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CRITICAL DELAY FACTORS IN HOUSING CONSTRUCTION PROJECTS IN SAUDI ARABIA: ASSESSMENT AND SOLUTIONS

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DECLARATION

This thesis was submitted according to the rules and regulations of the University of Nottingham Trent to award a PhD by research. I certify that this project or any project that has not previously been partially or fully submitted as a paper document for obtaining a degree at any other university. I affirm that the intellectual contents of the work are the results of my efforts, and the ideas taken from other people are identified and identified by the reference.

Signature: 

Date:07 January 2021

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ABSTRACT

Given the Kingdom of Saudi Arabia's (KSA) current housing shortage, the government recently made substantial investments in public-sector housing projects across the country. To maximise the efficiency of these investments, the problem of construction projects delay must be overcome. Therefore, this research project identified delay factors in public-sector housing construction projects in the KSA, and proposed solutions for mitigating or avoiding the construction delays.

The main aim of the study is to assess housing projects in the KSA, in terms of delays in the construction phase, and to develop a comprehensive framework based on the analysis of the delay factors (such as client-related, consultant-related, etc.) to mitigate or prevent their occurrence. The study highlights the importance of delays in construction and provides a complete review of issues of importance in terms of concepts, principles and challenges. In addition, the literature was reviewed through an effective survey to find out the causes of delays in order to build general knowledge of delayed construction projects.

A mixed-method research design was adopted involving a literature review, surveys, interviews and case studies. The primary data focused on the delay factors contributing to housing projects delay in the KSA's construction industry, as well as viable solutions. Data analysis involved descriptive statistics and thematic analysis, and the participants were clients, consultants and contractors in the KSA's construction industry. Consequently, more than 80 delay factors were identified, then classified into 10 groups and ranked in terms of their severity.

A conceptual framework has been developed to advise on the processes that stakeholders should embrace in housing construction projects. Whereas, the solutions identified were used to generate an evidence-based framework, which practitioners can use to mitigate or avoid delays in housing projects. Key aspects of the solution may include the use of building information modelling (BIM), review and assess the government's role in housing projects. Furthermore, all stakeholders should take measures to prevent and reduce delay in housing projects, by promoting FIDIC contracts, establishing an independent planning board, integrating training and awareness initiatives, and eventually implementing the proposed conceptual framework.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

BIM	Building Information Modelling
B-BIM	Bidding and procurement - BIM
BTSP	Building Technology Stimulus Programme
BRE	Building Research Establishment
BREEAM	Building Research Establishment Environmental Assessment
LEED	Leadership in Energy and Environmental Design
C-BIM	Construction – BIM
CI	Competitive – BIM
CPM	Critical Path Method
D-BIM	Design - BIM
EPD	Evidence for Policy Design
Estidama	Sustainability in Arabic
GAS	General Authority for Statistics
GCC	Gulf Cooperation Council
GSAS	Global Sustainability Assessment System
KSA	Kingdom of Saudi Arabia
FIDIC	International Federation of Consulting Engineers
MEP	Ministry of Economy and Planning
MLSD	Ministry of Labour and Social Development
MMC	Modern Methods of Construction
MOF	Ministry of Financing
MOH	Ministry of Housing
PBRS	Pearl Building Rating System
PMI	Project Management Institute
SD	System Dynamics
SEC	Saudi Engineering Council
SENS	Saudi Environmental Society
SGBC	Saudi Green Building Council
SLR	Systematic Literature Review
SPSS	Statistical Package for the Social Sciences
TLR	Traditional Literature Review
UPC	Urban Planning Council
USGBC	UNITED STATE Green Building Council
PPP	Public-Private-Partnership
HKHA	Hong Kong Housing Authority

WTO	World Trade Organisation
MEP	Ministry of Economy and Planning
UPC	Urban Planning Council
PBRS	Pearl Building Rating System

CHAPTER 1: INTRODUCTION

1.1 Overview

Infrastructure development in Saudi Arabia in two decades has significantly improved various aspects of citizens' lives. The government has initiated diverse projects for its citizens' convenience. For example, new and modern housing projects have improved the standard of living across the country. The government has further ensured that such projects are undertaken in all parts of the country.

From 2010 to 2014, the Kingdom's Cabinet approved the 9th Development Plan with a budget of 20 billion Saudi riyals (over £4 billion) for housing and services and infrastructure development (MOF, 2019). The development plan aims to complete the preparation and adoption of a comprehensive housing strategy and accelerate its application. Furthermore, it should reduce the growing gap between the demand and supply for housing. In 2011, King Abdullah announced a SR250 billion proposal to construct 500,000 home units (in many cities such as Riyadh, Jeddah, Jizan, etc.) to address housing shortages among lower-income citizens (MOH, 2019). It reflected the sustained efforts by the government to undertake projects to improve the infrastructure in Saudi Arabia (KSA). Moreover, the government has enacted regulations to facilitate the projects and prevent any disruptive activities in the projects' implementation. Nevertheless, a number of projects have experienced delays in their completion, even though the contractors involved possess classification certificates issued by competent government authorities (MOH, 2019).

Moreover, Assaf and Al-Hejji (2006), reported that infrastructure projects in the KSA experienced delays due to disputes mainly between clients and contractors. Furthermore, Al-Khalil and Al-Ghafly (1999) reported, about 60% projects in the KSA's Eastern Province witnessed delays over a period of ten years. In addition, among a group of construction projects, 20 projects were randomly selected, the average range of delay in these projects was about 110% of the planned project duration.

Thus, the delay in construction industry in the KSA is inevitable. Delays became the norm, with local industry gaining a negative reputation (Sweis et al., 2008). The negative image of this delay in the construction industry has stimulated many researchers and professionals to explore the subject (Assaf and Al-Hejji, 2006; Sweis et al., 2008; Al-Kharashi and Skitmore, 2009).

1.2 Justification

The Kingdom of Saudi Arabia is experiencing a rapid population growth, which increased the need for housing. Moreover, for more than three decades, the government supported citizen ownership of housing through the Real Estate Development Fund program. This allowed nearly a million citizens to own homes by renting out through contracts, this was a viable solution but insufficient.

Furthermore, numerous factors like increased population growth and a shortage in available housing units have worsened the housing crisis in the KSA. While King Abdullah unveiled a plan in 2011 to build 500,000 new housing units, the project was not implemented in time due to various issues, such as the lack of infrastructure (MOH, 2019). In addition, the allocation of assistance was a problem, and the process became a complex bureaucracy. Conversely, construction in the residential segment enjoyed a steep rise, as the value of residential construction properties rose for the sixth consecutive year in 2012, according to data from Saudi Arabian Monetary Authority (SAMA, 2019), by up to 11.4% per year to SR95.6 billion.

Numerous studies (A-Kharashi and Skitmore, 2009; Alaghbari et al, 2007; Assaf and Al-Hejji, 2006) have identified main causes for delays in construction projects in the Kingdom of Saudi Arabia:

- High costs of materials, due to the unsatisfactory purchasing decisions,
- High costs of subcontractors,
- Poor contractor and subcontractor relations,
- High insurance costs due to damage to equipment or materials and inadequate safety practices,
- Low-profit margins or loss due to construction volumes.

These causes may appear in the construction phase, which lead to the project delay or its suspension. In addition, they contribute to the emergence of social and economic problems at the same time.

Nowadays, there is a fundamental pillar in the housing industry, which is the importance of the sustainability integration throughout the life cycle of the project that contributes to an efficient development of housing and ensures a balanced life for the residents.

Sustainable housing is linked to integrating energy and environmental issues into an acceptable economic and social framework. This integration is taking into consideration all aspects of sustainability at various stages of the project development which are design, construction, operation and maintenance.

Furthermore, BIM contributes to solving problems at all project stages. It is a process that gives construction professionals the insight and tools to more efficiently design, construct, and manage housing projects.

Table 1.1 provides information on housing projects in Saudi Arabia and most of the projects encountered problems during construction. There are projects with a 100% completion rate and projects with a low completion rate (20 - 45%). Some delays were unjustified, prompting the Ministry to suspend some of them (MOH, 2019). The reasons for these delays are unknown, as well as who is responsible for them, while delays are limited to one or more of the project parties (Client, contractor or consultant). In fact, the multiple projects simultaneously for the Ministry of Housing led to weak control over them. In addition, the review of all projects in the table below showed there was no application for any sustainability requirements (MOH, 2019).

But according to the vision of Saudi Arabia 2030, the government will move toward more sustainable housing development. Therefore, this vision will be taken into account in the developed conceptual framework based on the results drawn from the Saudi market.

Table 1.1: The KSA Housing projects (MOH, 2019)

Project name	Start date	Duration time	End date	Completion rate	Project product*		Sustainability requirements
					House	Block	
Khayber	Feb 2010	2 years	Mar 2012	53% after 2 years (Delay)	149	0	N/A
Buraidah	Mar 2010	2 years	Apr 2012	59% after 2 years (Delay)	381	0	N/A
Haferalbatin	Aug 2009	3 years	Aug 2012	64% after 3 years (Delay)	900	0	N/A
Alaflaj	July 2011	2 years	July 2013	30% after 17 months (Delay)	127	0	N/A
R. Alkhabra	Jan 2012	2 years	Jan 2014	0% after 11 months (Delay)	92	0	N/A
Qunfuthah	Dec 2009	3 years	Dec 2012	12% after 26 months (Delay)	593	0	N/A
Traif	Oct 2009	2 years	Oct 2011	26% after 2 years (Delay)	342	0	N/A
Mubarez	Apr 2012	2 years	May 2014	0% after 8 months (Delay)	116	95	N/A
Rumah	Apr 2012	2 years	Apr 2014	0% after 7 months (Delay)	82	88	N/A
Rafha	May 2010	2 years	May 2012	7% after 2 years (Delay)	328	104	N/A
Alshunan	Feb 2011	2 years	Mar 2012	34% after 21 months (Delay)	111	950	N/A
Arar	May 2010	3 years	May 2013	4% after 31 months (Delay)	254	361	N/A
Alkhuber	May 2010	2 years	June 2012	59% after 2 years (Delay)	272	0	N/A
Zulfi	Sep 2011	2 years	Sep 2013	6% after 15 months (Delay)	250	250	N/A
Amleg	Sep 2011	2 years	Sep 2013	10% after 15 months (Delay)	359	359	N/A
Onaizah	Feb 2011	2 years	Feb 2013	12% after 22 months (Delay)	340	367	N/A
Ahssa	May 2011	2 years	June 2013	20% after 18 months (Delay)	0	1518	N/A
Hail	Apr 2010	3 years	May 2013	27% after 32 months (Delay)	1040	720	N/A
Taymaa	May 2012	3 years	May 2015	0% after 7 months (Delay)	388	388	N/A
Nabhanyah	Feb 2012	2 years	Feb 2014	7% after 10 months (Delay)	90	403	N/A

Dawadmi	Apr 2012	3 years	April 2015	0% after 8 months (Delay)	501	735	N/A
Thadeq	June 2011	2 years	July 2013	0% after 18 months (Delay)	115	99	N/A
Alkhurmah	Aug 2010	2 years	Aug 2012	13% after 2 years (Delay)	260	260	N/A
AlQuryat	Oct 2009	2 years	Oct 2011	52% after 2 years (Delay)	225	18	N/A
Aloaynuh	June 2012	3 years	June 2015	0% after 5 months (Delay)	316	196	N/A
Shaqraa	Jan 2012	2 years	Feb 2014	0% after 11 months (Delay)	250	235	N/A
Tabuk	May 2010	3 years	May 2013	55% after 32 months (Delay)	901	0	N/A
Albkairyah	Nov 2010	2 years	Dec 2012	23% after 2 years (Delay)	100	0	N/A
Majmaah	Feb 2012	2 years	Mar 2014	0% after 10 months (Delay)	440	0	N/A
Almuthneb	Mar 2012	2 years	Mar 2014	0% after 9 months (Delay)	100	0	N/A
Shmasyah	Nov 2010	2 years	Dec 2010	14% after 2 years (Delay)	78	22	N/A
Oyoon	Sep 2011	2 years	Oct 2013	9% after 15 months (Delay)	76	24	N/A
Alrres	Oct 2010	2 years	Nov 2012	41% after 2 years (Delay)	100	0	N/A
Alolaa	Aug 2010	2 years	Sep 2012	20% after 2 years (Delay)	201	0	N/A
Albada'a	Oct 2010	2 years	Nov 2012	31% after 2 years (Delay)	102	0	N/A

*Project product: Products offered by the Ministry of Housing (Homes & apartments)

1.3 Aim and Objectives

Firstly, the main aim is to explore and investigate the factors of delay in the housing construction projects in Saudi Arabia and reduce or prevent the delay causes by providing new approaches and practical solutions by developing a framework.

The aim of the project translates and can be measured against the following objectives:

- Identify and classify the factors of delay and their causes in the Housing Sector projects in the KSA,
- Analyse and evaluate delay causes in the Housing Sector projects in the KSA,
- Study the sustainable agenda in the housing sector in the KSA and its impact on delays in housing construction projects,
- Develop a framework that improves quality and develops effective management methods by proposing solutions that minimise delays in construction projects.

1.4 Contribution

During the research process there will be a wide range of literature and insight on the topic of the housing construction in the KSA. This needs to develop an appropriate research method to obtain sufficient and relevant data. Furthermore, the quantitative and qualitative data will require a consistent analysis on delays

in the KSA housing projects. Therefore, the key data will contribute to knowledge and suggest a practical framework to mitigate and reduce delay in the construction phases.

1.5 Assumptions

This study explores the thinking and experience of professionals about practical work, the surveys and interviews revealed explicit and implicit reasons for the delay in housing construction projects. Similarly, the survey and interviews will be conducted in a neutral and non-judicial manner.

1.6 Thesis Structure

The research is divided into eight chapters starting with the first chapter, which addresses the purpose of the research. The last chapter discusses suitable solutions for research.

Chapter 1:

This chapter provides an overview of project delays around the world and addresses the Saudi Arabian context, focusing on the most critical factors in the delay of these projects. The research aim is highlighted along with the objectives, research justification, limitations and assumptions. Lastly, the measures taken to adhere to ethical research practices are described.

Chapter 2:

This chapter discusses the literature review of construction delays in general and in Saudi Arabia in particular and provides a review of key topics related to field concepts, principles, and challenges. The literature review is based on previous studies in this field, as well as books, articles and official sites. Also, this chapter assesses the most common delay factors and limitations of the proposed solutions.

To preserve the environment, sustainable building standards will be discussed according to the housing market in Saudi Arabia.

Chapter 3:

The third chapter reviews the research methodology. It begins with an introduction to various research strategies, methods and philosophies. Moreover,

this chapter presents various methods for collecting and analysing research data, and clarifies the mechanisms used to evaluate the data sets.

Chapter 4:

This part of the research presents the data extracted from the survey. These data reveal how the sample interacted with the research by answering the survey questions and determining the most serious delay factors.

Chapter 5:

This section is about semi-structured interviews, it reflects the extent to which respondents are aware of delays in projects. The sample consisted of consultants, clients and contractors.

Chapter 6:

In this chapter, research is conducted to find out the relationship between delay factors and sustainability. This relationship is verified by case studies. Then compare the two studies to find the real factors that support the success of projects.

Chapter 7:

In this section, the conceptual framework. This framework was created after data acquisition and analysis in the previous sections. Then explain how the conceptual framework works to contribute to reducing or eliminating project delays. In addition, an explanation of the project construction phase and the relationship between stakeholders and how it works in these stages to reduce delays.

Chapter 8:

In this section, the conclusion, limitations and recommendations. The conclusion contained how the objectives of this research were achieved. This investigation was done through mixed methodologies in data collection. As for the restrictions mentioned again in this section due to what was experienced during the research process, appropriate recommendations were made.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

In this chapter, the intention of the literature review was to support the development of a conceptual framework and practical solutions to construction delays. Additionally, by detailing and discussing the research work of other writers, this literature review offers insights into the main research problem. This chapter identifies relevant studies addressing the subject of the factors which cause delays in construction projects, and it presents a detailed discussion of each finding. It also identifies studies that support the actual research and illustrates the gaps that these studies lacked to address. Therefore, it examines studies and discusses the nature and causes of delay factors in housing construction projects.

The research gaps identified in this literature review will contribute significantly towards consolidating the main aim of this research. The evidence explored throughout this chapter forms the basis of future discussions. Furthermore, relevant studies are presented to assist the current research with pertinent data and findings that will be analysed. At the end of the review, other researchers' areas of focus identify preliminary information to help guide the next chapters of this study.

2.2 KSA's Construction Industry

Compared to other developed or developing countries, the KSA's construction industry is still in its start-up period on the industrial scale. Despite this, profits can still be made in both the public and private sectors, which are influential within the industry. According to Al-Sedairy (2001), the public sector consists of financing and managing government projects. These projects work towards the construction and development of KSA. Contrastingly, the private sector consists of projects that are either privately-owned or funded by all private firms in KSA. Shoult (2006) stated that in Saudi Arabia, construction has moved in direct correlation with accelerating economic growth, principally backed by oil exports. Furthermore, he reported that 80% of the KSA's economy is connected to oil exports, the implication being that construction activity generally rises and falls in tandem with the price of oil.

In December 2005, the KSA joined the World Trade Organisation (WTO), allowing the construction market to reach out to international organisations. As a result, the country's GDP grew to become the largest in the Middle East. Due to increasingly rapid population growth, the demand for affordable housing is rising across the KSA, thereby cementing a prosperous future for the country's construction sector.

In 2008, the Saudi Ministry of Economy and Planning (MEP) released a report stating that 9% of the national GDP was generated from the construction sector in the past decade. Then the government paid great attention to this increase and turned to the construction sector through continuous stimulus. Oil prices contributed directly to the construction industry in Saudi Arabia (fluctuating up and down). Therefore, the annual output was increasing and decreasing in the whole year affected by these prices.

At the end of 2008, the construction sector was 7% of Saudi national GDP, outperforming many sectors (MEP, 2019). So, the government implemented new projects with huge budgets, the most important of which is housing construction.

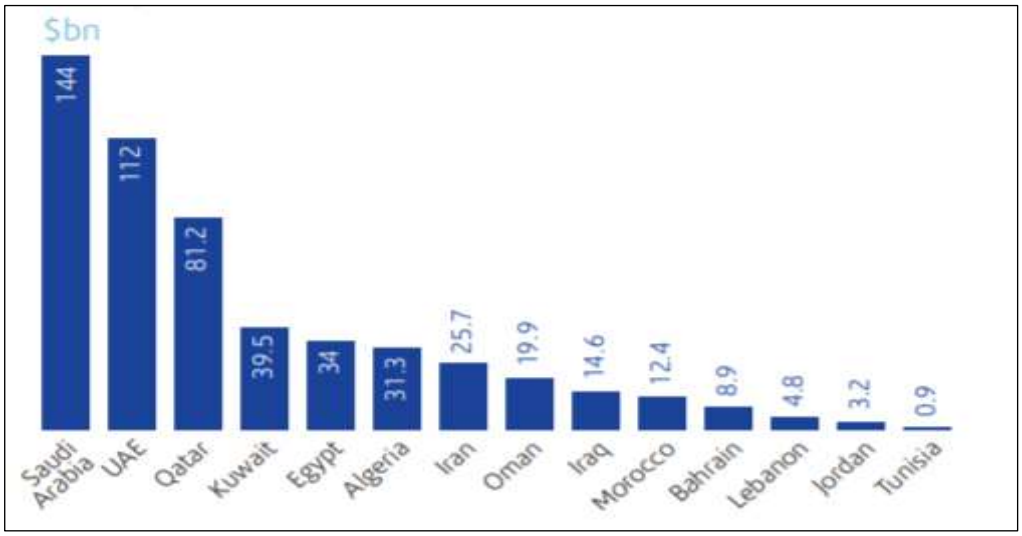

Figure 2.1: Projects in Mena (Middle East & North Africa. (Source: MEED, 2017)

Evidently, the Saudi construction industry has recently undergone an astounding boom (Figure 2.1). Predictions suggest that this boom will continue to sustain itself while the industry undergoes rapid expansion. This will involve

the construction of new cities, airports and highways. However, the vast majority of future projects will face enormous challenges and difficulties arising from market opportunities. Indeed, over the past two decades, the rate of substantial differences over construction contracts within Saudi Arabia has increased significantly (Jannadia et al., 2000). As a case in point, Al-Sultan's (1987) survey examined the time performance of public sector, in Saudi Arabia, revealing that 70% experienced delays.

For projects funded by the Saudi Ministry of Housing (MoH), more commonly known as the public sector, Assaf and Al-Heiji (2006) performed a study not dissimilar to that of Al-Sultan (1987). 73 delay factors were identified and clarified by relevance, the latter determined based on the question of how the different parties (namely, clients, consultants, contractors, and labourers) perceived them within the project. Delays and their subsequent implications were experienced in 70% of all the projects undertaken. A later study by Mahamid and Dmaidi (2013) applied a comparable research design to public sector construction projects, revealing that approximately 60% exceeded their original budget.

The issue of distrust is especially profound, as demonstrated by Al-Reshed (2002). After investigating 77 cases of disagreement between public clients, government agents, and principal contractors, the researcher found that 92% took more than a year to be heard in court, with the longest overrun time amounting to eight years. Therefore, it can be stated that the construction industry in the KSA, at least the public sector, is fraught with difficulties and disputes that could lead to delays.

2.3 Definitions

Definitions are important to know the responsibilities of each individual, as they need to prioritise each construction project. Also, knowing the general concept in order to find accuracy in work.

2.3.1 Construction Project

In 2012, the Health and Safety Authority in Australia described construction work as a high-risk career choice (Wundersitz, 2019). Furthermore, the organisation advised that construction projects must be well managed and controlled from initial acquisition through the design process until the very end of the project. Every person involved in a construction project must understand

the role they undertake, ranging from the client to the project supervisor, designer, contractor and labourers.

Other projects tend to differ from construction projects in terms of their time, nature, and size, as well as many other variables. A particularly distinctive aspect of construction projects is the huge financial burden they represent, which is associated with a considerable amount of time required for completion. Alongside this, construction projects are characterised by the lack of health and safety management systems.

According to Majid (2006), a successful construction project should include some of the following characteristics: "good management", "commitment to schedule", "on budget"," within specifications", and "satisfy all parties". At the same time, successful construction projects must enable the contractor to profit without suffering from financial claims or legal proceedings.

2.3.2 Delay in Construction Projects

In prior studies, the concept of 'construction delay' has been defined as an unscheduled overrun past the deadline stipulated in the contracts (Marzouk and El-Rasas, 2014). However, in other cases, construction delays have been defined as simultaneous delays emanating from the general contractor, project client and consultants, which affect the scheduled project completion date. According to Pickavance (2005), the term 'delay' in construction is a technical word that has yet to be clearly defined. This fact stems from the different circumstances surrounding each project's execution. However, in most cases, the term is used to refer to a delay to finish or start time of any activity in a project. Nevertheless, it is worth noting that a delay can also be defined as any act that extends the expected time needed to perform a given contract.

