industry in South Australia is made up of several types of organisations of various sizes including architects, consultants, head contractors, sub-contractors and suppliers.

There is therefore, a need of exploring and understanding the full effects of stimulus packages such as the BER on the South Australian construction industry. The theoretical underpinnings of this study is based on 'organisation learning' and 'strategic management' principles and concepts which would require further examination to provide a strategy which a construction organisation can implement during future stimulus package to create a sustainable competitive advantage post stimulus. The present study is aimed at filling the knowledge gap by conducting a survey among the stakeholders within the South Australian subcontracting sector. It is

aimed at exploring the lessons learnt from the strategies implemented by the construction organisations during that BER period.

The rest of the study is structured as follows: The following section presents and summarises a review of the literature on economic stimulus and the BER projects. Following the review is a summary and identification of gaps in the impact of the GFC and relevance of BER knowledge. This is followed by the mixed methods methodological approach adopted for this research study. An explanation of the statistical methods employed for the quantitative part of the study and associated techniques for analysis of the qualitative data, as well as interpretation of the findings are presented. The final section addresses recommendations made and conclusions.

THIS SECTION SHOWS SOME AVAILABLE STYLES

Economic stimulus and the BER

This section seeks to explore and review the linkages between economic stimulus and BER. Prior to exploring the linkages the following definition of ‘economic stimulus’ is highlighted: According to Pettinger (2010), economic stimulus involve a government attempting to boost the economy out of a recession. A good example of how the government can increase spending stimulus could be through the National Building and Jobs Plans and specifically the BER as undertaken in Australia. The same study by Pettinger (2010) identified the following two mechanisms by which the stimulus packages could be implemented as through expansionary monetary policy or expansionary fiscal policy. Drawn upon international examples from Canada, the construction industry in Canada followed a similar economic pattern to Australia after the GFC. According the Construction Sector Council (2009) study, stimulus targeted building design that would utilize a wide range of materials which in turn generated jobs in other industries. Like the Australian stimulus package, this package set out to impact local economies across the nation by injecting cash and improving employment.

Lessons learnt within the construction industry

There is a plethora of ‘lesson learned’ studies in the construction industry such as measurement tools for capturing lesson learnt in form of project reviews (Kululanga and Kuotcha, 2008; Fuller *et al.* 2011); Barriers to conducting lessons learned in terms of capturing the knowledge lessons learned (Collinson and Parcell 2001; Carrillo *et al.* 2004; and Schindler and Eppler 2003); as well as studies highlighting the benefits of lessons learned such as the main sources of knowledge in construction industry (Rezgui *et al.*, 2010), alongside recorded documents, experiences and interactions. However, despite the benefits, a recent study by Shokri-Ghasabeh and Chileshe (2014) aimed at identifying barriers to effectively capture lessons learned in Australian construction industry established that, there is a lot to done to encourage and convince construction organisations to adopt lessons learned. From the review of the literature, it could thus be argued that while lessons needed to be learnt in the South Australian construction industry as to how fiscal stimulus such as the Building Education Revolution affects organisations and how they should adapt to the volatile economic conditions stimulus packages create, the barriers and appropriate measurement instruments associated with capturing lesson learned should be taken into account when examining the BER projects. Furthermore, lessons also needed to be learnt as to how construction organisations can survive in the depressed construction industry post stimulus.

RESEARCH METHOD

To explore the lessons learnt from the strategies implemented by the construction organisations during that BER period, the following mixed methods approach involving quantitative methods (through survey questionnaires), and qualitative approaches obtained through two interviews as conducted were employed in the study. The aim of the interviews was to validate the findings.