Braimah (2008) illustrated that in the context of construction agreements, the term 'delay' term lacks an exact technical meaning. That is to say, the sense in which the word is used may be adjusted to explain different cases during project implementation. Nevertheless, the term is primarily used in its simple form, where it refers to any happenings that increase the project duration or interrupts the commencement or completion of project events. According to Assaf et al. (1995), construction delay occurs when a time overrun pushes the project completion time past the final date stated in the agreement, or past the date which both parties originally stipulated. Similarly, Majid and McCaffer (1998)

defined delay as exceeding time after contract time, or after the date when specific activities should have been completed to avoid interruption.

According to Bartholomew (1998), a delay can be described as the slowing down of an activity without fully ending it. Therefore, delay is not the same as suspension, which entails stoppage of the job assigned to the contractor. Delay is conceptualised by Aibinu and Jagboro (2002) as a scenario in which both the contractor and the client contribute to the stalling of project activities despite the stipulated or agreed-upon contract duration.

Delay has also been taken to refer to an event which lengthens the stated period for finalising contract activities, which reveals itself as extra work days (Zack, 2003). According to Majid (2006), delay equates to the wastage of time, where 'time' denotes the time taken to complete project activities. Hence, when there are delays in a project, the specified timeframe for project completion will be affected. Therefore, the delay in construction can be defined as the additional time that elapses between a project commencement date and completion date, as stipulated in the contract.

2.4 Delay Factors in the Construction Projects

The issue of construction delay is a major problem for most of the world's construction projects. Due to this, the building industries typically experience higher levels of risk and uncertainty when compared to other sectors (Gardezi et al., 2014). It is also worth emphasising that the issue of construction delay is a prevalent problem in civil engineering activities. It affects the lifespan of the whole project, which results in disagreements and legal processes (Marzouk and El-Rasas, 2014).

Given that the majority of construction projects experience delays, it is imperative to identify the factors which contribute to delays (Ahmed et al., 2002). Delay factors extend the project deadline, strain resources, and create other inconveniences for the contractor, the client, and – in the context of public projects – society.

Since any given project will always be affected by delay factors arising from the environment and the characteristics of the site and general project, delay factors can be considered universal and common. In view of this, researchers have attempted to identify delay factors, and in response, to develop solutions to help the client, contractor, and consultant mitigate or avoid construction project

delay. Prominent delay factors will be discussed in the next section as they emerge from the literature review.

Various factors are responsible for delays in construction projects. Early studies in this area grouped the causes of delays into different classes of objects. Such a classification is necessary because it enables the isolation of causes that are linked through a mutual factor (Odeh and Battaineh, 2002). This process facilitates the identification of related causes, and at the same time, it allows for a greater emphasis to be placed on probable causes for a particular group.

Furthermore, it is worth identifying the specific factors that cause construction project delay, since this promotes the formulation of the necessary long-term solutions (Majid, 2006). Consequently, classifications of delay factors published in the existing literature offer the foundation for determining classifications of causes concerning the objectives of the present study's survey.

Table 2.1: Causes of Construction Project Delay by Group

Odeh and Battaineh (2002), Sambasivam and Soon (2007), Long (2004)	**Ahmed et al. (2002)**	**Aibinu and Odeyinka (2006)**
1. Client/ owner issues 2. Contractor's issues 3. Consultant's issues 4. Materials issues 5. Labour and equipment-related issues 6. Project-related issues 7. External issues 8. Issues related to the contract relationship 9. Contract-related complications	1. Management-related issues 2. Financial issues 3. Construction-related issues 4. Design-related issues 5. Acts of God	1. Client-related issues 2. Subcontractor Issues 3. Contractor Issues 4. Supplier-related complications 5. Services engineer-related issues 6. Structural engineer-related issues 7. Surveyor-related issues 8. External complications

It should be noted that the reasons for delaying the construction projects by group listed in Table 2.1 are not exhaustive. That is to say, other groups of delay factors exist aside from those which have already been identified. In terms of how the categorisation of groups of delay factors takes place, this process is dependent on how the researchers obtained the outcomes to satisfy their

research targets. Therefore, the following part illustrates the causes of delay for each identified group of reasons.

2.5 Identification of Delay Factors

In this section, all possible delay factors that can be encountered during a construction project are discussed in detail, as synthesised from the literature review's findings. The specified factors were grouped into major categories: contractor factors, consulting factors and client factors, as well as other factors.

2.5.1 Client Factors

According to Kwakyi (1998), the project client is the most important participant in a construction process. The duties of the client are onerous, and it is necessary for them to seek assistance from other knowledgeable parties throughout the project lifecycle. In some instances, clients establish an in-house construction management team. However, in most cases, clients hired the services of a project manager to help run project activities (Odeh and Battaineh, 2002). Clients are responsible for determining how long the project will last, and in almost every case, they prefer projects with a short duration. However, technical studies should be conducted by professionals during the planning phase to determine how long a project should last. Among the delaying factors that arise due to the project client are delays in preparing and submitting the site to the contractor, payment delays to the contractor, weak communication, poor cooperation with the principal contractor, excessive bureaucracy, poor coordination with the government, slow decision-making, unrealistically short project durations, and frequent suspensions of project activities.

2.5.2 Consultant Factors

Consultants are the professionals that a client consults to assist in project's organisation. Their main responsibility is to design and oversee the project. Their consulting activities are architectural, structural, electrical and mechanical. These designers prepare technical and financing documents, specifications and details (Long, 2004). In some cases, the consultants are known to perform cost control, planning, quality control and assessment of activities. Delays emanating from consultants are witnessed during project activities such as drawing design,

performance inspection and testing, and design approval, among others. Other factors leading to delays include inexperienced personnel, poor communication with the client, poor coordination of activities, and poor qualifications (Ogunlana et al., 1996). Some of the delays that commonly occur in the project phases as a result of poor consultants consist of delays in creating drawings or giving permission to contractor submissions, as well as accepting design drawings which are below standard. It is also worth noting that the issue of poor qualifications or low experience can give rise to these issues, not just from consultants but also their staff.

According to Odeh and Battaineh (2002), routine inspections conducted by a consultant's team during a project's construction phase are associated with inconveniences and project delay. In certain cases, when an error is detected, consultants can request that the job be redone even if the contractor may have a different solution. Among the outlined consultant factors that because delays are poor qualifications of the assigned consultant personnel, late drawing preparation, delayed approval of the drawings by the contractor, poor communication between the consultants and other project stakeholders, inadequate design information, and deferred inspection by the consultant engineer.

Delays may also arise from insufficient coordination or communication with other project participants. Throughout the project, the contractor may have many questions for the consultant engineer. As a result, smooth project progress may be undermined if the consultant engineer takes too long to respond to these enquiries. Furthermore, it is noteworthy that the contractor may favour a process where they formulate and execute a solution to a problem without the help of a consultant. This change in approach increases the risk of an unsatisfactory outcome, and therefore could lead to the possibility of rework (Odeh and Battaineh, 2002).

To conclude, consultants are highly advised to meet with contractors before construction begins. At the same time, consultants should take all measures to ensure they can respond rapidly to contractor questions when construction is underway.

2.5.3 Contractor Factors

In fact, the contractor plays the most important role in determining the overall success of the construction project. As a reflection of this, almost all delay factors involve the contractor, whether directly or indirectly. If the project is finished within the stipulated duration, the contractor tends to receive praise from the client, and in certain cases, bonuses are offered. However, failure to deliver the contract as agreed leads to blame, a strained budget, and – in severe cases (e.g., those involving negligence) – compensation is demanded. Contracting is a complex and demanding profession that includes important undertakings to overcome delays. Although other stakeholders (e.g., subcontractors) play a critical role, the principal contractor is held liable for the work of all parties involved in a contract (Shi and Arditi, 2001).

The likelihood that a contractor completes the project within the agreed-upon project duration is dependent on their managerial competences and the availability of resources (e.g., money, materials, equipment, and manpower). The contractor can hire labour either through a subcontractor or directly. In cases where the subcontractor is the source of delay in a contract, the principal contractor and the project client can decide to look for a solution elsewhere. This makes it necessary for the contractor to continually supervise the daily activities of the site operations (Abdul-Kadir and Price, 1995).

The review identified a number of factors related to the contractor that are causing project delays. Thus, factors can be separated into these categories: materials, equipment, manpower, and management performance and financing.

2.5.3.1 Materials

Materials are an important part of the project; they are the basis for project completion. They also account for a majority of the project client's expenditure. Management of the onsite materials, therefore, is a great concern for the contractor. Procurement of the materials and the question of how to ensure that the materials reach their destinations on time forms an important part of the contractor's initial workload (Abdul-Rahman et al., 2006). When materials are poorly handled and when the contractor fails to engage in advanced planning for procurement, the chances of delay increase. Problems such as equipment theft and damages may also complicate matters further. Odeh and Bataineh observed that the timely-flow of construction materials is the full responsibility

of the contractor, since delays in materials delivery result in a deadline extension, which subsequently leads to greater expenses (Odeh and Bataineh, 2002).

According to Koushki et al. (2005), an increase in materials prices tends to hinder the client's purchase decisions, thereby contributing to delays. For projects involving many materials, price increases may lead to the client's decision to wait for prices to subside. The period spent waiting for prices to fall may not be recoverable, thereby leading to a delay. This can frequently occur in large construction projects due to that fact that they require an enormous number of materials. However, this issue can also affect other industries. Ultimately, postponing materials purchasing until prices are more favourable can lead to delays for specific activities, some may be an integral part of the completion of the project, which in turn leads to a comprehensive delay (Wiguna and Scott, 2005).

Furthermore, they argued that modifications made to the design can also be classified as delay factors. Design changes may be introduced at some stage in the project lifecycle either to improve the design or to correct errors resulting from the original design.

Additionally, with the introduction of new materials, it may be necessary to modify designs for compatibility. This may delay the project further since the materials will have to wait for approval, and negotiations may be involved. Client approval and price negotiation are key factors that affect the time taken for these new materials to be delivered (Baloyi and Bekker, 2011).

To conclude, all material-related delays fall into one of the following categories: shortages, delivery delays, material specification, modifications, and fluctuating material costs. This includes special materials for the application of sustainability such as thermal insulators.

2.5.3.2 Equipment

Any piece of equipment used to perform repetitive operations and tasks during the construction phases of project can be classified as either a haulier or an operator. Hauliers include transportation machines such as trucks, as well as other forms of equipment such as skips, which are used to perform different activities at the location (Odeh and Bataineh, 2002). Operators include cranes,

graders, and others, which can only be left at the construction site and its boundaries.

This equipment can be purchased by the contractor or leased to the project, the main consideration being frequency of use (Kikwasi, 2012). One of the contractor's responsibilities, therefore, is to acquire these critical machines, to oversee their maintenance, and to protect them from theft and damages. Delays caused by equipment can be categorised as follows: insufficient equipment, equipment breakdown, lack of spare parts, outdated equipment, and low mobilisation.

2.5.3.3 Manpower

The workforce is a critical variable with regard to construction projects. The workforce comprises teams of supervisors, engineers, technicians, and others. Every segment of the workforce is fundamental to the project success. Indeed, according to Hendrickson (1998), productivity can be, and often is described as an "output per labour hour". Worker manpower can be separated into three distinct skill levels: skilled, intermediate, and unskilled. Such classes span a range of professions such as inspectors and engineers (civil engineers, mechanical engineers, etc.). It also requires the provision of skilled workers to implement the sustainability and quality specifications. It is therefore commonplace for contractors to develop a workforce plan, consisting of determining and then assigning project roles, responsibilities, and reporting relationships. These responsibilities and tasks may be given to an individual or a group of people. Drewin (1982) stated that "the choice of determining the correct number and category of manpower will significantly affect the quality, cost and progress of the works and may lead to a complete failure of the project."

In many countries, including the KSA, most construction workers are expatriates. It is worth recognising that this may hinder the smooth running of project activities (Odeh and Bataineh, 2002). Among the workforce-related factors that may result in deadline overrun are unskilled labour, low labour supply, strikes, absenteeism, and low morale. Therefore, it is important to ensure that planning occurs near the beginning of the project. Furthermore, the establishment of control processes is a requirement to guarantee that workers are working as intended, as well as undertaking the necessary tasks as the project progresses.

2.5.3.4 Management Performance

As a way to guarantee that everything is under control and to manage the project, contractors must develop coordination and communication methods with every member who is part of the project. This includes subcontractors, suppliers, clients and local authorities. Problems may arise due to the different levels of communication required from each of the project members, but meeting on a regular basis minimises these problems and helps to resolve these issues (Al-Khalil, 2005).

Every project has a unique set of needs. Therefore, contractors should take this into account. They need to select, in terms of both skill and size, a suitable workforce which help to perform the specific tasks required for that project. Providing training and positivity increase workforce productivity, while choosing the wrong workforce and improper training, result in lower productivity, thus contributing to delays. Managing problems inside of the contract company is critical throughout the project handling process (Alkhathami, 2004).

As Kungari (1998) quite rightly pointed out, any weak links in the business structure or management can negatively affect the smooth progress of project activities. Furthermore, bad practices within the organisation may also undermine the degree to which specific jobs can be performed effectively. The researcher also reported that among the other challenges faced by construction companies, those related to management include the turnover of key personnel, incompetent leaders, insufficient numbers of professional and administrative staff, and inadequate levels of managerial and technical expertise. Inadequate skills can lead to improper considerations for the project during the crucial stages (Alkhathami, 2004). These may include acquisition methods, poor planning, inaccurate estimations of project duration, and a loss of control of third-party companies in the hierarchy of the project's organisation, including suppliers and sub-contractors.

According to Kraiem and Dieknam (1987), project management is principally concerned with applying the necessary tools, skills, and knowledge to a project to meet expectations. In the construction industry, project management is a field that usually changes every day with the progress of the construction. Sustainable management takes the notion of sustainability and combined them with management concepts.

A successful application of project management necessitates effective teamwork, comprehensive planning, and an error-free delivery. Among the factors related to project management that can result in deadline extension are low-motivation within the contractor team, shortage of administrative staff, poor communication between stakeholders (contractor, consultant, etc.), lack of control of subcontractors, weak qualifications of designated technical personnel, poor scheduling and ineffective planning by the contractor, and poor-quality control (contractor side).

2.5.3.5 Financing

Among the most complicated and volatile areas of the modern construction industry are building financing methods. Typically, the client covers these expenses, but in recent years, the contractors or consortium have started to fund the project or projects they have undertaken. Best and De Valence (2002) stated that this funding method was first used within infrastructure projects in transport and energy, and it is now starting to be used for projects related to housing. As a result, contractors may encounter financial issues regarding project funding, much like the clients. They may be unable to avoid delays when paying for both indirect and direct expenses. Materials, labour and subcontractor expenditures are all direct, while other expenses such as supervision and warehousing costs that are needed to support direct activities, are regarded as indirect. Given sustainable financing, it is a form of financial service that integrates environmental and social standards into project decisions for the permanent benefit of customers and society as a whole.

Additionally, delays may arise from common issues in construction projects, such as disagreements with suppliers about payments, alongside other complex financing (Long, 2004). A contractor, therefore, is required to confirm that they have enough money to complete the desired project, as well as adopt a suitable method of financing for the project in order to ensure that all financial matters are well managed.

2.5.4 Other Factors

2.5.4.1 Planning in Time

Appropriate planning and preparation of project design ensure that sufficient time is available in which to make necessary changes before the construction phase begins. This ensures the smooth running of the project and timely completion. However, to finish a project on time, attention to all details is critical, as well as necessary information must be gathered (Carnell, 2000). Unclear and incomplete drawings and documents, which confuse the client and other stakeholders in the project, should be avoided, as well as specifications. According to Odeh and Battaineh (2002), an effective design that ensures project success should include a precise shape, location, materials specification, infrastructure, and size. Based on the literature, there are four delay factors related to timely design and planning: inconsistency in the drawings and specifications; frequent adjustments to the project scope; inaccurate documentation of the site; and short contract duration.

2.5.4.2 External Factors

In this part, these factors can be defined as those beyond the control of the client, contractor, etc. For example, the temperature on the site may be unsuitable for activities to commence on any given day, thus hindering project progress (Ameh and Osegbo, 2011). In certain regions (e.g., areas in the United States), temperatures can fall below 1 °C, while in other places (e.g., KSA), temperatures can exceed 50 °C, making construction work difficult. According to Ogunlana et al. (1996), extreme weather conditions can also disrupt the gas and electricity supply, thus slowing down activities in the construction phase, and in turn, extending the completion deadline. Due to the delay in the initial construction schedule, the total project cost will increase which may affect the completion of project phases and the implementation of sustainability.

As previously noted, price fluctuations for materials have a major impact on construction phases. This is always beyond the control of the project participants, and so can be considered an external factor (Sambasivan and Soon, 2007). Other external factors influencing a project are unexpected ground conditions, unforeseen geological conditions, extreme weather conditions, increased material prices, and poor traffic and site access restrictions. A summary of the factors designated 'Other Delay Factors', including external factors and factors related to planning in time, is presented below (Table 2.2).

Table 2.2: Other Delay-Factors

Other Factors	Planning in time	- Defects, ambiguity, and inconsistency in drawings and specifications - Frequent adjustments to project scope - Inaccurate documentation of site - Short contract duration
	External Factors	- Ground conditions - Weather conditions - Increased material prices - Poor traffic
	Sustainability performance	- Green building design - Design documentation - Construction schedule - Communication among project parties - Monitoring and checking

2.5.4.3 Sustainability performance

It is imperative that sustainability requirements are well handled to be reflected in the building's performance, as well as to avoid any delays in the construction schedule. Firstly, Green building designs need a different approach that takes into consideration the surrounding environmental conditions, and this technique may take longer than normal design methods (Kats et al., 2003). Secondly, the design documentation needs to be more comprehensive and this requires more time for engineering designs and detailing to incorporate green practices.

Furthermore, due to the sustainability requirements during implementation, it may have a direct impact on the construction schedule from the project start to delivery (Glavinich, 2008). This may also lead to a lack of communication between the project parties, which contributes to delaying decision-making during construction.

Therefore, due to the technological complexity used in green buildings during the construction process, it requires high and continuous levels of communication among project teams and involves quality checks (Kats et al., 2003). Furthermore, contractors must ensure that the actual construction schedule and resources are properly monitored and reviewed regularly so that performance is aligned as scheduled and to avoid any cost overruns and potential disputes. Whereas the consultants must check for mistakes and discrepancies in design documents to avoid redoing of designs and drawings to avoid defects or variations (Hwang and Leong, 2013).

2.6 Classification of Construction Delays

A critical analysis of the different kinds of delays that are clearly shown in the literature is conducted. In turn, the general overview of the types of construction delay presented in Figure 2.2 will be given. As the figure indicates, construction delays can be classified in terms of how they occur, the effects of the delays, and the liabilities befalling the construction parties.

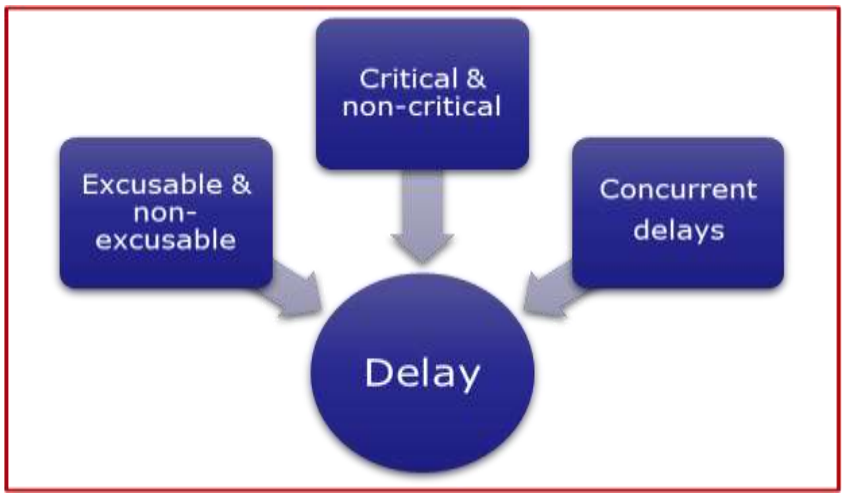

Figure 2.2: Delay Classification (Source: Trauner, 2009)

Numerous attempts have been made to categorise the causes of delays in projects. Scott (1991) claimed that there are three broad types of delays: firstly, those arising due to the client; secondly, those arising due to the contractor; and thirdly, those arising due to external factors. Contrastingly, Ahmed et al. (2003) suggested that construction project delays can be divided into two general groups: firstly, those influenced by internal issues (i.e., associated with the factions working on a project); and secondly, those influenced by peripheral issues (i.e., associated with factors which lie beyond the control of the project participants). Another typology indicates that delays in construction can be considered forgivable, unforgivable, or concurrent (Ochoa, 2013). Finally, Trauner (2009) utilised an opinion survey to suggest that delays can be classified as critical or not, excusable or non-excusable and concurrent.

2.6.1 Critical and Non-Critical Delays

According to Callahan et al. (1992), noticeable delays are those that result in the extension of the project deadline. When excusable critical delays occur, the contractor has the right to extend the deadline. Trauner (2009) defined critical delays as important activities within a project that if delayed, may slow down the whole project's completion. However, some structural changes occur in the project but do not necessarily delay the completion of the project. The activities that determine the timeframe within which a project will be accomplished include the design itself, the contractor's timeframe and the project's characteristics.

Non-critical delays, once they occur, do not influence the deadline of the contract's completion. Research led by Leary and Bramble (1988) revealed that excusable non-critical delays do not warrant the extension of a deadline, since these delays have no effect on the overall project completion. However, in cases where the delays affect the cost performance of the contractor, they are entitled to receive extra performance costs.

2.6.2 Excusable and Non-Excusable Delays

Delays in construction industry can be considered either excusable or non-excusable. Excusable and unintended delays are caused by factors beyond the control of the project parties (contractor, consultant etc.). Before the start of a project, all involved parties should seek to define factors considered excusable or non-excusable. According to Trauner (2009), the following events lead to delays that are deemed excusable: acts of God, fires, client instruction changes, unexpected site conditions, extreme or unusual weather conditions, government interference, delays in state inspection, labour strikes, and political crisis.

Non-excusable delays are predictable, factors that are caused by the contractor or any other party, who is liable. Therefore, non-excusable delays do not warrant a deadline extension (Sambasivan and Soon, 2007). However, the contract should be able to define all non-excusable delays, and an agreement is to be reached between the contractor and the client at the outset. The following are the factors that may be classified as non-excusable: supplier delays, worker strikes, poor performance by the contractor and subcontractor.

2.6.2.1 Compensable and Non-Compensable Delays

Excusable non-compensable and compensable delays are caused by the project's clientele or the project's client, and they can be grouped under the same umbrella (Ahmed et al., 2003; Mubarak, 2005). In this case, the contractual staff could be granted an extended deadline, or the ability to claim any costs.

With regards to excusable delays, these can be classified as compensable or non-compensable (Mubarak, 2005; Ahmed et al., 2003; Ochoa, 2013). In addition, compensable delays tend to appear due to client actions.

According to Mubarak (2005), excusable non-compensable delays tend to fall beyond the control of the clientele. However, Trauner et al. (2009) has argued that while some issues stipulated in the project's contractual agreement might, in theory, be excusable (e.g., different site conditions), this does not necessarily mean that the contractual team should be compensated.

As previously discussed, Mubarak (2005) claimed that delays are excusable but not eligible for compensation if they are outside the control of the contractor or clientele (e.g., conflicts, extreme or unusual weather conditions, or workforce disorder). On the other hand, Trauner et al. (2009) stressed the importance of contractual agreements, arguing that the nature of this will always inform the compensation awarded or the extension of the deadline due to delays.

Apart from delays caused by contract adjustments which tend to be compensable, other forms of compensable delay have been identified in the literature. Examples of such delays are excusable delays, suspensions, or disruptions to the whole project (or just a section of it due to the client's failure to respond), which lead to the breach of stakeholder contractual responsibilities. If such a delay is compensable, the contractor can lawfully demand an extension of the project duration, and reimbursements can also be requested for the extra expenses resulting from the delay (Al-Gahtani and Mohan, 2007).

2.6.3 Concurrent Delays

They are defined as those created when one or more issues unfold simultaneously (Mubarak, 2005). This can encompass both excusable and non-excusable delays. Furthermore, Levy (2006) recognised that this type of simultaneous delay can be caused by either the contractual staff or the clientele. This means that while two groups may be held responsible for the delay, neither group can exclusively be compensated.

As highlighted by Long (2004), the term "concurrent delay" is principally used to explain a scenario in which two separate delay factors occur simultaneously during project execution. Therefore, concurrent delays arise if the delay that is related to the client happens to be on a similar activity path with a delay that is related-to contractor. Hence, if the contractor-related delay and the client-related delay affect a similar event concurrently, or a separate event which was scheduled to run alongside, and if this causes an extension to the project completion date, then this delay is considered concurrent.

According to Hamzah et al. (2011), a concurrent delay occurs when the project completion date is affected by more than one factor. Alaghbari et al. (2007) explained that when one issue is undermining project completion, the simplest strategy is to determine the time and finance in such a case, as compared to when more than one issue is affecting the project. So, the complexity increases when these factors occur together at a sensitive stage of a particular project.

2.7 Impact of Construction Delays

As the literature indicates, construction project delays are becoming a recurring issue across the world. Delayed projects are often either extended beyond their scheduled completion date or their activities are sped up. In addition, rises in project expenses are often caused by delays. Therefore, a number of researchers have studied the problem of delays and concluded that they will always have a negative impact (Mubarak, 2005; Majid, 2006; Abdul-Rahman et al., 2006; Ochoa, 2013).

According to Majid (2006), delays can cause "disagreements, poor productivity, and an increase in expenditure". Furthermore, as noted by Alkass et al. (1995), when (potentially legal) disputes arise between project stakeholders, the cause is often a costly delay. In particularly severe cases, projects may be abandoned altogether due to delays according to Aibinu and Jagboro (2002). While Abdul-Rahman et al. (2006) found that delays lead to "work disruption, decreases in productivity, projects being completed late, increased expenses relating to time, claims from third parties, and ultimately the cancelling of a contract". Additionally, delays can undermine the quality of the work, create extra expenses, and lead to rework (Li et al., 2000).

These outcomes are incredibly damaging to any business relationships, and the resulting distrust may also hinder parties from being able to settle the claims

quickly. Ahmed et al. (2002) stated that contractors, clients, and consultants can experience stunted growth due to "mistrust, confrontation, poor negotiation, financing issues, and general unease between parties".

Moreover, Khoshgoftar et al. (2010) stated that parties involved in a contract can often reach a decision on additional financing and extended timelines arising from the delay. However, in many cases, they lead to serious disputes between contractors and clients. Aibinu (2008) stated that as a result, this could produce "distrust and tension between the client and their project management team and the contractor".

Furthermore, Aibinu and Odeyinka (2006) explained that claims arising from lost revenue as a result of any delays tended to lead to more conflict, and in this way, cause even further delays. Disagreements can arise from a number of key elements, including questions about why the delay happened, interpretation of the contract, and the general relevance of the claim. However, it is worth noting that delays may sometimes be no fault of either party. Indeed, Yates and Epstein (2006) explained that delays might result from multiple problems, and in these cases, each factor must be examined to ensure that responsibility is assigned correctly. Resolving the difficult issues caused by multiple delays tends to require a great amount of effort and time.

Aibinu and Jagboro (2002) investigated the effects of delays on project outcomes within the Nigerian construction industry. The results indicated that delays can cause one of the following six outcomes: firstly, an extension of the scheduled deadline; secondly, budget overrun; then, conflict due to disagreements; the need to reach compromises; project abandonment; and finally, the pursuit of legal action.

2.8 Success Factors of Construction Projects

Abdul-Rahman et al. (2006) stated that in order to ensure that a project is successful, effective management which pays close attention to cost, time, and quality must be administered. Noteworthily, the ideals of cost, time, and quality are closely interlinked, and so affecting one will also change the others.

2.8.1 Cost

According to Sanvido et al (1992), construction activities are successful to the point of achieving project goals and expectations (include financial aspects). In almost all cases, project managers will attempt to maximise the project's

profitability, and so when evaluating bids from contractors, the one associated with the lowest costs is selected. However, it is worth emphasising that the final cost of the project rarely matches with the first estimate. Therefore, Scott (1993) advised the use of cash flow management, which centres on the relationship between time and cost, since both correlate with the project budget.

2.8.2 Time

The time allocated within a project indicates the time period required to complete the project when referring to the timeline (Wiguna and Scott, 2005). Due to the varying nature, type, and size of projects, each is associated with a different timespan. Considerably, time is considered to correlate with quality, as good quality work cannot be achieved when too little time is available.

2.8.3 Quality

Quality is defined by engineers as conforming to specifications. Hence, accurate evaluation of quality consists of questions such as "Does the product meet the required specifications?" and "Does the product achieve the stated requirements?" As noted by Peter, Morris, and Hough (1979), the quality implementation is informed by the quality of the resources supplied. Also, Bosneneh (2011) agreed with this statement. Resources range from equipment to materials to skilled workers and any parties involved, such as the contractor, the consultant, and the client and the management of the project itself.

2.9 Previous Studies on causes of Construction Delay

Delays have long been a common problem in the construction process in KSA and throughout the world. They tend to occur frequently in major projects, which leads to disputes and litigations. Therefore, this section presents a list of studies that have examined the factors leading to construction delays.

2.9.1 Global Projects Delays

Various studies have been carried out to investigate the issue of project delays. One such study aimed to identify the impacts of project delay factors on the Nigerian construction sector (Aibinu and Jagboro, 2002). The study also aimed to investigate strategies for reducing the general costs of construction. Surveys were used to collect primary data, the analysis of which uncovered a link between project delays and problems with meeting the set deadlines for each

project, as well as budgets overflows. Notably, the evidence revealed that at some point, clients cause delays. These forms of delay mean that attaining projected budgets is unattainable, as the expenses exceed projected figures. This produces losses that would, in some cases, lead to claim refunds.

Odeh and Battaineh (2002), Jordan-based study investigated delays in large construction projects. A self-administered questionnaire with delay factors was used as the data collection instrument. The researchers noted that multiple causes of these delays could be identified in a project's implementation. These were grouped into subcategories, including factors related to the client (e.g., financial delays, slow decision-making, and client interference) and factors related to the contractors (e.g., improper planning and site management). Consultants were also found to have contributed to the delays through factors such as drawings approval, quality assurance, and general contract management. The labour and materials factor were also a fundamental cause of delay. Discrepancies or order changes in the contract documentation, as well as disputes arising from actual construction work, were cited as major contributing factors.

In the research project conducted by Ogunlana and Krit (1996), the researchers examined the causes and impact of delays in the construction industries of developing countries, taking Thailand as a case study. A postal survey was used to gather information from a total of 17 contractors, 8 consultants and design firms, and a single client. Only 8 contractors and 6 consultants allowed the researchers to conduct site visits. A total of 12 projects were identified and site visits scheduled. Both structured and unstructured interviews were used to gather qualitative data. Approximately 30 people were interviewed, which represents 2.5 individuals per project. Based on the results, the researchers classified the problems faced by developing countries' construction sectors into three categories: firstly, the issue of inadequacy or shortfalls in the sector's infrastructure; secondly, the provision of resources, as well as issues related to clients and consultants; and finally, issues related to the contractors' lack of experience and qualifications. In addition, the causes of the delays were organised into three categories: clients, designers and suppliers.

As noted by Williams (2003), the momentary implications of delayed construction activities show how expensive the consequences of time overrun are. The direct delay damages may include labour costs, idle equipment, loss of productivity, home and field overheads, storage costs for materials and equipment, other mobilisation

costs, escalation of costs to deliver materials, and extended insurance coverage. Additionally, consequential damages result in current and future profit loss, legal fees, loss in bonding capacity, and financial costs.

In the investigation of the Egyptian construction industry, Marzouk and El-Rasas (2014) identified a set of major causes of project delay. The researchers developed questionnaires to collect demographic data and other data from respondents from 71 construction companies, and the outcomes were evaluated using statistical analysis. The respondents were required to choose the one-degree frequency for each causal factor of delay, and the severity level was denoted as either extreme, high, moderate, or low. The study concluded that poor site management is a primary cause of delay that affects labour productivity in the Egyptian construction industry. Material-related delays were identified as another source of delay, with transport representing a serious challenge. Furthermore, given the limited availability of skilled personnel, the need to train and import labour were important manpower-related causes of delay. Slow decision-making, client-initiated variations, inadequate contractor experience, poor site supervision, and unforeseen soil erosion were among the other factors identified by the research. The project clients also cited design changes, inadequate planning, and reduced labour productivity as factors leading to delayed contract delivery.

Holt et al. (1995) classified delay factors in Hong Kong as the result of cost and time overruns. Their study brought to light the fact that in Hong Kong's construction industry, the main influential factors in terms of time and cost overrun can be considered increases in material prices (due to inflation), inaccurate estimations and miscalculations during material evaluations, and the high degree of complexity associated with opinions. Alongside this, the study reported that the principal causes of delay were weak labour enrolment, design changes, poor planning, and resource shortages. Delays were also attributed to differences in the perceptions of different project groups and stakeholders, especially those in building and civil engineering works. With these findings in mind, Holt et al. (1995) concluded that the biases of the various industries involved directed the blame for delays on one another. Therefore, the researchers established that many delays arise from the fact that project stakeholders tend to direct blame at their counterparts.

The origins of delays and oversights in spending in the Ghanaian construction industry were assessed by Frimpong et al. (2003), with a particular focus on water projects. In this study, information was gathered by surveying 55 site

clients, 40 building contractors, and 30 industry consultants. Overall, the study demonstrated that a variety of key issues contributed to delays and overspending in the construction of water projects, particularly relating to concerns in developing nations. All three groups of respondents concluded that the 5 most prevalent issues affecting construction were the increasing costs of goods and materials, difficulties in receiving regular payments, inadequate contractual supervision, obtaining the required materials, and ineffective technology. Site clients acknowledged that inadequate contractor control was the crucial issue affecting delays and costs, while building contractors and industry consultants perceived that difficulties in receiving regular payments were the most prevalent causes. Instances such as unforeseen natural disasters and poor weather were regarded as less significant, but still of importance.

Gwinn's (2006) study focused on the construction industry within South Carolina, the fastest growing state in the United States. At the outset, the researchers noted that the state is facing challenges in trying to keep pace with its transportation needs. Significantly, the state's need to de-congest its roads and create an efficient transportation system is what motivated it to secure contracts with companies in the construction industry. While South Carolina, at the time of Gwinn's (2006) research, had the 4th largest highways in the United States with 800 miles of interstate roads and 42,000 miles of highways, its limited traditional highway funds were insufficient to finance the required improvements. Due to this, the state attempted to pursue more efficient programs to ensure the timely completion of construction projects. However, delays always resulted in contractors demanding compensation and additional time, and since the cost of uncompleted projects was always substantial, traffic congestion remained unsolved at the time of the study.

Therefore, the purpose of Gwinn's (2006) research was to identify the leading factors that cause construction delays for active projects. Six major factors were identified, and the information was made available at the database. Study's findings were particularly useful in helping South Carolina administer its active projects. Contract extension demands were precisely evaluated, and the reasons for deadline extension were identified as follows: utility delays (21%), administrative delays (15%), extra work delays (17%), design change delays (12%), weather delays (10%), quantity adjustment delays (8%), and unknown delays (17%). The paper concluded by stating that delays in the completion of South Carolina's road projects show no signs of being reduced in the future.

However, the department for construction must move quickly to explore new and innovative ideas that will help contractors complete the projects on time. Contractors must also embrace cooperation with the government and subcontractors to ensure project success. Training must also be continually conducted to ensure the continued supply of skilled labour.

Alaghbari et al. (2007), in Malaysia, studied the causes of construction delays. The research team developed questionnaires that were distributed to construction companies to identify which factors contribute to delays in projects. Engineers, contractors, and government agencies were all involved in the study, and the survey concerned more than 22 projects. The results were later analysed using statistical methods. The study revealed that there are three types of delays in a construction project: excusable and non-compensable delays; non-excusable delays; and excusable compensable delays (which are attributable to the client or agents, for example, insufficient drawings). These delays can also occur when the client refuses to respond appropriately to the drawings request, then the contractor is entitled to compensation. Contrastingly, non-excusable delays are caused by contractors, subcontractors, and suppliers, while excusable delays cannot be blamed on any party. After analysing the collected data, Alaghbari et al. (2007), in Malaysia, noted the following reasons for the delay of construction projects:

Client Responsibilities:

- Slow decision-making,
- Poor coordination with the contractors,
- Contract changes,
- Lack of project knowledge,
- Financial challenges.

Contractor Responsibilities:

- Material delivery delays,
- Material shortage at the site,
- Construction errors,
- Inexperienced workforce,
- Labour shortage or ineffective labour,
- Inexperienced subcontractors,
- Poor site management,
- Lack of tools and equipment.

Consultant Responsibilities:

- Absenteeism of the consulting team at the site,
- Inexperienced consultant team,
- Delayed supervision.

External Contributing Factors:

- Shortage of materials at the site,
- Unfavourable weather conditions,
- Poor site topology,
- Changes in government regulations,
- Transport system.

Due to the prevalence of construction project delays, Abbas and Gidado (2012) undertook a research project to identify the principal factors contributing to delays in Afghanistan's construction industry. The study aimed to ascertain the top 10 leading factors for contract delays. The team developed questionnaires that were issued to key stakeholders in more than 60 construction companies. The participants were asked to respond within a stipulated duration of time, and the collected data were analysed and tested using statistical methods. The study identified a range of delay factors and grouped these in the following way:

Client Factors:

- Delayed payments,
- Delays in handing off the site to contractors,
- Order changes,
- Late approval and revision of design documents,
- Delays in receiving approval for drawings,
- Slow decision-making,
- Conflict among the clients of joint-projects,
- Lack of incentives for contractors.

Contractor Factors:

- Delays from subcontractors,
- Late site mobilisation,
- Frequent subcontractor changes,
- Ineffective site management,
- Poor communication with the subcontractors,

- Poor planning and project scheduling,
- Unqualified staff,
- Conflicts in the project,
- Financial challenges,
- Communication difficulties.

Consultant Factors:

- Inadequate skills and experience,
- Conflicts with the design team,
- Late review of the designs,
- Rigid consultants,
- Inadequate communication with the involved parties.

Project Factors:

- Lack of penalties for delayed work,
- Legal disputes,
- Short contract duration.

Designer Factors:

- Inexperienced developer team,
- Poor communication with the client,
- Inadequate experience by the designing team,
- Delayed production of the design documents,
- Complex project design,
- Insufficient site information.

Labour Factors:

- Labour shortage,
- Inexperienced workforce,
- Strikes.

Asnssshari et al. (2009) studied the Iranian construction sector from a novel perspective, noting that the sector is one of the main contributors to the country's growth in prosperity and employment rates in recent years. For example, given Iran's geographic location, the renewal and strengthening of the country's historic building sites is frequently necessary, and transport projects, undertaken to improve the country's railways, roads, and airports, are plentiful.

Indeed, it is estimated that 800,000 extra units are required annually in Iran's housing development, which means that there is great demand in the construction sector. Nevertheless, delays are frequent, and projects are often costly and time-consuming. This, combined with the shortage of materials and the growth in costs of equipment and land, has resulted in the decline of the country's construction sector.

In a study based in Aceh, Indonesia, Majid and McCaffer (1998) highlighted 57 causes of construction project delays. This array of causes was classified into eight distinct categories, including delays related to staff availability, external factors, technology and equipment, cost, site contractors, the clientele, resources, and industry consultants. In summary, an oversight of costs and the time required to complete the project were the two most prevalent causes of delays for projects in Aceh.

2.9.2 Projects Delays in the GCC States

Research by Al-Tabtabai (2002) revealed that the Kuwaiti construction industry is a fast-growing sector, with the government taking up a huge share in its different sectors. However, as is the case in all other parts of the world, delays in the completion of construction projects in Kuwait continue to cause inconveniences. As revealed by a field study, a questionnaire, statistical analysis, and interviews with engineers, government personnel, contractors, and consultants, the most commonly cited factors contributing to delays were the following:

Organisational and Client Factors:

- Slowness of the decision-making,
- Poor flow of information,
- Lack of field skills among administration staff,
- Bureaucracy in the customer's department,
- Insufficient drawings (lead to rework),
- The client's overcontrol of the site,
- Poor coordination with the government.

Contractor-Related Delays:

- Lack of experience,
- Construction errors,
- Misinterpretation of drawings,
- Late mobilisation for construction,
- Poor site management,

- Lack of specialised and competent subcontractors,
- Errors in shop drawings.

Design Problems:

- Errors in drawings,
- Poor coordination among different design drawings,
- Lack of consultations in the process of producing drawings,
- Inaccurate scope,
- Frequent design changes.

Manpower Factors:

- Labour market shortages,
- Delayed visa acquisition for human resources,
- Under-skilled workforce,
- Ethical background of the workforce hindering effectiveness,
- Workforce disorientation due to expatriate status.

According to Al-Tabtabai (2002), it is necessary to carefully examine the issue of hierarchy within the government agencies that are responsible for handling construction contracts. This is because the decision-making channel must be fluid, allowing information to be conveyed up to the top management and back down. The researcher further recommended that certain levels of the organisation structure should be merged to facilitate the ease of activities. Incentives and bonuses for contractors who achieve high-quality work and timely completion were also identified as valuable ways to mitigate and avoid construction project delay (Al-Tabtabai, 2002).

In the United Arab Emirates, Zaneldin (2006) conducted a construction claims study on projects. A sample population of 124 construction project claims was collected from the research setting of Abu Dhabi and Dubai. The critical objective of the study was to determine how these claims were filed, to ascertain their causes, and to explore their nature. The researchers analysed the findings and gave recommendations on various ways to minimise construction claims.

In addition, Faridi and El-Sayegh (2006) in the UAE noted that more than half of construction projects suffer from delays. A survey administered to 105 industry practitioners revealed 43 factors associated with delays. The researchers included contractors and consultants in the study but excluded clients. The most important factors associated with delays were related to logistics, in the form of late preparation and approval, inadequate planning, inadequate manpower, indecisive clients, low productivity, poor management,

under-skilled labour, equipment and material inaccessibility, approval challenges within the government and municipal authorities, and financing challenges by contractors. Other common factors contributing to construction project delay in the UAE, Lebanon, and the Kingdom of Saudi Arabia were client indecisiveness, and insufficient availability of materials. It should be noted that Faridi and El-Sayegh (2006) found that individual factors did not have equivalent effects across the UAE and the KSA. Consequently, the study concluded that the key factors which give rise to construction project delay are context-dependent, the implication being that generalisation is not advisable.

Motaleb and Kishk (2013) also examined the factors causing delays in the construction industry in the UAE. Analysis of 35 construction companies drew attention to 42 factors. Some of the most critical factors associated with the greatest impact included altered orders, indecisiveness among clients, poor client representation, inexperienced clients, and poor construction site management. Moreover, the outcomes of the projects point to order changes, client factors, and related financial factors as major causes of delays. Financial and time overruns were also identified as widespread. A comparative investigation of earlier studies, including Faridi and El-Sayegh (2006), revealed that the major causes of delay had changed in the four-year period spanning the two studies. According to the clients, the lack of power to make decisions was the most prominent factor contributing to construction project delay.

In the study conducted by Ruqaishi and Bashir (2015), 44 factors were identified contributing to the backlog of projects. A total of 59 project supervisors participated in the research, and various factors related to delays were highlighted by the participants. The major delay factors drawn attention to by the project supervisors were as follows: poor management of the site by the contractors, inadequate project arrangements, delayed supply of materials, communication breakdown between project stakeholders, and inexperienced vendor communication in the professional and obtaining stages. Additionally, the project supervisors supported the idea that these causes of delay could be consistently observed across the GCC countries.

Finally, Hasan et al. (2014) examined factors that contribute to construction project delay in Bahrain. The researchers focused on project clients, consultants and contractors; they distributed a survey that listed up to 47 causes. The results indicated that for contractors, unskilled labour was a major factor

associated with delay, while according to project clients, the lack of power to make decisions was the key factor.

2.9.3 Projects Delays in the KSA

Al-Momani (2000) investigated the factors contributing to delay in 130 construction projects in the KSA. The researchers concluded that the principal causes of delay were linked to the designer, late deliveries, weather conditions, economic conditions, user changes, and increases in quantity. Moreover, the study highlighted the importance of inadequate numbers of qualified and experienced personnel, the lack of sufficient funding from clients for the completed work, material shortages, subcontractors' predicaments, the failure and scarcity of equipment, poor communication among stakeholders, and construction errors.

In the KSA-based study conducted by Al-Khalil and Al-Ghafly (1999), delays in government projects were organised into three categories namely: firstly, delays emanating from the project clients; secondly, delays attributable to engineering consulting firms; and finally, contractor-related factors in construction projects. The samples identified for the specific categories were identified as follows: firstly, clients, consisting of projects owned by the state; secondly, consulting engineering firms, consisting of 20 firms that specialised in construction works in the KSA's Eastern and Riyadh provinces; and finally, contractors, consisting of 200 individuals categorised as undertaking construction works in the national classification scheme.

The findings of Mohammed Al-Khalil's (2005) study revealed a collection of vital factors that contributed to delays. The most substantial of these was the issue of cash flow and – more generally – financial problems. These financial issues may be caused by the inability of the contractors or delays resulting from clients in processing the cash on time. The other important factor was the issue of the state allocating contracts to the lowest cost bidder, thereby disregarding their competence. In summary, the research primarily concentrated on contractors, consultants, and clients to analyse instances of delays in government projects, and to determine the most liable parties. The author found out that most projects experienced delays, and that the likelihood of delay was related in a directly proportional way to the size of the project.

Assaf and Al-Hejji (2006) conducted an extensive review of the construction industry in the Eastern region of the KSA. The objective of the study was to

determine the origins of delays in various projects. The study involved 23 contractors, 19 consultants, and 15 site owners, and it sought to examine how each group rated the importance and prominence of each cause of delay. Overall, one particular cause was common to all three groups: namely, an adjustment of the instructions by the site owner once construction works have begun. The researchers also found that numerous factors were shared between two of the groups, including payment delays, bad planning decisions, poor contractual scheduling, unproductive supervision, and shortage of finance. Additionally, the three groups of respondents agreed on the causes of delay that were the least prominent in the KSA's construction projects. These causes included alterations to governmental policies, restrictions to vehicles on the site, wider social and cultural influences, and incidents occurring during the project construction phase.