Measurement instrument and pilot study

The questionnaire distributed to the South Australian construction contractors (SACC) comprised two distinct sections as follows: The first section of the questionnaire was composed of 5 questions. The demographics question included the categorical variable, nominal in nature and associated with the business type of respondents. The remainder of the questions were dichotomous in nature that asked for a 'yes / no' response, and sought the background information on the BER. The second section was designed to identify the strategies adopted by the respondents during BER, and ascertain the impact of post BER (i.e. turnover, planning). The majority of the questions were dichotomous type, as is associated with nominal data, whereas two questions associated with management of the BER projects, lesson learnt and strategies post BER project required open ended responses and the BER impact question was measured using a 3 Point likert scale (where 3 = Agree, 2 = Do not agree, and 1 = Unsure). According to Champney and Marshall (1939 cited in Matell and Jacoby, 1971), there are different schools of thought on whether using a higher number of points on the Likert scale increase the validity and reliability of the instrument. The same study suggested that the optimal number of steps is a function of the conditions of measurement. Given that the need to simplify the options for the respondents, and only one question required a Likert type of response, this study adopted a Likert scale of only three points as this wouldn't affect the overall reliability and validity of the measurement instrument. The data was subjected to frequency analysis using the *Statistical Package for Social Sciences* (SPSS) computer program. As opined by Forza (2002), this type of analysis is relevant and generally obtained for nominal variables when the objective is to ascertain the number of times various subcategories of certain phenomenon occur (Forza, 2002, pg. 182). A pilot survey was distributed to two professionals working within the South Australian contracting organisations. The professionals had vast experience within the industry, and the main purpose of the pilot study was to ensure that it could be completed in minimal time and that no obvious or irrelevant questions were included. Forza (2002) outlines the justification for this approach, and highlights the specific role that colleagues and industry experts provide such as the prevention of inclusion of obvious questions and determining whether the questions accomplishes the objectives.

Characteristics of the sample (quantitative study)

The targeted respondents were drawn by the probability strategy of 'random sampling' from a list of sub-contracting organisations that were available to the authors by virtue of tenders submitted. While it was not known 'a priori' the actual number of organisations that had provided products or services for BER projects, it was assumed that this would be determined by the survey. In addition, those targeted had been operational for more than five years, and had experience providing services for BER projects. Four hundred and six questionnaires were sent out by post and 48 were returned. This resulted in an overall response rate of 11.8%. While this number might be deemed as small when compared to the overall population of over 1000

organisations in South Australia, in comparison with previous construction related study undertaken in South Australia (Newton and Chileshe, 2012), this was deemed to be adequate. For example Newton and Chileshe (2012) used a sample size of 75. Similarly, when compared with previous studies published outside Australia such as Lim and Ling (2012); Yong and Mustaffa, (2012), this sample size was adequate, and further complimented by the qualitative data. On the contrary, the study by Lim and Ling (2012) only had a sample size of 32 respondents whereas Yong and Mustaffa (2012) employed a smaller sample size of 14 respondents. In both studies, only the quantitative approach was employed. Furthermore, as asserted by Coviello and Jones (2004 cited in Yong and Mustaffa, 2012), if high-quality survey data are obtainable from smaller sample drawn using well-developed selection criteria, meaningful findings can still be generated (Yong and Mustaffa, 2012, pp. 547). Table 1 provides a background of the respondents according to the type of the organisation. As indicated in Table 1, the majority 62.50% (30) of the respondents were employed by a subcontracting organisation, followed by 33.33% (16) drawn from the head contractors. The significance of the respondents being drawn from the subcontracting sector was through provision of valuable data which had not previously been researched. The obvious omission of professionals drawn from the 'architectural firms' and 'government departments' was largely due to the limited number of questionnaires sent to that group. While this result might be disappointing, however it poses no great impact on the results of the survey.

Table 1: Profile of study sample (organisational type)

Type of organisation*	Frequency	%	Cumulative
Subcontractors	30	62.50	62.50
Head contractors	16	33.33	95.83
Engineering consultant	2	4.17	100.0
Total	48	100.0	

Notes: *The survey document also has options for selecting the 'Government department' and 'Architectural firm'

Architecture firms and government departments make up only a small proportion of the South Australian construction industry.

Study protocol (Qualitative approach)

The interviews set out to achieve a greater understanding of the strategies implemented by organisations during the BER as well as the lessons learnt as a result of those strategies. As stated by Brinkmann and Kvale (2009), the main aim of the conducting interviews was to understand the research issues from the interviewee's perspective in order to discover information from participants prior to scientific interpretations. As this study was focussed on determining the professional's experiences over the last five years (post BER), ultimate success of the interviews were dependent on building trust between the researcher (Fellows and Liu, 2008).

Profile of interviewees

The profile of the two interviewees according to the designation, and brief description of their respective organisations are shown in Table 2. As can be seen from table 2, although the two organisations offered completely different services, the effects and risks their organisations were exposed to during the BER are very similar. Consequently, many of the strategies which were and could have been implemented apply to both organisations.

Table 2: Profile of Interviewees headings

Interviewee	Position	Description of organisation and interviewee
A	Managing director	Tier 2* type of Head contracting organisation: Had built approximately 23 BER projects and employed more than 45 people during the BER Implementation process. However, the number of employees had since decreased to 30 post BER
B	Senior estimator / construction manager ¹	The interviewee has been actively involved in the South Australian construction industry for over 20 years. The organisation contributed their services to 12 BER projects.