Similarly, Alkass, Mazerolle and Harris (1996) concluded that delays related to construction projects are enduring delay, even in the light of technological improvement and advancement. Therefore, the estimated completion dates continue to be postponed. Indeed, the researchers cited empirical evidence showing that delays are the most frequent and expensive issue that affects any given construction project. Furthermore, delays are often interrelated and interdependent, which makes the issue complicated and inherently multifaceted. For example, causes of delay such as failures in machinery, insufficient materials, inadequate planning, strikes, an alteration to instructions, and acts of God. The researchers further noted that, at present, the modes of examining and assessing these instances of delays are ineffective, expensive, and lengthy. In light of this, a new method of analysis has been developed, namely, the Isolated Delay Type (Alkass, Mazerolle and Harris, 1996). Active modes of analysis are pertinent in this industry because delays are expected, and so companies run the risk of finding themselves in costly legal cases.

Al-Kharashi and Skitmore (2009) observed that one of the principal challenges facing the Saudi government is the long duration needed for contractors to complete the allocated construction projects. The study concluded that approximately 70% of the construction projects undertaken by the Ministry of Housing experienced delays, while 70% of public construction projects overran the stipulated deadline. The researchers also found that project delay is the most severe challenge with respect to costs and the implications of rising expenses. This is because delay increases the direct expenses of the project, as

more must be done past the deadline, and contractors always have to request compensation. When it concerns public project, the case becomes increasingly complex given that the client is always the government. In particular, bureaucratic processes must be followed to resolve conflicts. The implication of delays for the government in such cases relate to budget disturbance, confusion regarding public plans and inconveniences.

For contractors, the impact of delay produces a longer construction phase, higher overhead costs and unplanned expenses, the entrapment of working capital in a single project, and an increased risk of revenue and output losses (Al-Kharashi and Skitmore, 2009). Additionally, the challenges resulting in the delay of contract delivery are dynamic, and they involve a high level of uncertainty. Therefore, these tend to be accepted by project stakeholders as inevitable, and they are considered a universal phenomenon affecting all projects. In their study, Al-Kharashi and Skitmore (2009) surveyed and interviewed contractors, engineers, and project owners. 5 major construction companies were selected in Saudi Arabia, and the respondents were recruited into the sample randomly. Each participant was given one month to complete the questionnaire. Approximately 86 surveys were returned, leading to a response rate of 43%. After analysing the data, the researchers identified reasons for the delay, and they drew on these findings to improve contractor performance and increase project success rates. The principal factors were as follows:

Client-Related Delays:

- Lack of finances,
- Poor work supervision,
- Payment processing delays and non-payments.

Contractor-Related Delays:

- Lack of experience,
- Underqualified technical staff,
- Financing difficulties,
- Conflicts between the contractor and their staff.

Consultation Delays:

- Contract review delays,
- Lack of consultants on site.

Labour-Related Delays:

- Shortage of unskilled and skilled workers,
- Workforce instability in the KSA.

Material Delays:

- Market shortages of construction materials,
- Procurement delays,
- Misinterpretation of drawings,
- Late mobilisation for construction.

Other critical factors affecting the timely completion of construction projects in the KSA were identified as follows, by Al-Kharashi and Skitmore (2009):

- Lack of drawings' clarity and specifications,
- Inadequate time for the contract,
- Insufficient employee allowances,
- Cover up of defects by consultant when they occur,
- Poor quality management,
- The need for client to analyse the project as it progresses,
- Inadequately experienced engineers,
- Inadequate consultation between the involved parties,
- Unclear instructions on the scope of work,
- Lack of clear study of the contractor by the client before hiring,
- Selection of contractors offering the lowest price for tenders,
- Lack of ethics,
- Poor pay for the consultant staff,
- Delay in employees' salary payments,
- Choice of construction materials that are not locally available.

Although Al-Kharashi and Skitmore (2009) outlined many factors that they regarded major contributors to construction project delays, they concluded by drawing attention to the three principal factors affecting projects in the KSA's construction industry. These were the failure to develop a strategic plan; the minimum involvement of the parties; and finally, disagreement between the parties. Regarding the first principal factor, they observed that most contractors lack an adequately developed strategic plan on how to execute the contract. This leads to crisis and confusion regarding the availability of materials and labour.

As for the second principal delay factor affecting projects in the KSA's construction industry, Al-Kharashi and Skitmore (2009) drew attention to the problems caused by the minimum involvement of the parties. In particular, the researchers observed limited participation from the client, namely, the government, in KSA-based public construction projects. The government is less aware of technical matters because it passes on the tasks to a consultant body.

Therefore, the clients know nothing of what is happening at the site, and therefore cannot make any decisions. Therefore, would be advisable for the government to provide consultations and encouragement to the contractors.

Finally, the third principal delay factor was disagreements between parties (Al-Kharashi and Skitmore, 2009). The researchers found that when conflicts arise between the three parties involved in the contract, this leads to a delay in completing the contract. This is due to the lack of a single management system, as all parties want to be involved in the running of the technical parts of the contract. With this in mind, modern management methods should be included to facilitate dispute avoidance.

Albogamy et al.'s (2012) KSA- and Jordan-based study identified 63 delay factors and applied a great index ranker. The study participants were asked to rank each factor based on its frequency of occurrence and its influence. The significance of the calculation was informed by severity and probability. The outcomes highlighted the ranking variations across the KSA and Jordan. In the KSA, the main causes of delay were substandard functioning of thelowest bidder contractor in developing tenders, delays in subcontractor activities, inadequate skills possessed by the contractor's workforce, poor project strategies, inadequate timetables, and delayed release of funds by the client. The main five causes of delay in Jordan revealed some noticeable differences in comparison to those of the KSA. These were as follows: substandard functioning of thelowest bidder contractor in developing tenders, delayed release of funds by the clients, design modifications by the client, insufficient strategies for the work requested by the contractor, inadequate project preparations at its launch.

An analysis was given by Mahamid and Dmaidi (2013) concerning the opinions of project owners on the causes of delay in KSA based public projects. A total of 22 public owners drew attention to 35 causes of delay. The outcomes revealed that the major causes of delay in public projects were as follows: assigning project tenders to thelowest bidder, poor communication methods, poor site management, delayed issuance of funds and unskilled workforce.

Table 2.3: Sample of GCC and KSA Delay Factors (Al-Kharashi & Skitmore, 2009)

Country	Study	Project Type	Factors
KSA	Al-Khalil and Al-Ghafly (1999)	Public projects	60
Kuwait	Al-Tabtabai (2002)	Public building and housing	54
KSA	Assaf and Al-Hejji (2006)	Massive construction	73
UAE	Faridi and El-Sayegh (2006)	Construction projects	43
KSA	Al-Kharashi and Skitmore (2009)	Public construction	112
UAE	Motaleb and Kishk (2010)	Construction projects	42
KSA and Jordan	Albogamy et al. (2012)	Public building	63
KSA	Mahamid & Dmaidi (2013)	Public construction	35
Oman	Ruqaishi and Bashir (2015)	Infrastructure construction	44
Bahrain	Hasan et al. (2014)	Infrastructure construction	47

2.10 Correlation of Factors Causing Delay in the Projects

It has become clear that the specific number of factors that lead to delays and their classification differ in many previous studies. However, a similar pattern of studies emerged, whereas the relative classification priorities seemed only different. Nevertheless, a total of 59 delay factors were considered worthy of close examination in this research. Therefore, the researcher allocated a specific number of factors that contributed to the delay based on those identified by Odeh and Battaineh (2002), as example:

- **Client Factors**

The factors include delays related to site preparation by the client, suspension of work, and difficulties in the payment system by the clients, see Table (2.4).

Table 2.4: Client Factors

Client Factors	- Delays in preparing and submitting the construction site
	- Delays in making payments to the contractor
	- Poor communication among stakeholders
	- Weak cooperation with the contractor
	- Excessive bureaucracy with the client
	- Poor coordination with the government
	- Slow decision-making
	- Unrealistically short duration
	- Order changes
	- Interference by the client

- **Contractor Factors**

The factors have insufficient experience, poor management, lack of materials, and manpower shortages. It is also notable that the contractor is responsible for the subcontractors' faults (Table 2.5).

Table 2.5: Contractor Factors

Contractor Factors	- Mobilisation delays
	- Slow order changes
	- Poor safety rules
	- Unskilled technical team
	- Incorrect study at the bidding stage
	- Site survey delays by the contractor
	- Poor management
	- Improper quality control
	- Submission planning delays
	- Difficulties arising from contractor financing
	- Finance issues with subcontractors
	- Construction incidents
	- Incorrect / Improper construction methods
	- Lack of experience
	- Inefficient work due to subcontractor changes

- **Consultant Factors**

These factors include delays in approving the contractor's work, slow inspections, and slow responses to the contractor's enquiries.

Table 2.6: Consultant Factors

Consultant Factors	- Poor qualifications of the assigned consultant personnel
	- Late drawing preparations
	- Delayed approval of the drawings
	- Weak communication
	- Inadequate design information
	- Delayed inspection
	- Poor response to contractor enquiries

- **Material-Related Factors**

These factors include productivity, shortages, and materials supply (see Table 2.7).

Table 2.7: Materials Factors

Material Factors	- Materials shortage
	- Difficulties arising from materials delivery
	- Specification changes
	- Prices increases

- **Labour Factors**

These factors include workforce, management, and work quality issues (Table 2.8).

Table 2.8: Labour Factors

Labour Factors	- Manpower shortages
	- Lack of skilled manpower
	- Lack of administrative engineer
	- Strikes and conflicts
	- Low productivity
	- Insufficient equipment

- **Contract Factors**

These factors include contract errors, changes to orders, and document-related problems (see Table 2.9).

Table 2.9: Contract Factors

Contract Factors	- Design complexity
	- Errors in drawings
	- Ineffectual penalties
	- Unclear specifications

- **External Factors**

These factors include changes in the organisation, weather, site conditions, and neighbour problems (see Table 2.10).

Table 2.10: External factors

External Factors	- Site conditions (soil type, etc.)
	- Cultural effects and social conditions
	- Traffic jams
	- Weather fluctuations
	- Government regulations (change)
	- Problems issuing work permits

2.11 Sustainable Development in Construction

One key tenet often encountered in human financial and community studies is the concept of sustainable development (also known as 'green development'). Central to our understanding of thinking in this area, the nature of which has been continually evolving, is the 1987 UN publication Our Common Future, as well as its later Conference on Environment and Development ('Earth Summit') held in Brazil in 1992 (UN, 2012). The organisation described the aim of sustainable development as being to provide a high standard of living for the current population, without causing undue damage and hardship to future generations. It is considered a complex issue with multiple considerations, which balances the protection of the natural world against the ever-increasing need for progress.

2.11.1 Introduction

The protection of nature and the desire for human progress are two notions which often find themselves in competition. Discussion around the question of how to meet the needs of both involves consideration of the interrelated ideas, which must be brought together into a unified whole. The purpose is to discuss two of these ideas: namely, living cities and sustainable communities.

The idea of sustainable communities implies thoughtful and well-planned urban development that in the immediate term and later on, is suitable for both residing and finding employment and providing a high standard of living for

residents, while remaining sympathetic to their setting. According to Hens (2010), a sustainable community is one which is constructed and governed effectively, promotes diversity, and defends the rights, prospects, and personal liberties of its population.

A second concept is that of the living city, which refers to an urban settlement with the appropriate infrastructure to ensure health, happiness, and a high standard of living for citizens. According to Pacione (2003), the living city encompasses the buildings where people live and work, who their fellow residents are and the relationships they have with them, the education and work skills held by the population, the available medical facilities, and general levels of wellbeing and fulfilment. As noted by Newton (2012), the most important difficult to overcome relates to the issue of balancing competing requirements.

In conclusion, as described by Dempsey and Jenks (2010), sustainability in an urban community is achieved by meeting the living requirements of the residents, freeing individuals from disadvantages, and providing all the necessary amenities regarding citizen fitness and illness prevention, schooling, accommodation, transportation, and law enforcement.

2.11.2 Sustainable Housing

Where people live is a key factor in determining their standard of living and general well-being, both for the individuals themselves and for the surrounding environment. The buildings themselves remain in their environment for a considerable time, and so – according to Berry (2006) – are fundamental when planning urban development to meet the needs of future citizens. Sustainable dwellings must take into account a number of factors, including location, aesthetics, construction, and their integration into the demographic context of the region. This is because such factors afford residents a safe, peaceful, and healthy day-to-day existence.

In addition, Edwards (2000) defines sustainable housing as follows: housing meets the present and perceived needs of the present in an efficient way to use resources while providing attractive, safe, and environmentally friendly neighbourhoods. (Figure 2.3)

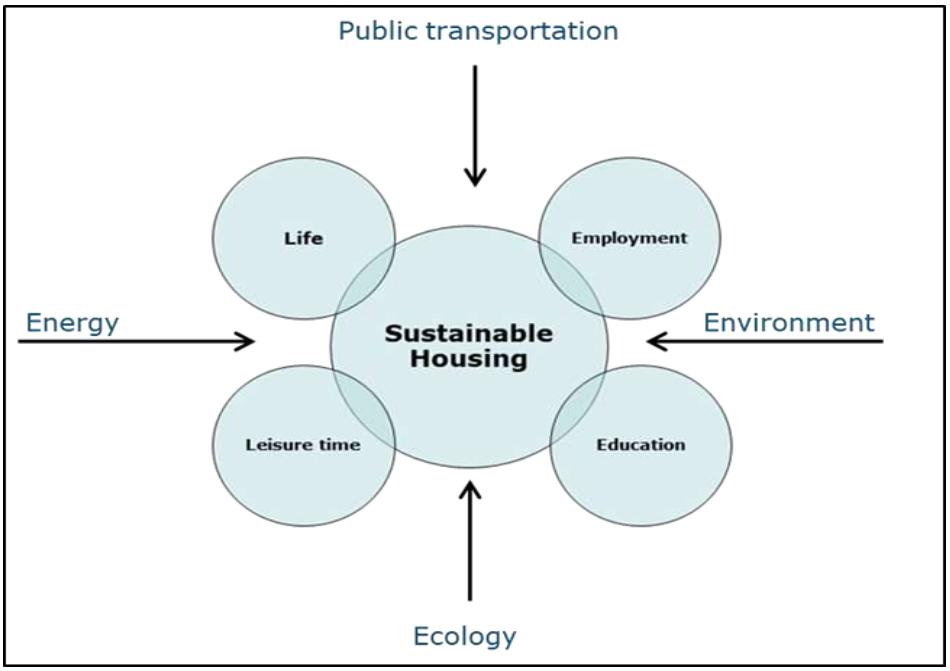

Figure 2.3: Relationships between sustainable housing and other related areas (Edwards, 2000)

A complex interplay also exists between human dwellings and the natural world. There is no question that providing new homes means using many raw materials which may be irreplaceable, from the sand, stone, and wood needed for construction to the power used to heat and light the completed building. In addition, human structures are prey to multiple threats from the natural world itself, such as earthquakes, floods, and other potential 'acts of God' - all of which must be taken into consideration when determining how to make urban expansion 'greener' (UN, 2012).

In order to minimise the impact of human settlement on the environment, taking into account the multiple issues involved, it is necessary to implement development guidelines. According to the UN's (2012) publication, each aspect of green development (e.g., impacts on nature, people and their relationships, and cultural and financial concerns) must be addressed by these guidelines. This encompasses multiple concerns, from the long-term effects of construction on global warming to the impact of housing quality on financial and family life. Also relevant are the questions of how it allows diverse groups within society to interact, how their unique cultures are supported, and how the disadvantaged can be helped to have a better standard of living.

Wealth should not be a prerequisite of having a resource-efficient home. Therefore, although this attitude persists in contemporary society, one aim of

sustainability is to improve access for all, including those earning lower incomes. Central, then, to the pursuit of green development is to find a way to provide environmentally-friendly dwellings at a reasonable cost. However, Sliogeris et al. (2012) warn that the desire to keep costs low needs to be weighed against any unintended detrimental effects on the natural world or to people.

Sliogeris et al. (2012) also suggested the need to consider construction within a wider social context. In particular, the researchers emphasised that construction should not be regarded simply as an activity concerned with creating standalone sustainable buildings, or even a set of such buildings, but rather as an activity which has an impact on wider urban society as a whole. According to Zuo and Zhao (2014), best practices in the domain of sustainability means taking multiple factors into account when planning urban dwelling development.

The UN's 'Habitat Agenda' describes the idea that every person has the right to a satisfactory living space. As such, this plays into our notions of what constitutes a 'green' dwelling that is also within the financial reach of all. According to CIB (2004), a satisfactory living space needs to incorporate the following factors at a manageable cost:

- Stable construction established using quality materials;
- Access to different areas of the dwelling for residents, without undue difficulty;
- Sufficient room to facilitate comfort;
- Access to clean water, heat, light, and fresh air;
- Facilities for managing waste, including bodily waste;
- A sanitary environment conducive to good health;
- Proximity to amenities such as shops.

2.11.3 Need for Sustainable Housing

The pursuit of greener construction gives us the chance to address some of the issues caused by sprawling urban development, increasing birth rates, and the resulting pressure on resources, social deprivation, poor quality of life, environmental worries, and the financial pressures experienced by many. By contrast, thoughtful housing design can improve how we use resources, including financial and social resources, and how we promote access to higher living standards while reducing impacts on the natural world (Abu Bakar et al., 2009).

Particularly in non-Western societies, the development of urban environments may be unplanned and somewhat chaotic, without a great deal of holistic oversight. Economic considerations may take precedence over the social needs and desires of citizens, as well as their long-term benefits and well-being (Sidawi and Meeran, 2011). Treating development in this way, without considering the bigger picture, can be considered to be hazardous, since it stores up problems and passes these onto future generations.

Contrastingly, urban development conducted in a considered, forward-looking, and planned fashion is highly worthwhile, especially if robust guidelines are followed (Sharifi and Murayama, 2012). The beneficial effects on a population with varying needs and preferences, including those at a financial disadvantage, will have long-term repercussions on everything from medical costs to social cohesion. It is also notable that effectively designed housing is less susceptible to damage and dilapidation, and so fewer maintenance costs are incurred.

2.11.4 Environmental Sustainability

According to Yates, Gabriel and AHURI (2006), the degree to which we can consider our homes 'green' depends on their effect on the natural world, associated concerns such as global warming, and the nature of the natural world's impact on the homes in return. Here, it is worth drawing attention to three specific issues concerning the interplay of urban development and the natural world:

- The use of raw materials such as stone, sand, wood, and water, as well as the power needed in construction activities and the land to build on;
- Threats posed by the natural world (such as earthquakes) or by the actions of people (such as contamination of the soil or water), or by both;
- The effect on the nearby landscape of human residents, such as the production of waste.

Taking a sustainable approach to construction planning offers a vital pathway for tackling these worries, both at a national and international level. Furthermore, it concerns how we use natural resources, produce waste, emit polluting substances such as carbon into the atmosphere, and manage other risks to human well-being.

To address the green issues surrounding the production of new homes, it is necessary to lessen the effect that home building has on its natural surroundings, including how it consumes resources and any pollution it creates. Alongside this,

special attention should be paid towards development and its environmental impact, its effect on human welfare and safety, and the way in which it informs hygiene maintenance and the goal of mitigating contamination. Finally, development should be future-proofed, made strong in the face of risk, and implemented with a view to further upgrades in the future (Yates, Gabriel and AHURI, 2006). Therefore, criteria may be affected by delay due to sustainability, the most important of which is the relationship between the environment and people. That is why the standards differ in their achievement and their real practices. For example, preserving the materials and how to use them during the projects, as well as disposing them upon completion. Each stage requires special treatment so that the environment will not be affected.

2.11.5 GCC Sustainability

According to AL-Zubaidi (2007), the energy sector in the Gulf Cooperation Council (GCC) plays a crucial role in social and economic development. Simultaneously, it is essential for economic growth, as well as the development of policies relevant to environmental issues across the GCC, and sustainability as well.

As a result of factors ranging from socioeconomic expansion and burgeoning populations to extensive industrialisation, domestic consumption of non-renewable forms of energy and other natural resources, including oil and gas, is growing among member states of the GCC. This is especially noteworthy in view of the fact that the economic foundation of many of these countries rely on the availability of hydrocarbons, and in particular, their exportation to other parts of the world. Although natural energy resource scarcity is not yet an issue in many of the GCC states, the increasing energy-intensiveness of their domestic conditions creates circumstances in which this may become a problem in the future, thus highlighting the unsustainability of the current position.

Fortunately, this fact is currently being recognised across the region, and it is now the case that measures are being taken to create a foundation on which renewable energy generation technologies can be implemented. This is especially the case among stakeholders in the construction industry, ranging from builders to site client. In particular, on the part of clients, the demand is prevalent for service providers to construct sustainable sites with respect to their energy consumption. This is reflective of a wider regional trend, characterised by the increasing commonality of buildings which now rely more

on renewable forms of energy (e.g., solar, wind, and water) than the non-renewable consumption of hydrocarbons.

2.11.5.1 KSA Sustainability

At present, as reflected by the government's promotion of renewable energy consumption nationwide, it is imperative for the KSA to underpin innovation rather than standard approaches. One of the main reasons for this is that progressive attitudes towards green, sustainable operations are becoming increasingly prominent across the KSA, with this fact attributable to the recognition that reliance on renewable rather than non-renewable energy generation technologies can enhance quality of life for the public. Sustainable development initiatives have been established by numerous enterprises, including non-governmental organisations (NGOs) and government agencies. Examples of prominent NGOs in this respect include the Saudi Environmental Society (SENS, 2019) and the Saudi Green Building Council (SGBC, 2019).

In the case of the SENS and the SGBC, each organisation is embedded within the Saudi construction industry, and its primary goal is to promote environmentally-friendly activities across the country. The majority of these enterprises' initiative's involve raising public awareness, guiding the construction industry regarding environmentally-friendly practices, motivating manufacturers and suppliers to adopt green supply and production activities, promoting green labelling, and offering relevant training schemes (SENS, 2019; SGBC, 2019). Nevertheless, it is important to recognise that the two enterprises depend on international building sustainable assessment tools (e.g., LEED), all of which were not formulated in view of the KSA's built environment. Therefore, in response to this, the purpose of this research is to establish a reasonable basis on which a modified environmental assessment system can be established, specifically in line with the built environment of the KSA.

2.11.5.2 Qatar Sustainability

As the MENA region's first performance-centred system, the purpose of the Global Sustainability Assessment System (GSAS) is to establish a built environment characterised not only by sustainability, but also by direct relevance for the Qatar and Gulf region. At the same time, GSAS was designed to be relevant for the region's surrounding environment (Figure 2.4). One of the defining features of GSAS is its performance-centred nature, which is paired

with the fact that it is a quantifiable rating system. Furthermore, GSAS is comparable to approaches including LEED and PBRS in that it seeks to interact with the following fundamental issues of sustainability: firstly, energy, water, and materials; secondly, indoor environments; and finally, cultural and economic value.

A key aspect of GSAS's development was that it capitalised on a systematic examination of evidence-based practice, a process which relied on the close analysis of the extant and related rating systems. This review was conducted to gain insight into the distinctive aspects of Qatar's culture, environment, and policy. In view of this, the sustainability criteria associated with other rating systems are not similar in the context of GSAS, and one of the main considerations for formulating the rating system's measurements relate to the need for a performance-centred and quantifiable system. Noteworthily, however, the outcome is a performance-centred rating system that can be applied to the distinctive conditions in Qatar's construction industry.

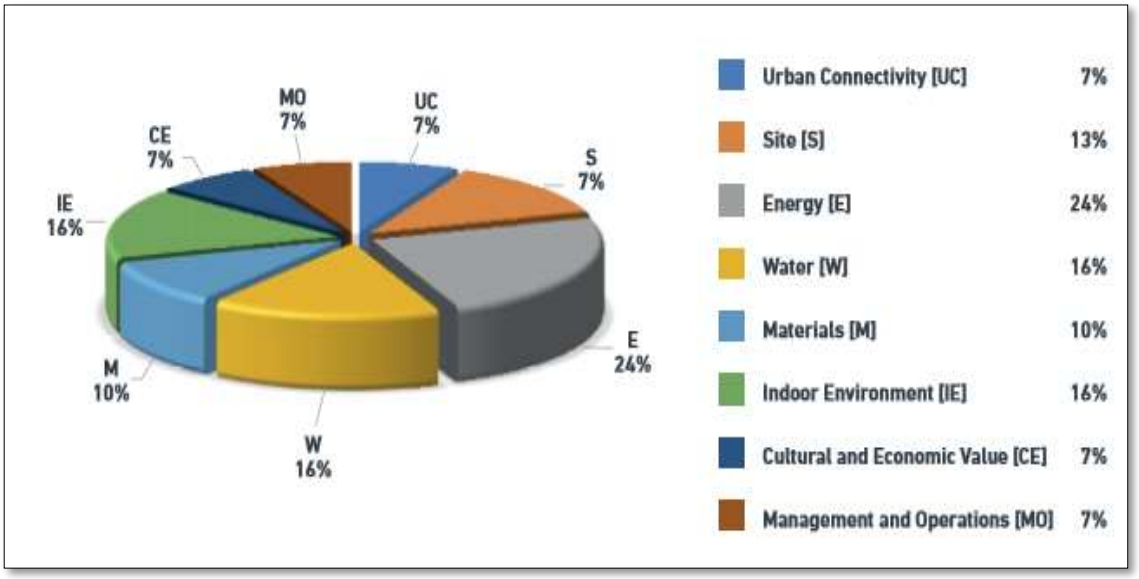

Figure 2.4: GSAS Category Weights (GSAS, 2016)

2.11.5.3 United Arab of Emirates (UAE) Sustainability

Entitled Estidama by the Abu Dhabi Urban Planning Council (UPC) and issued at the outset of April 2010, the Pearl Building Rating System (PBRS) is characterised by its comprehensiveness as a rating system (Figure 2.5). The underlying intention behind the design of the PBRS was to create a bespoke

rating sustainability assessment scheme for the United Arab Emirates (UAE) with respect to its cultural and climatic characteristics.

The following fundamental aspects of sustainability lie at the core of the system itself: firstly, environmental; secondly, economic; thirdly, cultural; and finally, social. Moreover, another important feature of PBRS is its focus on the sustainability of any particular development based on the entire lifecycle of the project, the delay may be direct or indirect. It is also noteworthy that the Estidama system offers design-related advice relevant to the rating of an initiative's potential performance (Estidama, 2018).

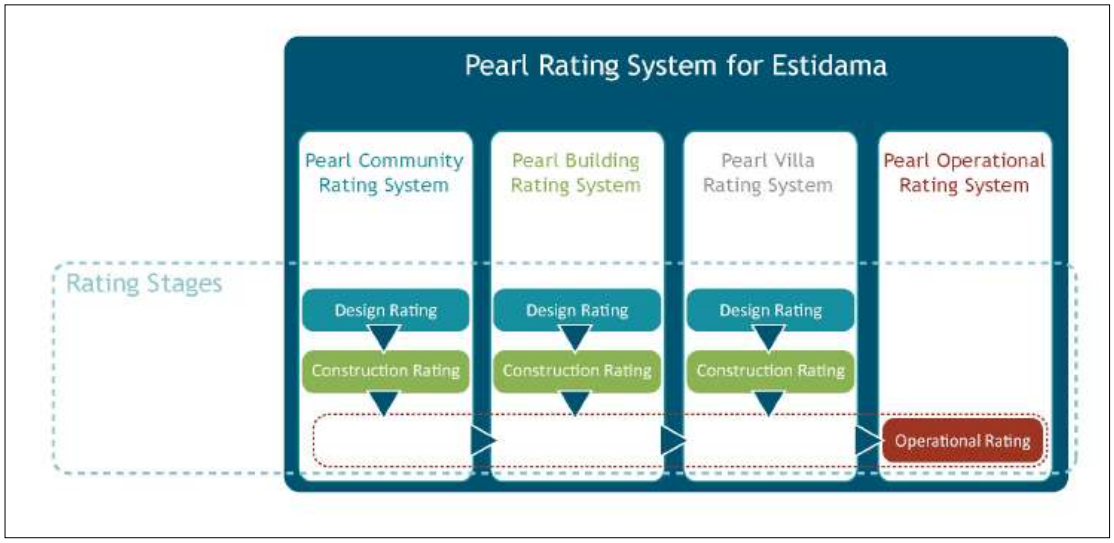

Figure 2.5: Links between the Pearl Rating Systems (Estidama, 2018)

2.11.6 Sustainability Rating Systems

In the last three decades, a variety of green building assessment systems have been implemented around the world. Developed and developing countries have their own systems and methods for the rehabilitation or maintenance of green buildings (GRIHA, 2010). Some of the prominent rating systems are BREEAM, LEED, and GBTool. Noteworthily, the overarching purpose of green-building classification systems is to focus on the issues of energy, environment, and sustainability. For example, in 2015, ISO 14001 - the leading standard in environmental management system (EMS) - was significantly updated (IEMA, 2017). The updates aim to achieve the future use of the standard that creates well-suited management systems to deal with environmental sustainability challenges.

2.11.6.1 LEED

The United States Green Building Council (USGBC) is a public not-for-profit body which works to encourage a sustainable approach to construction, design, and building usage. As described in their 2011 publication, a team at the USGBC created the LEED programme, the purpose of which is to accelerate the worldwide introduction of sustainable construction. According to Zimmerman and Kibert (2007), LEED certification, which is voluntary by nature, represents a straightforward way in which to verify that a building satisfies a range of criteria relating to its environmental impacts and resource consumption. To provide an overall score or rating, all measures are considered on an equal basis, without giving greater emphasis to some over others.

The LEED is characterised by 35 thematic areas, each linked to a unique goal. In each part, Specific measures can be identified and included in the home. These measures, usually, are organised as follows: good practices (mandatory measure), better practices (worth a point), and best practices (worth two points) (USGBC, 2019).

Table 2.11: LEED Requirements (USGBC, 2019)

Credit Category	Prerequisites (Mandatory) Measures	Minimum Point Requirements	Maximum Points Available
Innovation & Design Process (ID)	3	0	11
Location & Linkages (LL)	0	0	10
Sustainable Sites (SS)	2	5	22
Water Efficiency (WE)	0	3	15
Energy & Atmosphere (EA)	2	0	38
Materials & Resources (MR)	3	2	16
Indoor Environmental Quality (EQ)	7	6	21
Awareness & Education (AE)	1	0	3
Total	18	18	136

2.11.6.2 BREEAM

The Building Research Establishment (BRE), a venerable institution which provides advice and consultancy on construction and its impacts, has been in

operation for almost a century. In the early 1990s, BRE developed BREEAM, but the organisation has also developed a range of other methods (BRE, 2019). The purpose of BRE is to assess the environmental impact of building work, including tools for lifecycle impact analysis and the construction of new homes.

According to BRE's own 2011 publication, the BREEAM system puts in place a framework for meeting the highest possible standards when planning construction. Due to this, it is possible to calculate and understand the different impacts of the structure on the surrounding environment. Kibert (2013) described how the BREEAM system assigns weights to the different criteria, which are arrived at by a process of discussion with stakeholders. At the outset, key areas are measured against 'standard' expected results. Following this, points are awarded against a number of topics and subtopics, which may be adjusted to the project's individual needs. These weighted points may be added together, and the total rolled over, or a separate assessment method such as the Standard Assessment Procedure 2009 may be employed. Finally, a single final rating is awarded, ranging from 'Good' to 'Outstanding'.

2.11.6.3 GBTool

According to Chew and Das (2008), the Green Building Tool (GBTool) framework comprises four descriptive levels, from the top generic domain (constituted of a single goal) to increasingly specific 'problem' and 'category' criteria. Each smaller consideration is scored on a scale from -2 to 5. Designing it in this way allows operators to set their own priorities for attention, based on their national customs and practices. According to Lee and Burnett (2006), groups using the tool in different countries have suggested modifications in terms of how the scores are accrued, and new recommendations have been given regarding the issue of how scores influence the final result.

Table 2.12: Key Features of LEED, BREEAM, and GBTOOL (Yoon & Lim, 2016)

Items	LEED	BREEAM	GB Tool
Developed by	USGBC	BRE	iiSBE
Location & year	US, 1998	UK, 1990	Canada, 1998
Category	- A sustainable site - Indoor environmental - Quality - Energy & atmosphere - Water use efficiency - Materials & resources - Innovation - Regional priorities	- Management - Health & wellbeing - Transport - Materials - Water waste - Land use & ecology - Pollution & innovation - Energy	- Site selection - Project planning & development - Energy & resources - Environmental loadings - Indoor environmental quality - Service quality - Economic & social aspects - Cultural & perceptual aspects
Building assessment	- Residence - School - Retail - Commercial building - Multifunction building - Health care	- Residence - School - Office - Retail - Commercial building - Multifunction building - Health care - Court - Unusual building	- Almost any building
Flexibility	- Flexible in the USA & abroad relatively	- Flexible in the UK & abroad relatively	- High flexibility around the world
Approach to scoring criteria	- Additive simple approach (1 for 1)	- Additive Pre-weighted credits	- Additive improved weighted scoring approach
Ratings	- Certificate 40-49 points - Silver 50-59 points - Gold 60-79 points - Platinum 80+ points	- Unclassified <30 - Pass ≥ 30 - Good ≥ 45 - Very good ≥55 - Excellent ≥70 - Outstanding ≥85	- -1= unsatisfactory - 0= minimum acceptable - 1to 4= intermediate performance levels - 5= best practice

2.12 BIM Implementation

Due to the development achieved through the application of BIM in different places and projects such as Scandinavia and the UK (Cabinet Office, 2011), it has proven useful in projects. Also, many countries have endeavoured to implement BIM in their projects to reduce time, cost and achieve quality. Therefore, it was used in developing the framework to achieve the above.

2.12.1 Introduction

BIM or Building Information Modelling is a digital solution that has introduced revolutionary changes in the construction industry that have been both accepted and lauded on the global scale. It has been deemed as a pathbreaking change that allows for a collaborative methodology backed by a robust process driven approach that ensures countless benefits from inception to facility management and more. Its successful adoption on a global scale, majorly by developed nations such as UK, Singapore, Australia, Germany and USA, has been highlighted through research, industry reports and surveys (Cabinet Office, 2011).

2.12.2 Implementation BIM in the UK

As presented by Cabinet Office (2011), the adoption strategy of BIM in the UK picked up pace after the UK Government's construction strategy mandated a minimum of level 2 BIM in all major public sector projects by 2016. In 2012, the National Building Specifications revealed a survey that the use of BIM across the construction industry increased from 10% in 2010 to 39% at the time of the survey and the percentage of people unaware about BIM reduced from 43% to 6% in the same period (Cabinet Office, 2011). This result was bettered in the 2013 survey with a total of 73% of the construction industry adopting BIM, with the UK industry poised to surpass its level 2 target set for 2016. These figures paint a very good picture and indicate the progress of the industry. Therefore, it is necessary to allocate resources for training and development to better serve BIM's needs and benefits to better achieve project objectives, as well as to mitigate problems and conflicts during project phases.

Regardless of all challenges, the UK is a world leader in working towards a more efficient and productive construction industry through better information management with BIM.

2.12.3 Implementation BIM in Hong Kong

The Hong Kong Housing Authority (HKHA) has been one of the pioneers leading the way for BIM adoption with BIM enabled designs, coordination of construction in public housing projects, and sustainability studies since 2006. All the efforts in this regard are on complete compliance with the directives laid down by the regulatory policy of the Development Bureau of Hong Kong. To promote the adoption of BIM by the construction industry at large and encourage sharing of

feedbacks and reviews, a BIM centre was established within the HKHA headquarters in 2009. While HKHA is certain that BIM improves productivity and efficiency due to better collaboration, conflict detection, design optimisation and planning of the construction process, it is also of the opinion that it can help save time and cost and eventually eliminate wastage (Wong et al., 2011).

HKHA aims to increase the use of BIM in the industry to cover all projects from 2014-2015, as well as promote its ease of use by researching on more applications such as automatic extraction of bill of quantities from BIM models, integration with specification, verifying building codes to adhere to building regulations and prefabrication to name a few. It also proposes that in times to come BIM will no longer be a desired skill but a required skill in the construction industry (Wong et al., 2011).

2.12.4 BIM Implementation in the GCC

Successful adoption of BIM in numerous projects by companies in the GCC region has created both an interest as well as a market for the adoption of BIM amongst the countries, with the government promoting the idea.

2.12.4.1 BIM in the UAE

In the last decade, the real estate industry in the UAE has been on a rise with the construction industry growing at an annual growth rate of 5% since 2016 (Deloitte, 2014). The industry has over 30 billion USD worth of construction contracts for infrastructural and housing projects. This rise is especially prominent on Dubai with work starting on stalled projects and a growth in the number of government-led infrastructure projects where technology can help create, manage and execute projects with better efficiency. The need of latest technology that reduce both cost and time while increasing quality is only amplified by the sheer scale of the projects and the strict timeline to deliver results before major events, such as Expo 2020. This makes the adoption of BIM inevitable and its compulsory use for all public-sector projects from 2013, as directed by Dubai Municipality, does not come as a surprise.

The use of BIM has been made compulsory by Dubai Municipality for architectural and MEP projects with 1) 40 stories or more; 2) area of 300,000 sq. ft or more; 3) hospitals, universities, and other such dedicated buildings; 5) all projects being delivered by an external stakeholder. Deloitte (2014) suggests that the step to make BIM compulsory in the region is driven largely by the

quantifiable and proven results of BIM in reducing project cost and time, enhancing construction quality, and allowing for collaborative efforts amongst participants in various project phases. In countries such as the Abu Dhabi and Al-Ain the universities are playing a major role in informing the industry about the benefits of BIM adoption and its workings to support the efforts of the government towards BIM adoption (Gomez, 2013). One of the most well-known examples of BIM enabled projects in Abu Dhabi is the Louver Museum, Abu Dhabi.

2.12.4.2 BIM in the KSA

The King Abdullah University of Science and Technology built in 2007 is one of the major landmark projects built in KSA with outstanding BIM management (BuildingSMART-ME, 2011). The project client, contractor and consultant adopted BIM from the conceptualisation and design phase to project completion and highlighted the following advantages:

- Better design that allows for the use of renewable energy resources and reduces CO_2 emissions.
- Around 25% decrease in total energy cost,
- Over 70% of construction waste was recycled,
- Preservation of natural habitat through the visualisation aspect of BIM,
- Better utilisation of local material and off-site manufacturing options,
- Timely completion of project due to better collaboration and accuracy (Sharif, 2011).

In summary, the harmony between stakeholders has been a success of the project. Moreover, the collaboration was so unparalleled that delays in the project were avoided, and it was a challenge to accomplish such a huge project with such success.

2.13 Project Management Frameworks

Frameworks can be viewed as maps, models, or diagrams of the relationships that exist between the variables relevant to a particular issue, system, or process (Leshem and Trafford, 2007). More specifically, as described by Paradies and Stevens (2005), a framework can be considered a "diagram of proposed relationships among a set of concepts, factors, or variables about a particular hypothesis, question, context, problem, or topic". Frameworks are

versatile because they can be designed to illuminate wide-ranging issues, systems, or processes, and they serve as valuable visualisation tools for key stakeholders (Leshem and Trafford, 2007). Notably, an especially active area of framework design is the field of healthcare and public health (Paradies and Stevens, 2005), in which frameworks have proved useful in specifying what types of delays affect specific services, and elucidating the variables which drive innovation in healthcare delivery systems (Omachonu and Einspruch, 2010).

In this regard, frameworks defined by Paradies and Stevens' (2005) definition, are regularly used in construction project management studies, often with the intention of determining how and why delays occur in certain contexts, or how specific processes can be improved. For example, Altarawneh, Thiruchelvam, and Samadi's (2017) UAE-based study presented a conceptual framework which outlined the critical success factors that contribute to delays in infrastructure construction projects. As shown in Figure 2.6, this conceptual framework identified six variables, and subsequently mapped the direct positive association between these variables and project delays using single arrowheads. As a more complex example, Yap, Abdul-Rahman, and Wang (2016) designed a conceptual framework to promote the effective management of design changes in building construction projects. The researchers applied the system dynamics (SD) methodology to formulate their framework, the key advantage is the methodology's ability to capture and reflect the non-linear relationships that exist within highly-dynamic systems (Figure 2.7) (Yap, Abdul-Rahman, and Wang, 2016).

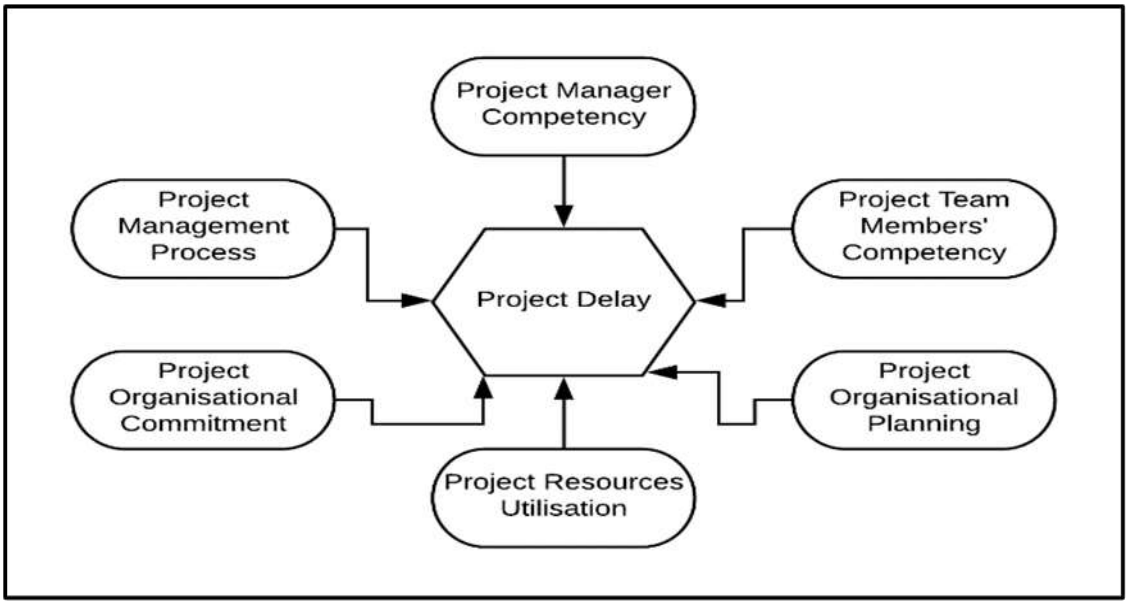

Figure 2.6: Conceptual Framework of delays in Infrastructure Construction Projects in the UAE (Altarawneh et al., 2017)

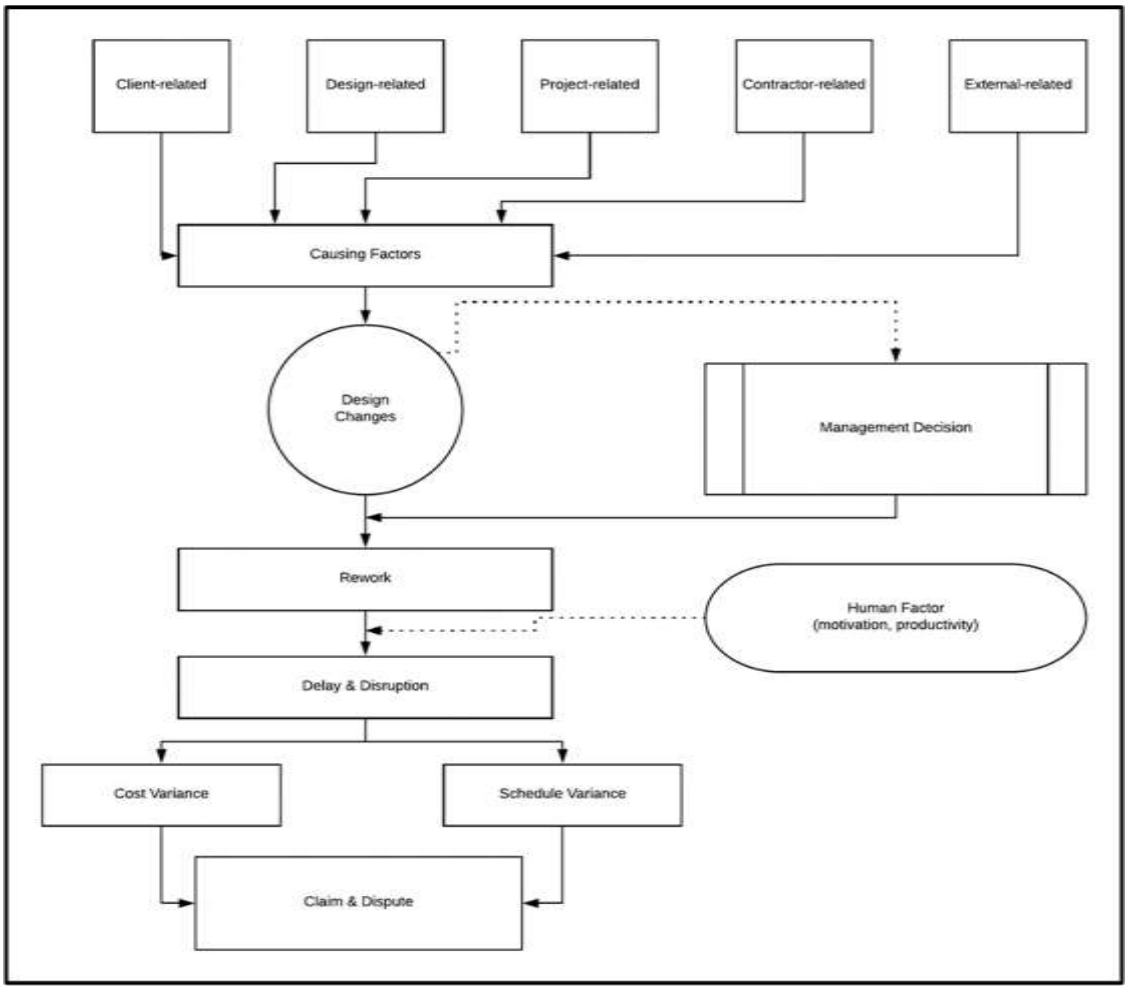

Figure 2.7: Conceptual Framework to Promote Effective Management of Design Changes for Building Construction Projects (Yap et al., 2016)

2.14 Discussion

Despite the enormous resources held by the Saudi government, previous studies have identified financial issues as the major contributing factor to public construction backlogs in the KSA. Additionally, the literature has revealed issues concerning bureaucracy in Saudi government departments, particularly those tasked with the responsibility of approving project finances.