Notes: ¹At the time of BER, the interviewee was employed by a tier one electrical organisation operation as a subcontractor for projects ranging in size from \$(AUS) 500,000 to \$50m; *Classification of Tier 2 organisation implies one that is able to bid for projects worth up to \$10m in contract value.

SURVEY RESULTS AND DISCUSSION

Experience with BER Projects

To ensure that the respondents had a first-hand experience with BER projects, and were familiar with the stimulus package, one of the questions posed was whether the organisation that the respondents had worked for provided services to the BER projects. The majority 92% (44) of the participants provided services to BER projects. The implication of this finding is that it ensured that the results from the study and participants were accurate and informative.

Impact of the GFC and BER on the Private Sector

Many effects of the BER solely revolve around the diminishing input of the private sector. The majority 87.5% (42) of the constructional professionals agreed that the private sector of the no residential constructions was yet to recover whereas an equal number comprising the minority 6.25% (3) did not agree and were 'unsure'. This finding is consistent with literature as evidenced from the recent report by the WT Partnerships (2013). While the study by WT Partnerships (2013) was aimed at the public sector, there are many underlying effects that the failure of the private sector has had on construction organisations. The review of the literature demonstrated that in order for organisations to adjust to the effects, redundancies were made and were going to continue. For example, the survey found that the majority 56.3% (27) of the respondents were employed by an organisation that had made redundancies over the past 18 months. While the review of the literature implied that government stimulus was the cause of these redundancies, they are many other factors which might have contributed to the sudden decrease in construction employment.

Construction professional's perception on the linkages between 'redundancies' and 'BER'

In order to explore the linkages between associated effects of BER and redundancies, the following question was posed: "If yes [to BER as the cause of redundancies], do you think redundancies were required to adjust decreased availability of work and fierce competition created by the completion of the BER?". The majority 77% (37) of the respondents believed that redundancies in their organisations were caused by the decrease in availability of work largely due to the completion of the BER stimulus package. The emergent implication of that finding is that, the sudden decrease in post stimulus has had a major effect on the level of employment in construction organisations. Furthermore, the literature review highlighted that for every \$1m spent

in the construction industry, seven jobs would be created whilst up to 37 jobs outside the construction industry could be created. This suggests that there were [is] potential for the construction industry to have the reverse effect post stimulus when the demand for construction is completed.

Strategies implemented during the BER

Table 3 summarises the strategies adopted by the organisations during the BER. As can be seen from Table 3, just half (52.08%) chose the second strategy where organisations selectively chose BER projects whilst operating within their capabilities. On the contrary, 22.92% (11) of the organisations expanded to increase turnover. The general perception that was found through the review of the literature was that most organisations expanded to unsustainable levels. Yet, it is interesting to note that the most dominant strategy found through this study and survey was ‘to operate within capabilities of the businesses.

Table 3: Strategies adopted during BER

Strategy	Frequency	%
1. Attempted to secure many BER projects, increase no of employees, increase resources an turnover	11	22.9
2. Selectively chose BER projects and worked within organisational capabilities	25	52.0
3. Stayed away from the BER projects all together and focussed on private sector clients	7	14.5
4. None of the above	5	10.4
Total	48	

One possible explanation for this strategy was that it posed less risk. A recent study (WT Partnerships, 2013) highlighted the linkages between the unsuccessful strategies and poor management creating the “roller coaster” turnover during and post the BER.

Findings from the qualitative study

The 16 questions as posed to the interviewees comprised the following two groups: (i) six ‘during BER’ related; and (ii) ten ‘post BER’. The six questions associated with ‘during BER’ ranged from the business values leading up to the GFC; strategies adopted; management of HRM; aims and objectives towards the BER; to perceptions about profit margins. The ten ‘post BER’ questions evolved around planning for decreased activities in the private sector of non-residential construction; sustainability of strategies and values; identification of threats and risks; valuable lessons learnt to perceptions of whether their competitors had changed.

Lesson one: The potential for high profits and the increased requirement for careful resource management - Interviewee A’s organisation attempted to treat the BER as a bonus to their normal workload and turnover whereas Interviewee B’s organisation did not experience profits of 20% in the second round of BER, they however implemented a careful strategy to prevent any unsustainable growth. As a result, Interviewee B’s organisation still grew by around 15% in terms of employment. The second lesson was “*The preservation of existing client base is crucial for post stimulus survival*”. One of the most difficult challenges that the head contractors, consultants and architects faced with during the BER was attempting to maintain the private sector clients.