It is clear from the findings of studies carried out in many countries that the causes of delay are comparable. However, specific modifications and combinations, levels of significance, and positioning differ for the factors in each country. The system of relations between clients, contractors and consultants is the most important area that will be investigated to ensure the smooth running of construction. The other areas that require consideration are the domains of administration and finance. For example, due to lack of awareness and the absence of strict regulations, the emergence of sustainable homes in the Saudi construction market has been minimal.

Since the construction sector is a vital part of any economy, it has been the topic of major studies, investigations, critical analyses, and examinations among scholars and professionals in recent years. In this way, the construction industry can be considered the meeting point of corporate and academic concerns. However, the issue of the most appropriate method for minimising delays in the construction sector is still being deliberated, and no resolutions have yet been made.

There is, however, progress after each phase of the study. Although most of the main aspects are almost the same, differences still exist with respect to the patterns in various countries. Key findings reported in the literature regarding the principal factors contributing to construction project delay are given in Table 2.13.

Table 2.13: Delay Factors Identified in the Literature

	Arditi et al. (1985)	*Mezher and Tawil (1998)*	*AlKhalil and AlGhafly (1999)*	*Al-Momani (2000)*	*Odeh and Battaineh (2002)*	*Al-Tabtabai (2002)*	*Assaf and Al-Hajji (2006)*	*Faridi and El-Sayegh (2006)*	*Sweis et al. (2008)*	*Abd El-Razek et al. (2008)*	*Al-Kharashi & Skitmore (2009)*	*Motaleb and Kishk (2010)*	*Pourrostam & Ismail (2011)*	*Albogamy et al. (2012)*	*Ruqaishi & Bashir (2015)*	*Mahamid (2013)*	*Hasan et al. (2014)*	*Fugar & A.-Bah (2010)*	*Sambasivam & soon (2007)*	*Toor & Ogunlana (2008)*
Site preparation	✓						✓		✓		✓									
Claims payments			✓						✓		✓									
Suspension the work			✓				✓		✓		✓						✓			
Change orders: issuance			✓			✓	✓		✓		✓							✓	✓	✓
Slowness decision-making		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Delays of payment	✓	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		
Poor communication			✓			✓					✓									
Coordinate with government departments			✓			✓					✓									
Variations during process	✓			✓	✓	✓		✓	✓	✓		✓	✓	✓		✓	✓			
Short contract time	✓		✓		✓	✓	✓	✓			✓	✓	✓		✓	✓				✓
Replacement of key staff											✓									
Client interference			✓						✓		✓				✓		✓	✓	✓	✓
Tendering process			✓				✓				✓		✓	✓		✓	✓			
Head-office participation			✓							✓										
Mobilisation delays			✓			✓	✓		✓		✓	✓								
Safety rules					✓				✓	✓										
Crew efficiency			✓				✓				✓			✓				✓	✓	✓
Incorrect study		✓						✓			✓	✓		✓	✓					
Scheduling & planning			✓		✓	✓		✓	✓	✓		✓		✓	✓		✓	✓	✓	✓
Insufficient site-survey			✓							✓	✓									
Monitoring process									✓		✓			✓	✓			✓		✓
Quality supervision: ineffective		✓							✓	✓	✓				✓					
Prepare submissions		✓						✓			✓			✓						
Funding issues		✓	✓	✓			✓	✓	✓	✓		✓	✓		✓		✓	✓	✓	✓
Sub-contrctors complications		✓	✓		✓					✓			✓	✓	✓					
Construction incidents		✓					✓										✓			
Working ways		✓	✓		✓		✓	✓					✓	✓		✓	✓	✓	✓	✓
Terrible weather	✓		✓	✓	✓	✓	✓	✓		✓			✓	✓	✓	✓	✓	✓	✓	✓
Subsurface conditions	✓	✓		✓	✓	✓	✓	✓					✓	✓				✓	✓	✓
Traffic	✓	✓	✓				✓					✓				✓	✓			
Cultural conditions	✓	✓	✓			✓	✓							✓	✓	✓	✓			
Location conditions		✓	✓			✓	✓			✓				✓	✓			✓	✓	✓
Delays of inspections			✓			✓	✓	✓	✓		✓	✓	✓				✓			✓
Slow response to queries		✓	✓						✓	✓								✓	✓	
Rigidness							✓				✓									
Variations approvals				✓	✓		✓				✓			✓			✓			
Lack of equipment		✓	✓		✓		✓		✓	✓	✓	✓	✓	✓	✓					
Low productivity	✓	✓	✓				✓	✓	✓			✓			✓					
Lack of manpower		✓	✓		✓		✓	✓	✓	✓	✓	✓	✓		✓		✓			
Weak manpower skills	✓	✓	✓			✓	✓	✓	✓		✓	✓				✓	✓	✓	✓	✓
Administrative staff			✓						✓	✓	✓			✓						
Disputes and strikes												✓			✓			✓		✓
Scarcity of materials	✓	✓	✓		✓		✓	✓	✓	✓	✓		✓	✓			✓	✓	✓	✓

Delays of delivery		✓	✓	✓			✓	✓	✓	✓	✓	✓	✓					✓		
Specifications changes		✓	✓				✓		✓	✓	✓			✓	✓	✓				
Rises of material prices	✓	✓	✓			✓			✓								✓	✓		
Difficulty of project design							✓											✓	✓	
Specifications errors		✓	✓	✓	✓	✓	✓	✓	✓		✓		✓			✓	✓			
Ineffective fines			✓			✓	✓				✓									
Stakeholder intervention			✓				✓													
Main conflicts		✓					✓			✓	✓			✓	✓	✓				
Complexity of permits	✓	✓	✓				✓	✓	✓	✓	✓			✓			✓			
Change regulations									✓					✓	✓	✓	✓			

Delays are caused by various complex and interrelated factors (Swiss et al., 2008). Past studies have attempted to minimise these complexities by separating factors into specific categories for easier scrutiny. Noteworthily, the findings from studies which have sought to do this highlight a particular array of problems that give rise to backlogs. These problems are caused by specific parties concerned with the project, including the client, contractor, or consultant. The magnitude of the problem's impact on the project tends to differ due to a number of issues, particularly in cases where resources are related.

Moreover, factors that have a considerable impact on the backlog are identified as financial factors, such as when the project client fails to pay the contractor in time to complete the work. It is therefore difficult for the contractor to follow up and support the project activities (Odeh and Battaineh, 2002).

Furthermore, Assaf and Al-Hejji (2006) specified workforce resources as a major factor that creates problems in any given project. Most workers are not effective, and they lack adequate skills despite their level. Such an issue increases the number of problems that contractors must face in addressing their finances, especially for those who have qualified for the tender after submitting the lowest bids.

The uncertainties surrounding recruitment issues often lead to problems for contractors due to sub-optimal project management methods, as well as failure to achieve agreed project objectives. Staffing is, therefore, a major factor that contributes to construction delay (Sweis et al., 2008). Further, Zwikael and Globerson (2004) stated that successful completion of a project necessitates adequate strategies and preparations, since any modifications in terms of these aspects will affect the control of resources (e.g., staff, materials, tools, etc.) throughout the project.

As mentioned by Abd El-Razek et al. (2008), that the above factors lead to ineffective site-management, so naturally this has a negative impact on

contractual engagements between the major players in the project (i.e., client, contractor and consultants). As a consequence, the problem broadens whenever any of the stakeholders become dissatisfied (Mezher and Tawil, 1998). Therefore, for the project to progress well, the client must make well-timed decisions (Faridi and El-Sayegh, 2006). Furthermore, effective planning should be assured by the client both before and during the project phases (Sweis et al., 2008). It is, however, not sufficient simply to satisfy these targets, especially in the public sector. Various factors hinder effective planning, including imprecise project demands and protracted decision-making for regular procedures. Whenever it is unclear who the project client is (Al-Kharashi and Skitmore, 2009), the outcomes can create problems when trying to match the processes with the other stakeholders. This is also the case when essential work permits are delayed due to third-party issues.

A majority of studies, such as Al-Kharashi and Skitmore (2009), conducted in this field support the view that payment delays from the project clients to contractors is a common occurrence. And, the most common outcome of late payments was identified as important delays to the project and disagreements. This may be the result of decision-making processes that are time-consuming and which are designed to satisfy strict conditions. The study also indicated that, in most cases, clients slowed down the process of clearing claims presented by the contractors.

Additionally, contractors agreed with the fact that clients intentionally failed to accept claims resulting from administrative issues. The disruption by the project clients was also pointed out as a major contributor to project delays. Also drew attention to the fact that many clients may hinder the process of accessing the project site for their contractor. In the majority of construction projects, serious delays are also created due to order changes (Arditi et al., 1985). As a consequence, it is understood that the contractual duties of the key project stakeholders are fundamental for almost all projects.

The factors contributing to project delays, as discussed in the above context, are not universal across all industries. Although it may cause a delay somewhere, they can have the opposite effect in another. For instance, the project client may hinder the proficiency of a contractor in one setting, and the contractor may disapprove of the client's contractual obligations. Nonetheless, some studies demonstrate that delays in projects represent a certain matter, and with this in mind, their impact must be lowered to ensure success is realised.

The delay tends to develop with regard to the execution of activities in a project, despite the fact that project management is an area in which structured approaches are widely employed. Furthermore, each project is carried out within a specific condition, so researchers are often asked to analyse elements that have not been considered before. Therefore, it is necessary to study the factors that contribute to delaying the implementation of housing projects that involve construction in the Kingdom of Saudi Arabia (Figure 2.8).

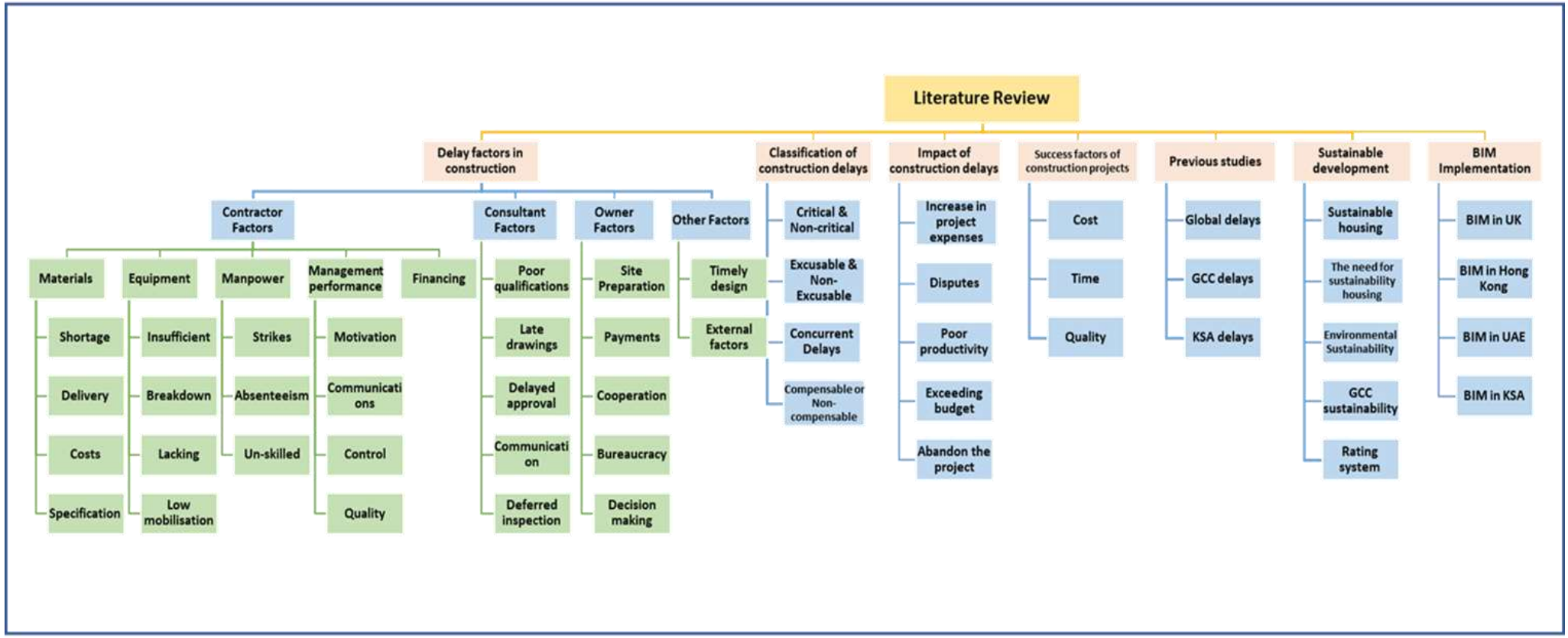

Figure 2.8: Summary of the Literature Review

2.15 Conclusion

In fact, the literature review contributes to reaching relevant studies that address factors and causes of delays in implementing housing projects. A few research studies were identified that had investigated the delay factors affecting construction projects in Saudi Arabia. However, these findings facilitated the identification of more than 60 delay factors. These were further subdivided into many categories associated with the following, for example: the client, the contractor, the consultant and external factors. Using a survey and interviews, the following chapters of this dissertation will evaluate these factors and categories. More specifically, the survey will consider the perspectives of construction specialists, including contractors and consultants, to assess the factors of delay.

The literature review also found that it is possible to improve the quality of housing projects by meeting the sustainability requirements (LEED) of each project. This is in line with the surrounding environment of the project, which promotes the public welfare. Through its use as a design guide and a third-party tool, the evidence indicates that LEED has improved the well-being of residents, economic returns, and the environmental performance of buildings through effective practices, standards, and innovative technologies.

In addition, LEED is the standard applied in the KSA. But the ministry ignores this in their housing projects. With regard to the reasons that led to the delay of the delivery of some housing projects, the Ministry of Housing began to build the dwelling units before their infrastructure works, ignoring the final quality of work. This is a clear indication that there is no relationship between the implementation of sustainability and delays in projects, but the ministry preferred to reduce the budget of projects at the expense of the specifications of their buildings, as well as the bad choice of the contractor.

Moreover, BIM creates efficiency and users will get many benefits. They will realise some of BIM's greatest value by being able to reduce redrafting of data, such as re-entering information into forms or making changes in this field. Thus, the more efficient the users, the better the chances of productivity.

The following section will investigate the research strategy implemented, the methodology employed in designing the survey, the sampling strategy, and the procedures utilised to recruit participants. It will also detail the statistical and mathematical techniques employed for data analysis.

CHAPTER 3: METHODOLOGY

3.1 Introduction

This part details the research that assessed arguments both for and against the assertions, providing data that confirmed or rejected different explanations for the construction delays. A comprehensive research plan was devised to obtain relevant data from the different stakeholders and experts. At this stage, the study mainly focused on readily accessible data. Primary and secondary data, as well as field research and surveys, were gathered using varied techniques and procedures.

In terms of the structure of this section, it begins with a broad overview of the key methodological considerations involved in the present research project. Section 3.2 also introduces the metaphor of the research onion (Saunders et al., 2012), explains how and why it is useful, describes how it was used to inform this study's methodology, and highlights the core methodological features of the present research (i.e., in terms of research philosophy, research approach, research strategy, etc…). Following this, details are provided about the chosen research philosophy, the methodological choice, the research strategy, the time horizon, and the study's techniques and procedures (i.e., data collection, data analysis, the pilot study, and the sampling technique). Finally, since this research involved human participants, relevant ethical considerations are drawn attention to.

Additionally, to ensure that the decisions made in this study about how data were gathered and analysed were not arbitrary, and thus to maximise the coherence and reliability of the study and its findings (Saunders and Tosey, 2013), Saunders et al.'s (2012) widely-used metaphor of the research onion was leveraged to guide and report on the study's methodological design.

The basic idea of the research onion metaphor, as shown in Figure 3.1, is that the process of designing a piece of research consists of various stages, which can be conceptualised as layers surrounding a central core of data collection and analysis (Saunders et al., 2012; Sahay, 2016). Using the research onion to design and report on a piece of research is strongly advocated by many methodologists, principally because it ensures that researchers consider essential elements (e.g., philosophy and strategy), as well as the ways in which these elements are interrelated (Al Zefeiti and Mohamad, 2015).

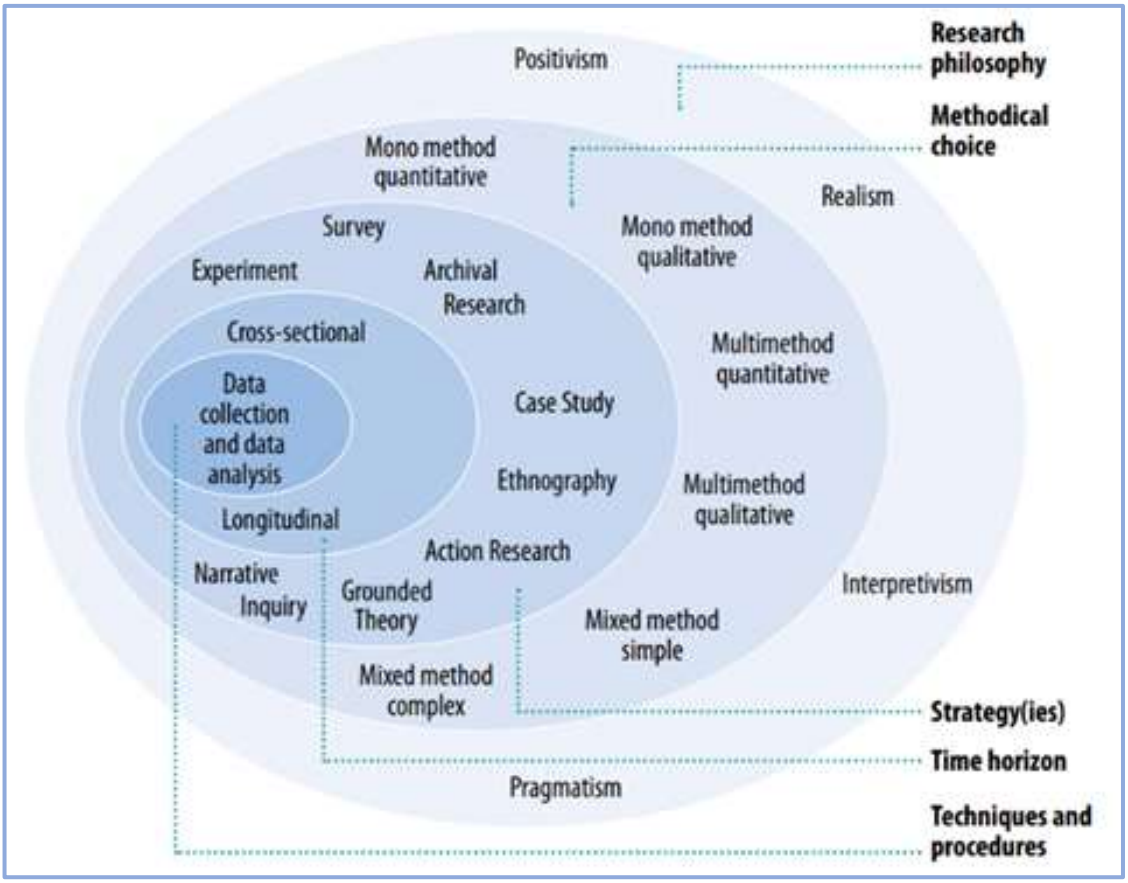

Figure 3.1: Research Onion (Saunders et al., 2012)

3.2 Key Methodological Features

Based on the research onion, the key methodological features of the present research design are illustrated in Figure 3.2. It is worth noting that, consistent with the recommendations of Saunders et al. (2012), each of the methodological features of the study's strategy of inquiry and research design was informed by the research aim, objectives, and the chosen research philosophy of pragmatism. Further information is given about the rationale for selecting each of these methodological features in the following sections.

3.3 Research Philosophy

Philosophers have long argued about the connection between knowledge itself and the process by which it is acquired. Lack of clarity on this issue can be highly detrimental to the quality of the research. As Easterby-Smith et al. (2008) argue, since different philosophical standpoints have different implications for research

strategy, questions, and methods, this issue must be taken into consideration while devising the research design.

On the basis of these protocols and principles, researchers can decide what to include or exclude in their research and judge what sort of inferences they can make during data evaluation. By defining questions, the researcher can devote their efforts to identifying which approach is most suitable for elucidating the phenomenon under investigation. To enhance the validity of the results, the philosophical approach adopted to answer the research question must be explained, which encourages other scholars to respect the research outcomes (Smith, 1998; Crossan, 2003).

Easterby-Smith et al. (2008) said that these philosophical questions must be addressed for three key reasons. First, the overarching research strategy can be made clearer by identifying the range of possible philosophical standpoints, since this forms a basis for researchers to choose and hone their research methods. Secondly, if they understand research philosophy, researchers will be able to assess the various methods and methodologies with confidence; they can, early on, establish what drawbacks different methods hold and thus will not waste time by adopting unsuitable methods.

Finally, as Crossan (2003) agrees, researchers who are aware of the range of different philosophical stances can make creative innovations in choosing and perhaps adapting particular methods which are new to them.

3.3.1 Ontology and Epistemology

According to Pathirage et al., (2008), ontology concerns the researcher's underlying assumptions about the nature of fact and the content of knowledge, that is, their understanding of how the world works. Ontological theories fall into two categories: objectivism and subjectivism. According to Saunders et al. (2009), an objectivist standpoint assumes that social entities have an existence which is outside the social actors who engage with them, whereas subjectivist thinkers assume that social phenomena only come into being through social actors' perception of them, and through the actions that follow these perceptions. Conversely, epistemology addresses knowledge and what it contains – that is, what, within a particular area of study, counts as valid knowledge (Saunders et al., 2009). As Audi (2005) explains, epistemology essentially covers questions about how we know things, the justifications that underpin our beliefs, and the

standards for acceptable evidence in our quest for knowledge about the world in general and about people's experience in it.

In sum, then, while the content of knowledge is covered by ontological assumptions, epistemological assumptions cover questions about how that content comes to be known.

3.3.2 Positivism

Lundberg and Young (2005) explain that positivism, which assumes that scientific rules can be applied to generate facts, stipulates some criteria: survival, explanatory power, and logical consistency. Moreover, they point out that the theoretical propositions deployed in the research must be interrelated. In addition, any theory that is generated must be able either to offer an explicit explanation or prediction of a rival theory. Finally, if a theory is to be falsifiable and explanatory, as well as consistent, it must be capable of standing up to empirical testing.

According to Bell (1993), positivist approaches assume that social scientists may adopt the same methodological principles as natural scientists. Positivist methods thus quantify variables of social phenomena in order to measure them. Moreover, positivist researchers tend to attain their research objectives by enhancing their predictive grasp of particular issues by putting theories to the test (Creswell, 2009). Indeed, as Saunders et al. (2009) stress, the credibility of results can only be guaranteed by proposing a hypothesis on the basis of an existing theory and testing it through empirical observations.

3.3.3 Pragmatism

The defining characteristic of the pragmatist philosophical paradigm is that it does not drive the researcher to rely on, and thus to base their research design on, restrictive ontological and epistemological assumptions, which highlights its distinctiveness when compared to the positivist or interpretivist paradigms (Biesta, 2010). As such, the strategy of inquiry adopted by the pragmatist to examine any given area of study, and thus the study's approach, time horizon, and methods, is outcome-oriented, and informed directly by the nature of the research aim and objectives (Johnson, Onwuegbuzie and Turner, 2007). Since broad and rich areas of research, including the field of construction, can only be illuminated inadequately by an inflexible dependence on the positivist or interpretivist assumptions detailed in Sections 3.3.2 and 3.3.3 (Tashakkori and

Teddlie, 1998), the pragmatist paradigm was utilised as the research philosophy for the present study.

3.4 Research Design

A clear structure informed by the pragmatist paradigm was devised, and all the necessary principles of the philosophical paradigm were carefully followed. Research objectives were first defined in accordance with the research aim (Table 3.1), and a research plan was then derived from this. Next, the study proceeded in phases: first, a literature review was conducted; then piloting of the survey; this was followed by interviews and questionnaires were constructed; and finally, data was collected and analysed (Figure 3.2).

Table 3.1: Methods of achieving research objectives

Aim	Objectives		Research methods and analytical techniques
Investigating delay factors in housing construction projects in the KSA and mitigating the causes of delay by providing new approaches and practical solutions by developing a framework.	1- Identify and classify the delay factors and their causes in the Housing Sector projects in the KSA.	What, Why, How	1- Litreature review, 2- Secondary data.
	2- Analyse and evaluate delay causes in the Housing Sector projects in the KSA.		1- Litreature review, 2- Primary data (Survey, semi structured interviews), 3- Excel & SPSS, 4- NVivo.
	3- Study the sustainable agenda in the housing sector in the KSA and its impact on delays in housing construction projects.		1- Litreature review, 2- Secondary data, 3- Primary data (semi structured interviews & Case studies), 4- NVivo.
	4- Propose practical solutions that will eliminate delays in construction projects by developing a framework that enhances quality and develops effective management methods.		1- Litreature review, 2- Primary data, 3- Secondary data.

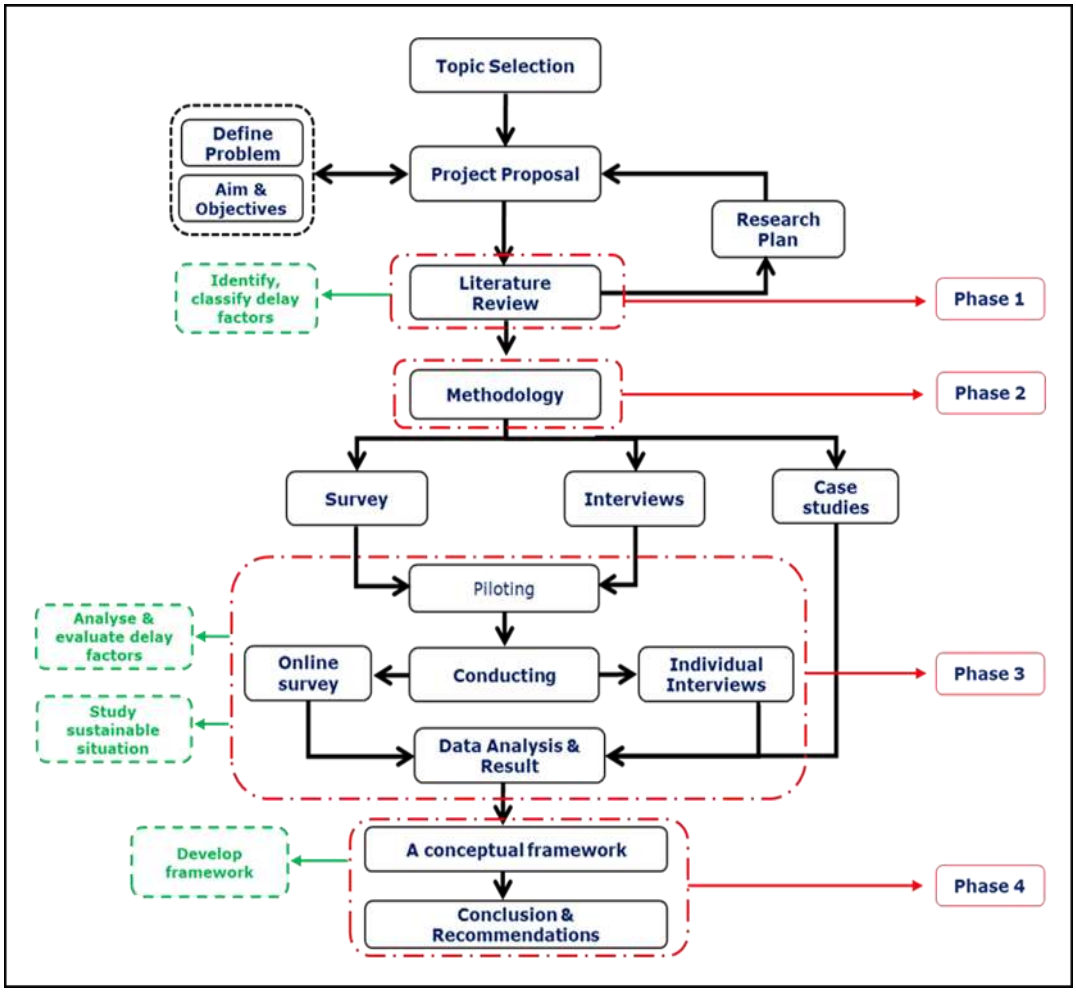

Figure 3.2: Research phases

Attaining the objectives of the research necessitated four stages of research. First, an informative overview was provided of the construction sector, both globally and in the Gulf Cooperation Council countries, as well as in KSA specifically. Secondly, the literature review focused on research about the causes for delays in identifying and assessing projects in the construction sector, in both the developed world and the developing world. The review located where the most important delay factors lay – with contractors, consultants or clients. The third stage involved establishing which factors should be measured, by carrying out semi-structured interviews among professionals in the sector, as well as the questionnaire. In the final stage, the data was analysed, and conclusions and recommendations were set out.

Both quantitative and qualitative data are crucial to this chapter, as well as methods for collecting and analysing information. Among the techniques and procedures used for gathering information were background research, survey (online through survey-monkey) ref, interviews (face-to-face), and triangulation.

Critically, the range of methods used to gather data was identified on the basis of which were most appropriate for yielding the desired outcomes. Thus, in the table below the research objectives and methods used to collect information aimed to achieve the set objectives.

3.5 Methodological Choice

Appropriate methodological choices promote the extraction of relevant information from collected data because they ensure that the data is obtained in a structured manner (Addis and Talbot, 2001). In the interest of carrying out the present research project in a suitably structured way, much consideration was devoted to the selection of an appropriate methodology before beginning the research. Emphasis was consistently maintained on the key aim of research, which, as Barton et al. (2000) explain, is the identification of a specific point through scrupulous and critical exploration.

3.5.1 Quantitative

According to Parkin (2000), if variables are quantifiable, if hypotheses can be devised and tested, and if inferences can be drawn from the sample to the population, it is suitable to deploy a quantitative methodology. Unlike qualitative research, which rests on constructivist paradigms, quantitative methods have their roots in positivist philosophy.

Knight and Ruddock (2008) strikingly remark that, depending on which a particular statistical technique is deployed, methods such as surveys can incorporate non-numerical data as well as numerical data.

Specifically, this approach provides an important statistical data, as the results provide a greater level of validity and a lower probability of error. So, the researcher used this approach to get real numbers of answers.

3.5.2 Qualitative

Woods (2006) explains that qualitative methods can be used to obtain non-parametric (or qualitative) data, including opinions, satisfaction levels, and attitudes. In doing so, these methods generate knowledge about changing behaviours or complex issues, most of which are not easily operationalised numerically. Qualitative methods are suitable for complicated social phenomena which cannot be readily quantified (Blois, 2004).

Accordingly, qualitative methods involve direct engagement with participants in their social settings, observing their behaviour and acquiring verbal information. It provides a more extensive insight of social issues than quantitative methods can offer. Therefore, this pattern was chosen to contribute to enhancing the credibility of these data.

3.5.3 Mixed Methods

According to Tashakkori and Teddlie (1998), the idea of mixed methods emerged in the early 1990s as scholars began merging distinct methods, especially quantitative and qualitative. When a study's research objectives are varied and diverse, and thus when a combination of parametric and non-parametric data would be required to address them adequately, the mixed methods methodological choice is suitable to be the most effective one (Saunders and Tosey, 2013).

In terms of an operational definition for the concept of the mixed methods approach, Shannon-Baker (2016) described the approach as "a type of inquiry that is philosophically grounded where an intentional mixture of both qualitative and quantitative approaches is used in a single research study". For example, the results from one phase of the research (e.g., the quantitative phase) can be incorporated into the investigation for the next phase (e.g., the qualitative phase), thus heightening the validity and comprehensiveness of the research project.

By combining quantitative and qualitative methods, the research gains a broad scope, deep understanding and affirmation, while compensating for the weaknesses inherent in using each approach on its own. Accordingly, the choice of mixed methods is more suitable for the current research project.

3.5.4 Triangulation

Different research perspectives are used to analyse and validate research data. Sometimes, the data collected comes from various resources with various contradictions. This makes it difficult for the researcher to find the most appropriate verification method. Therefore, this specific search used triangulation to verify the data obtained from the field, along with the analysed results.

This research concentrates on triangulation, not to weaken the evidence, but to delve into the available data in order to clarify further. Among the different types

of triangulation, the data method was the most important for this research. This is to increase the validation of information from different experts. An example is interviews, questionnaires and case studies. Furthermore, given the number of experts interviewed, triangulation in the data was best used to confirm the truth and lies in this research to verify consistency. One specific example of the information to be studied despite triangulation is the responses of various contractors to the reasons for the failure of most of their construction projects.

3.6 Research Strategy

The strategy of research is the overall direction that the research takes (Bryman, 2008). Given the range of different research strategies, which all have different features, it is crucial to adopt an appropriate one, since it will dictate the plan for addressing the research questions (Saunders et al., 2009). For Saunders et al. (2009), the selection of research strategy must be in accordance with the questions and objectives of the research, while also considering how much is known about the topic already, the philosophical standpoint of the researcher, and the resources available (including time).

Based on these considerations, researchers can choose from a wide range of research strategies. In the field of construction management, the most widely used research strategies include action research, surveys, experiments and case studies (Easterby-Smith et al., 2008; Yin, 2009).

Moreover, various information sources enhance data reliability and analysis results, as well as to obtain accurate results. The strategy of the research was to achieve a valid results and reliable outcomes using multiple methods (triangulation), including surveys, interviews and case studies. Therefore, for this research project, a mixed survey strategy was used.

3.7 Time Horizon

According to Saunders et al. (2011), the two-time horizons that are available for research projects are the cross-sectional time horizon, in which a snapshot is taken of a target population at a particular point in time, and the longitudinal time horizon, in which data are gathered from a target population at different points in time. One of the fundamental advantages of the longitudinal time horizon is that insights can be gained into the question of how target variables change over time (Bryman, 2008), but since this was not an aim of the present

study, a cross-sectional time horizon, which is more manageable in terms of available time and resources, was selected.

3.8 Techniques and Procedures

It is possible to gather data from participants, to analyse it, and to interpret it using various techniques and procedures (which is to say, quantitative and qualitative methods) (Saunders et al., 2011; Creswell, 2009). According to Roberts (2007), the most popular methods used to collect data include questionnaires, telephone interviews, and face-to-face interviews.

At the outset of this section, it is worth pointing out that data can be gathered either through primary or through secondary research (Saunders et al., 2009). Bryman (2008) explains that secondary research, such as systematic reviews or meta-analysis studies, entails bringing together and surveying a range of different studies to amalgamate existing data from diverse sources. In this vein, this research project involved a review of the existing literature about performance measurement systems in the construction sector, with a particular focus on Saudi Arabia, especially construction projects carried out by the Ministry of Housing. The main goal of the literature review was to locate which variables to study so as to achieve the research aim.

By contrast, primary research involves gathering entirely new data and thus creating previously unknown information about an issue (Bryman, 2008). Consistent with the pragmatist philosophy and the mixed methods approach, the primary research in this research project was a semi-structured questionnaire incorporating a combination of closed and open-ended questions; the latter gave participants the opportunity to discuss their attitudes and experiences openly. The questions addressed the key ingredients in the evaluation and measurement of performance in the construction sector.

3.8.1 Data Collection

Regardless of the field of research, data collection is the most important and essential step for research. The method of collection differs in different areas of research, according to the information required.

3.8.1.1 Surveys

Surveys, which allow information to be gathered from large samples of the population, are the only viable way of generating enough data for statistically

valid analysis. If well-constructed, a questionnaire can yield both general and specific data. Tang et al. (2007) remark that questionnaires have been deployed by a range of scholars and organisations to gather and analyse relevant information. Denscombe (2004) states that questionnaires can contain as many questions as necessary; the number of questions thus varies according to the topic being studied, the types of respondents and the time available. Thus, the main advantage of using the survey is that a large number of participants can be randomly accessed in an easy, practical and economical manner, as well as the comparability. Also, online surveys allow for complete hiding (anonymity and privacy) and this creates a comfortable feeling for respondents.

The questionnaire was designed after reviewing many studies related to the same subject, and a large number of them mentioned in the literature review (Chapter 2). Also, to know the main axes from which the questionnaire will be launched. Therefore, the questions were drawn to focus on a specific aspect to achieve the main part of the research in determining the severity of the delay factors to achieve the research objectives. The questionnaire consisted of three sections, the first part is the personal data of the participants, the second part is information about the projects, while the last section requires determining the severity of the delay factors.

Moreover, to design a rating scale, the researcher must determine the number of points. According to Marsden and Wright (2010), the rating scores used vary from 2 to 5 points. Whereas the Likert scale ranging from 3 to 7 points; Thurstone method uses 11 points; and the semantic differential uses 7 points. Thus, in rating scales, there is no standard for point number, and common practices differ greatly from one field to another. Therefore, we used the evaluation from 1 to 4 without a neutral answer.

Additionally, the target sample in this survey was engineers and professionals working in the public and private sectors in the KSA, and members of the Saudi Council of Engineers (SCE). The Council is a community that includes engineers, clients, consultants, and contractors. Therefore, the sample was chosen according to experience engineering attributes.

Furthermore, the survey (Appendix B) was launched online (via Survey-Monkey) to reach the largest number of experienced people and to avoid wasting time to move from one place to another. This contributed to reaching many respondents. Moreover, the data were obtained from the 'Analyse section' of the survey monkey.

3.8.1.2 Interviews

As a mixed methods research project informed by the pragmatist philosophical paradigm, one of the qualitative techniques and procedures used to obtain data from the participants in this study was that of interviews. Noteworthily, depending on the interviewer's own position, they may choose either unstructured, semi-structured, or structured interviewers. According to Houtkoop (2000), unstructured interviews are appropriate for interviewers who are in close contact with the organisation they are studying, while structured interviews include interviews that ask the participants Closed-ended questions. Semi-structured interviews give participants freedom of expression during the interview and express their opinions on their own terms. Moreover, these interviews provide reliable and comparable qualitative data. (Table 3.2)

Table 3.2: Interviews types (Source: Berg, 2009)

Structured interviews	Semi-structured interviews	Unstructured interviews
Most formally structured	More or less structured	Completely unstructured
No deviation from the question order	Questions may be recorded during the interview	No set order to any question
The wording of each question is exactly as written	Wording or questions flexible	No set wording to any questions
No clarifications or answering of questions about interview	The interviewer may answer questions and make clarifications	The interviewer may answer questions and make clarifications
No additional questions may be added	The interviewer may add or delete probes to interview subsequent subjects	The interviewer may add or delete questions between interviews

Creswell (2009) confirms the centrality of interviews to successful qualitative research. The research methodology defines how issues are explored in social sciences (Silverman, 2010). Indeed, as the interviewer gains experience, they can develop techniques to encourage their participants to engage in more in-depth discussion of the topic. Accordingly, the technique of semi-structured interviews was chosen for this research, to identify the key factors in delays in the Saudi construction sector. Furthermore, these questions (Appendix E) arose from studies (Literature Review, chapter 2) related to the research problem (Justification, Chapter 1).

Moreover, the target sample was a group of experts in the Saudi construction industry. Among them, there was an academic who had worked many years in the field of construction and gained extensive experience. Others are professionals with strongly knowledge in the field.

3.8.1.3 Case Studies

The case study is an empirical research and investigation strategy that investigates aspects of actual life context. It is a comprehensive and in-depth study of completed and incomplete projects (Yin, 2003). However, the interaction between multiple factors that clarify the development that occurs in a particular period. Moreover, the case study provides a clear picture of the project as it is an accurate method that provides detailed and comprehensive information about the project, which makes it contribute effectively to the formation of new hypotheses that open the way for future studies. Therefore, two case studies, traditional and sustainable housing, were used to investigate the delays in this research.

3.8.2 Pilot Study

Pilot study is crucial for all types of research because they allow the validity and reliability of the variables, or indicators, to be tested by the researcher (De Vaus, 1990). Indeed, one of the benefits of pilot study is that the researcher can identify any possible difficulties that might arise in the administration of the questionnaire (Blaxter et al., 2006). Pilot test can thus provide a range of benefits to researchers, including helping them rephrase questions in the most appropriate way possible, which ultimately leads to savings in both time and resources (Ritchie and Lewis, 2003).

For this research, the pilot study involved presenting the questionnaire to respondents similar to the projected sample for the main survey. The purpose was to assess whether the questionnaire was suitably clear and comprehensible, and whether there were any issues in its phrasing, or the length of time taken to complete it. The pilot survey was sent by email to various engineers who had worked in the construction industry; they worked in the public and private sectors.

Furthermore, the survey presented in the pilot test was designed based on the literature review conducted in the first stage of the research. A random sample was taken comprising 10 important stakeholders in the Saudi construction

sector. This sample size was chosen since it seemed suitable for the further development of the final questionnaire. After the responses to the 10 questionnaires had been gathered, it was found that no major changes to the questions were necessary.

3.8.3 Sampling

To ensure that the sample is representative, social scientists can choose from an array of sampling strategies and techniques. Sampling techniques can be divided into two broad groups: firstly, probability sampling, which includes simple random sampling, stratified random sampling, systematic sampling, and clustered random sampling; and secondly, non-probability sampling, which includes convenience sampling, judgemental sampling, and snowball sampling (Elfil and Negida, 2016). Smith (1998) explains that the sampling technique that is chosen depends, in the first instance, on how accurate the research is supposed to be, and the decision may also be affected by questions of cost.

In this research, the key considerations in choosing a sampling method were the need to ensure an unbiased sample, the conditions of the research, and the available time for the research. Since there would be substantial practical obstacles in acquiring data from all professionals working in the Saudi construction sector, this research employed a simple random sampling method (online), across different locations in the KSA. The choice of a probability sampling technique can be considered as an optimal one when compared to the choice of a non-probability sampling technique (e.g., convenience or snowball sampling), since it produces a more representative target population (Etikan et al., 2016; Elfil and Negida, 2016).

If a sample is chosen on the basis of specific characteristics that are not shared by the target population at large, it is termed an experimental unit. To ensure a sufficiently representative sample, it may be best to conduct a random, unbiased sample of a percentage of the target population, so that all possible experimental units are equally selected (Etikan et al., 2016). For this reason, the questionnaires were distributed to a random sample of professionals working in the Saudi construction industry, specifically, to those registered with the Saudi Engineering Council.

3.9 Ethical Consideration

As Saunders et al. (2009) point out, many educational institutions emphasise to their pupils the importance of conducting research considering the ethical implications of their actions. So, during this research, ethical procedures developed by the Nottingham Trent University were adhered to (Appendix A). In order to recruit people to take part, postal invites were sent out asking interested parties to join, as well as a short overview of what the study would cover and the reasons for carrying it out, and details of how their privacy would be protected. The parties were given the option to remain unidentifiable in the reporting of the results and were reassured that they would be able to stop participating before the end if required.

Those taking part were given full reassurance that all answers collected in the course of the study, whether in conversation or by questionnaire, would be kept fully private and protected, being used only for the purposes for which they were originally collected. No personal data nor any identifying information would be shared outside the confines of the study group, and those taking part were given written assurance of this. All answers provided are to be treated with total discretion, and the results written up in abridged form.

3.10 Conclusion

A pragmatic approach involves using the method that is most relevant to the research problem (Saunders and Tosey, 2013). Therefore, practical researchers are given the most effective way to use any of the methods, techniques, and procedures that are usually associated with quantitative or qualitative research. They realise that each method has its limits and that different methods can complement each other. They may also use different techniques at the same time or one after the other. For example, they may start having face-to-face interviews with multiple people and then use the results to create a survey to measure different conditions in a large sample for the purpose of performing statistical analyses or vice versa.

The chapter mainly focused on the research method. The mixed method included survey and semi-structural interviews to collect data, as well as case studies. This method enriches research and increases validation and reliability of results. In the survey, the targeted sample was random in construction in Saudi Arabia, using an online survey (Survey-Monkey). Participants answered questions related to their construction experience to assess the severity of the

delay factors (Chapter 4). Due to the use of the online survey, data was collected during both formal and informal hours, giving participants more flexibility to answer the survey without any restrictions. Furthermore, the data collected was analysed by the Excel and SPSS to determine the experiences of users in the construction field in the KSA.

For semi-structured interviews (Chapter 5), those with construction experience were selected (Clients, consultants and contractors). This sample was identified and coordinated with them to conduct interviews in a timely manner. The questions were determined based on the urgent need to know the reasons for the delay in Saudi Arabia, as well as for sustainability. Therefore, the interviews were very fruitful because of the vast amount of information, also because of the freedom to express their opinions without writing their names. Meanwhile, case studies have been used to investigate delays in housing construction projects (traditional and sustainable housing).

Lastly, the adopted approach enhances the integrated concept, where the researcher can take advantage of the strength of one of the research methods to address weaknesses of the other ones. Thus, the use of mixed methods strengthens the data collected to ensure that the data is valuable and reliable.

CHAPTER 4: CRITICAL DELAY FACTORS - QUANTITATIVE ANALYSIS

4.1 Introduction

The chapter aims to present, analyse and discuss the survey results. In addition, analysis was performed through the same site using statistical equations to avoid any errors. Data from the survey will significantly contribute to the development of a framework to improve work performance and avoid delays in construction projects.

Furthermore, the survey included three sections, in the first section information about the participant, including the nature of work, educational qualification, years of experience, etc. The second section contains the project performance and whether there was a delay or not. The last section contains 10 groups classified, and includes different factors causing delay in projects, for example a group related to the owner, contractor, consultant, etc. Also, through this section, the classification of these factors and their risk in the delay process is known by choosing the severity of the factor.