Lesson three: Identifying the threats and risks construction organisations were exposed to during and post the BER - The emergent risks were the amounts of demand

for construction [Interview A] whereas, Interviewee B identified ‘working outside their capabilities’. On the contrary, the threats to the organisations post stimulus were deemed as quite opposite with excess supply and insufficient demand as the main drivers for increased competition.

Lesson four: *A chance to build an organisation’s reputation* - Interviewee A identified the SA construction industry as one of the most difficult construction industries to operate in. “We could successfully manage the construction of 99 projects, however if we’re unsuccessful in one, our reputation could be ruined”. Notwithstanding that observation, according to Interviewee A: “Many organisations focused on building as many BER projects as possible which comprised their quality and resulted in a loss of reputation”. Interviewee B shared the same sentiments and further observed that the BER provided an avenue for building reputations, valuable long term relations.

Lesson five: *Learning from the changes in competitor behaviour* – During the stimulus packages, new programs such as the BER resulted in new competitors entering the market. As observed by Interviewee A, the head contractors were under pressure from both categories of contractors (smaller and larger). Interviewee A agreed that learning off your competition had proven to be just as important and noted: “I have seen many builders pushing the limits and have grown too big too fast. You must know your limits and learn off the organisations that break theirs”. The fifth lesson should be undertaken throughout stimulus. By undertaking further research into strategic management literature, a sixth lesson was identified as follows: *organisations must re-address their business strategies post stimulus to adjust to their new external environment conditions.*

LIMITATIONS

While the study makes several contributions to strategic management through examination of theoretical concepts such as ‘resource based view’ which informed the examination of the ‘external’ and ‘internal’ environment analysis, and secondly, contributions to ‘other organizational learning strategies’ underpinned by the ‘experienced based and outcome based learning’, some limitations should be noted. This first limitation relates to the ‘localisation’ of the research to the South Australian construction industry, and therefore the research findings may not reflect other Australian States and Territories. Future studies should be extended to construction organisations across Australia as well as employing larger samples. The second limitation relates to the lack of consideration of a number of factors that might have contributed to the failure of the private sector of non-residential construction to recover. In the main, these included the following: (i) the end of the mining and minerals boom; (ii) the political uncertainty of the 2013 federal elections; (iii) interest rates and reduced borrowing capacities; and (iv) other economic conditions other than the stimulus package which has affected the construction industry over the past five years (2009 – 2013). The third limitation was associated with the sample size of the interviewees. However, despite this shortcoming, the inclusion of organisations as such Head contracting provided some additional insights in validating the empirical findings. Future studies should employ a larger sample size of interviewees. The study further acknowledges that the strategies implemented by construction organizations, often takes into consideration a large number of variables and external effects, and that this study was limited to considering only those strategies which have been largely influenced by only the implementation of fiscal stimulus in the industry.

CONCLUSIONS AND RECOMMENDATIONS

The study explores the lessons learnt from the strategies implemented by the South Australian construction organisations during that BER period. The key emergent findings established from the study were as follows: (1) The private sector significantly decreased during the stimulus implementation and was yet to recover in South Australia; (2) Redundancies were made post stimulus in order for organisations to adjust to the decrease in workloads largely created by the completion of stimulus an excess supply of construction organisations; (3) The BER is largely responsible for the increase in competition post stimulus; and (4) The price of construction has now fallen, with the decrease in margins in turn creating project quality problems for subcontractors and head contractors attempting to operate with low margins. However, the survey further uncovered that all organisations did plan for the decrease in the private sector post stimulus. Previous research undertaken emphasised that not enough construction organisations planned for the forecasted slump, however this was clearly wrong. Some recommendations are further proposed: The major shortcoming identified in this study was the lack of strategic management (see Table 3) implemented by construction organisations post stimulus. The construction industry seems to be in a depressed state where organisations are waiting for the demand for construction to increase. Against that background, it is recommended that construction organisations There is a need for further research to explore the relationships between the identified must readdress their strategies focussing on the core aspects of creating a sustainable competitive advantage in construction organisation. Future studies could then be extended to examining how organisations in other industries achieve this, and testing the applicability of those best practices strategies within the construction industry organisations.

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