4.2 Description of the Survey Sample

The participants recruited for the purposes of this study were all professionals with experience and high-level academic qualifications, such as PhD degree. The Saudi cities in which the participants worked in included Riyadh, Jeddah and Dammam. Furthermore, the website 'Survey Monkey' was used to facilitate the distribution of the survey.

In addition, the author benefited from the support of the SCE and some government and private agencies. Consequently, an appropriate survey response rate was achieved. The survey was geared towards assessing how severe different project delay factors were, and to that end, client, consultants and contractors were all targeted as respondents.

The number of completed questionnaires was 720, and 45 of them were not fully completed, so they were not considered. In the figure (4.1), contractors constituted the largest proportion of respondents (n=384) and accredited consultants were the second largest proportion of respondents (n=210), while clients made up the remaining proportion of respondents (n=126).

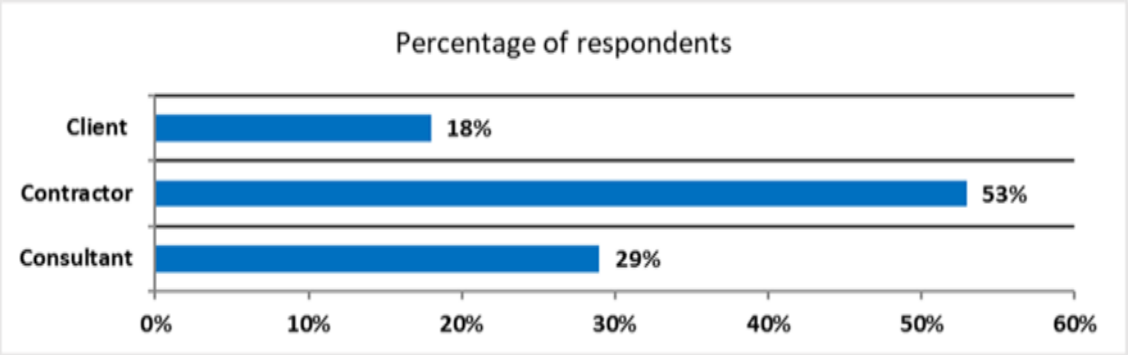

Figure 4.1: Percentage of respondents

The first section of the survey contained questions that were intended to extract information about the history of work experience that the respondents had accumulated in the construction industry. Thus, as can be seen in figure 4.2, the length of experience (in years) that the majority of the respondents had was 11-15 years (34%), while the experience of a proportion of 26% of the respondents exceeded 15 years. Furthermore, a proportion of 24% of the respondents had 5-10 years of experience in the construction industry, while those with 1-5 years of experience made up just 16% of the total sample of respondents. Hence, it is obvious from these statistics that more than half of the survey sample (58%) had over ten years of experience in the construction industry, which meant that they had good knowledge of the factors that could interfere with construction projects.

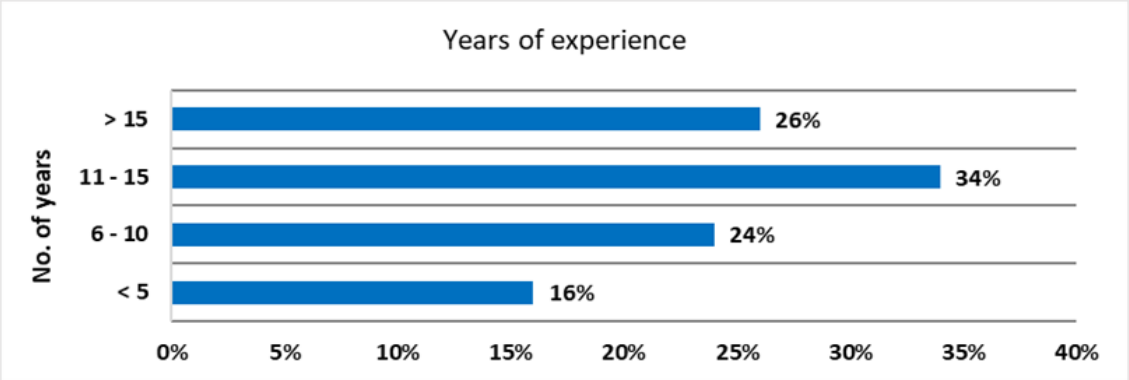

Figure 4.2: Years of experience of participants in the construction industry

4.3 Data Analysis Techniques

Data collected from the survey were analysed using descriptive statistical analysis methods. Survey-Monkey (online) and MS Excel were used for accuracy and reliability for the purposes of rapid and regular analysis of a large amount of data (Survey Monkey, 2018). The third section of the survey required the respondents to provide a rating to different delay factors in terms of how severe they thought the impact of those factors was on construction projects.

As indicated in Table 4.1, a scale of 1 to 4 was used for severity rating, with 1 denoting non-severity and 4 denoting extreme severity. This scale was chosen to obtain a clear answer (No effect, fairly severe, severe or very severe), without adding a neutral or misleading answer to the participants (Chapter 3). Therefore, each factor was attributed the same weight to establish a quantitative measure of severity.

Table 4.1: The scale of delay factor severity

Scale	Severity	Weight
1	No effect	1
2	Fairly severe	2
3	Severe	3
4	Very severe	4

The evaluation scale that was employed was a Likert scale, which can be described as a "matrix" with different weights attributed to the various response options. The weighted mean for every response is automatically determined by the evaluation measures on the basis of the equation below:

$$\frac{X1W1 + X2W2 + X3W3 \ldots XnWn}{Total}$$

W: Weight (1,2,3 or 4)

X: Response numbers

n: Participant number

Total: Total number of participants

While calculating the sample size, use the following formula:

$$Sample\ size = \frac{\frac{z^2 \times p(1-p)}{e^2}}{1 + (\frac{z^2 \times p(1-p)}{e^2 N})}$$

N: Population size

e: Margin of error

z: Z-score

P: Percentage value.

4.4 Respondents Personal Information

The results from the survey are presented and discussed. More specifically, the results are addressed in relation to the three sections of the survey, which are background details about the participants, aspects of construction projects and delay factors.

In this part, the survey results related to the background details of the respondents are discussed with the purpose of presenting the experience possessed by the respondents in relation to the research topic to demonstrate that the generated data are reliable.

4.4.1 Type of Construction Work

The participants are classified according to the nature of the work in the projects (Client, consultant, or contractor), and what are the categories involved in it. In addition, knowing the backgrounds of stakeholders in the project and the extent of their participation in the survey.

4.4.2 Educational Status

With regard to the type of academic qualifications that the respondents possessed, most of them (n=390) were educated to the level of bachelor's degree, while 145 respondents had a diploma qualification, 139 had a master's degree, and 46 had achieved a PhD.

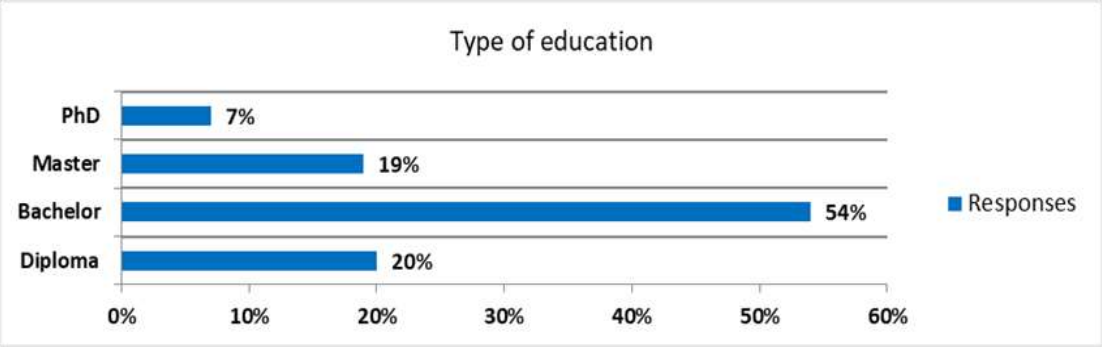

Figure 4.3: Different proportions of respondents according to academic qualifications

4.4.3 Organisation Type

Participants were asked to explain the type of their work organisation, namely, public, private or both. A number of 29 respondents chose not to answer this question, so the number of answers obtained for this question was 691. As can be seen in Figure 4.4, the majority of the respondents (n=505) worked in private organisations. The rest of the respondents worked either in public organisations (n=123) or both in private and public organisations (n=63).

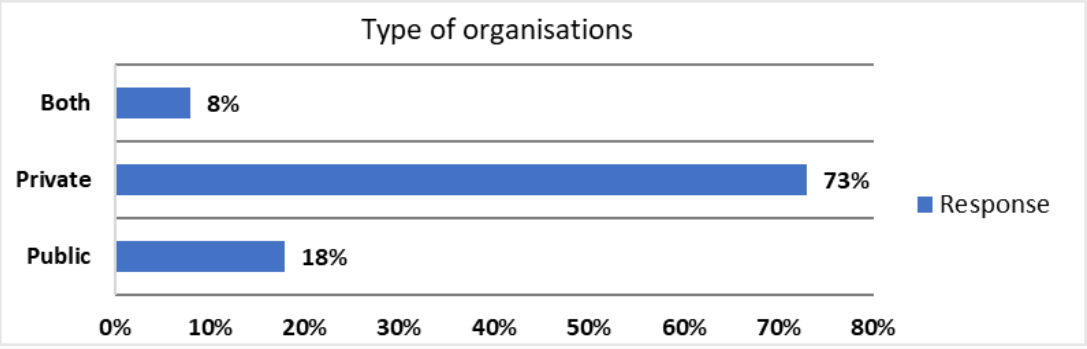

Figure 4.4: Proportion of respondents according to type of their organisations

Furthermore, 440 out of the total of 720 respondents were engineers, constituting the largest proportion of respondents (70%). Around 14% of respondents were site managers, while 12% were project managers (n = 87) and 4% were general managers (n=29), as shown in Figure 4.5.

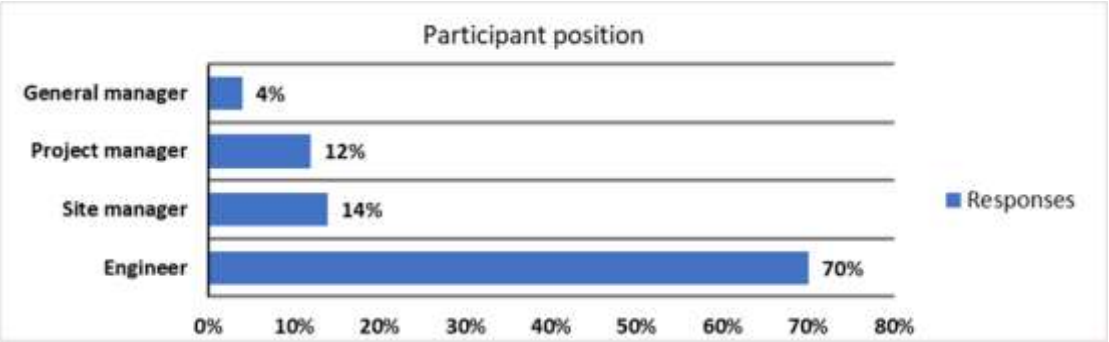

Figure 4.5: Proportion of respondents according to the work positions they occupied

4.5 Project Performance

4.5.1 Number of Construction Projects

Most of the participants (86%) had been involved in a large number of projects, as shown in Figure 4.6. What was deduced from this fact was that the majority of the respondents possessed multi-faceted knowledge and experience of construction projects, highlighting the fact that the major delay factors can be identified with precision on the basis of knowledge sharing.

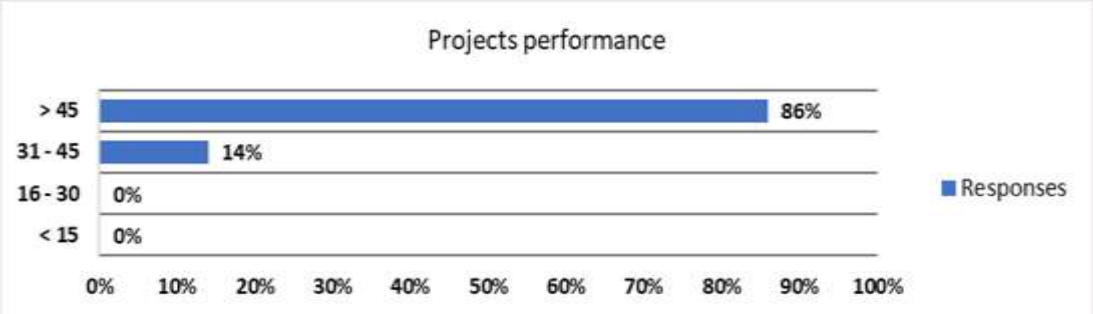

Figure 4.6: Proportion of respondents according to the number of construction projects involvement

The figure 4.6 illustrates the extent to which specialists who had varying levels of experience contributed to the present survey. The number of construction projects that the respondents had been involved in is indicative of their level of experience. It also depends on the size of the projects. This contributes to an analysis of the impact of delay factors to a large extent on projects in which respondents participated. Thus, in this way, it is possible to obtain highly reliable survey results.

4.5.2 The Ratio in KSA Construction Projects

Delays in construction projects (Figure 4.7) were an issue that most of the respondents had experienced. A number of 530 out of the total of 720 respondents, accounting for a proportion of 74%, had been involved in projects that went over the completion date that was quantified in the contract or was planned. Only a proportion of 26% of respondents did not experience substantial delay in the construction projects they had been involved in.

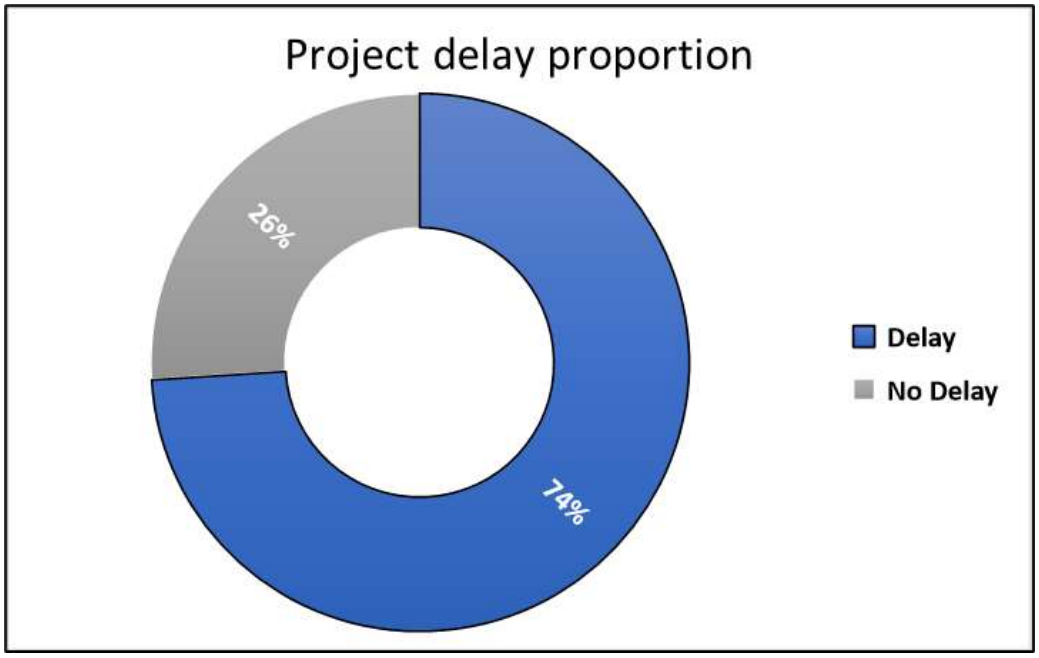

Figure 4.7: Proportion of respondents who were confronted with construction project delays

Furthermore, with respect to the respondents who faced project delays, the degree of delay that they experienced was not the same, but differed according to time and location, although the majority of these respondents stated that delays were usually greater than 20% in most projects. Moreover, as shown in Figure 4.8, there were also a couple of respondents who indicated that delays exceeded over 80%, leading to the dismissal of the contractor.

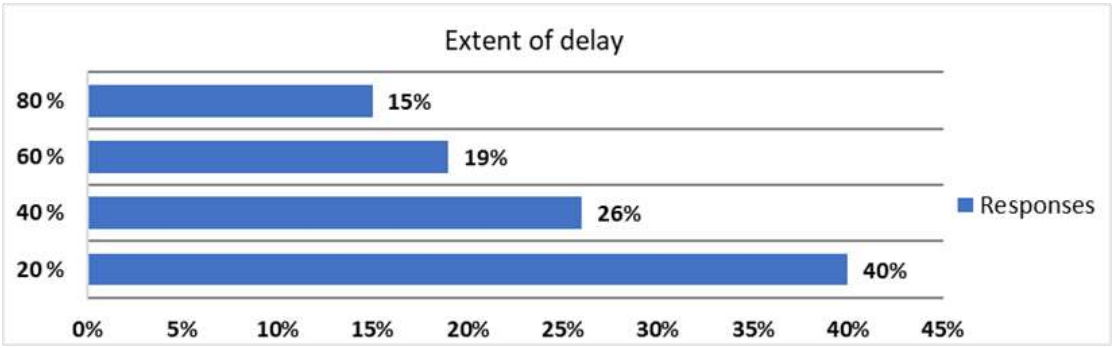

Figure 4.8: Proportion of respondents who experienced construction project delays and the extent of those delays

4.5.3 Parties Responsible for Delay

In this part, the respondents expressed their opinion on the responsible for delaying the projects they have been involved in. For example, delaying material access to the site is the responsibility of suppliers, but this falls under the responsibility of the contractor, while the real reason for the delay is weather factors which is outside the scope of all stakeholders. In fact, more than one party participates in the delay, but the reason falls under external factors. Therefore, the reason of delay is identified after the group-related causes are identified in Part Three of the survey.

Among the various parties involved in a construction project, the survey respondents believed that the greatest responsibility with construction project delays lay with the subcontractor (40%), followed by the contractor (30%), client (21%) and consultant (9%).

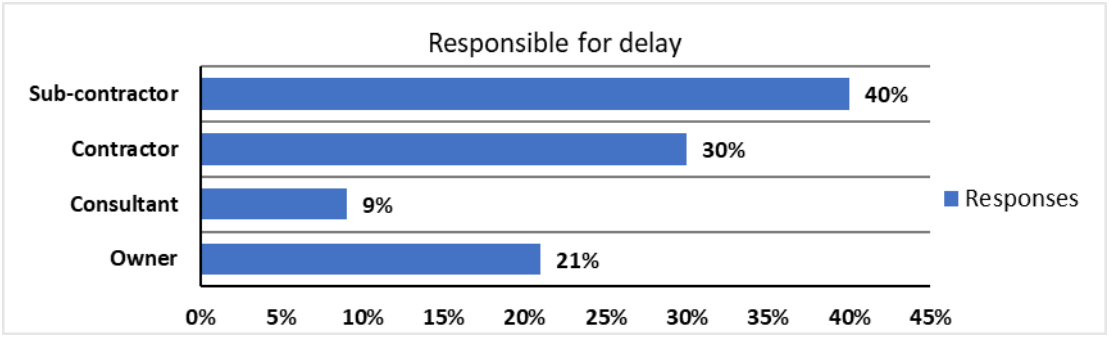

Figure 4.9: Proportion of different parties responsible for delaying projects in which they participated

Furthermore, in Figure 4.9, subcontractors represent 40% of the delay in construction projects in Saudi Arabia. So, the main victims are the contractor and the project client for this delay. But for the client, the delay is due to the contractor, and then disputes begin, leading to the accumulation of work during the phases of the project. Meanwhile, only 64 participants, representing almost 9%, considered that the responsibility for delays in the construction project rests with the consultants. It is vital to highlight that the consequences are general, drawn from all respondents. More specific results are provided in the next section and are determined based on the views of different groups.

4.6 Analysis of Delay Factors

Over 60 commonly encountered delay factors affecting construction projects have been distinguished above by reviewing the available literature on delay in construction projects around the world in general and in Saudi Arabia in specific. These recognised delay factors were subsequently compiled with the delay factors that were pointed out by the survey respondents. A construction project is affected to varying degree by different delay factors. Therefore, a specific goal of the survey was to establish the severity of various delay factors.

A weighted calculation approach was employed in order to determine how severe every delay factor was. To that end, the delay factors were divided into ten different groups in keeping with the construction project parties or aspects that they were associated with, from the contractor to the contract. Some factors causing construction projects to exceed their planned duration were included in every group. It is vital to note that the factors were analysed according to how severely they affected construction projects rather than how frequently they occurred.

4.6.1 Delay Factors Related to the Contractor

This part of the survey was intended to determine the extent to which housing construction projects were impacted by delay factors associated with the contractor. Thus, the respondents were asked to assess 24 delay factors in terms of how severe they thought those factors to be. The results are showed in Figure 4.10 below.

The survey results regarding the delay factors associated with the contractor were noteworthy. As shown in Table 4.2, the respondents placed the delay factors impacting housing construction projects on a range from 1.8 to 3.32,

with the highest grade being associated with the use of inadequate construction methods by the contractor, while the lowest grade was associated with lack of motivation on the part of the contractor's personnel.

Table 4.2: Delayed impact associated with the contractor

Ref.	Related to the Contractor	Impact	
		severity	Rank
Q28	Incorrect construction methods performed by the contractor	3.32	1
Q29	Contractor's financialdifficulties	3.31	2
Q34	Poor site management by the contractor	3.23	3
Q23	Unsuccessful planning during the project by the contractor	3.17	4
Q31	Sub-contractors work delays	3.12	5
Q20	Poor contractor's control of the subcontractor	3.08	6
Q33	Incompetence of the technical staff	3.06	7
Q16	Poor contractor coordination with all parties in the project	2.94	8
Q26	Inefficient control by the contractor of project quality	2.87	9
Q22	Inadequate contractor's qualifications for the allocated project	2.79	10
Q18	Insufficient contractor's head office implication in the task	2.73	11
Q19	Slowness of mobilisation	2.7	12
Q25	Ineffectual control by the contractor of project progress	2.66	13
Q14	Deficiency in specialised experts in the contractor's team	2.61	14
Q15	Poor contractor communication with all parties in the project	2.59	15
Q13	Deficiency in contractor's managerial staff	2.57	16
Q35	Corrective activities following construction phase	2.57	17
Q30	Poor communication among the contractor and other parties	2.55	18
Q24	Delays by the contractor in surveys	2.38	19
Q32	Payments difficulties (with subcontractor)	2.37	20
Q27	Delays in document submissions (contractor)	2.25	21
Q17	Delays in order modifications by the contractor	2.14	22
Q21	Poor safety rules and regulations in contractor's team	2.02	23
Q12	Absence of motivation of contractor's staff	1.8	24

The severity of delays varies from one cause to another and falls under one type of delay either needs compensation from the client or obliges the contractor to pay the fines. Sometimes the client cooperates with the contractor and avoids minor delays because these delays are not a burden on the project. For example, attracting unskilled labour and the inability to complete project steps correctly, this leads to project disruption and delays, and even the possibility of stopping the project.

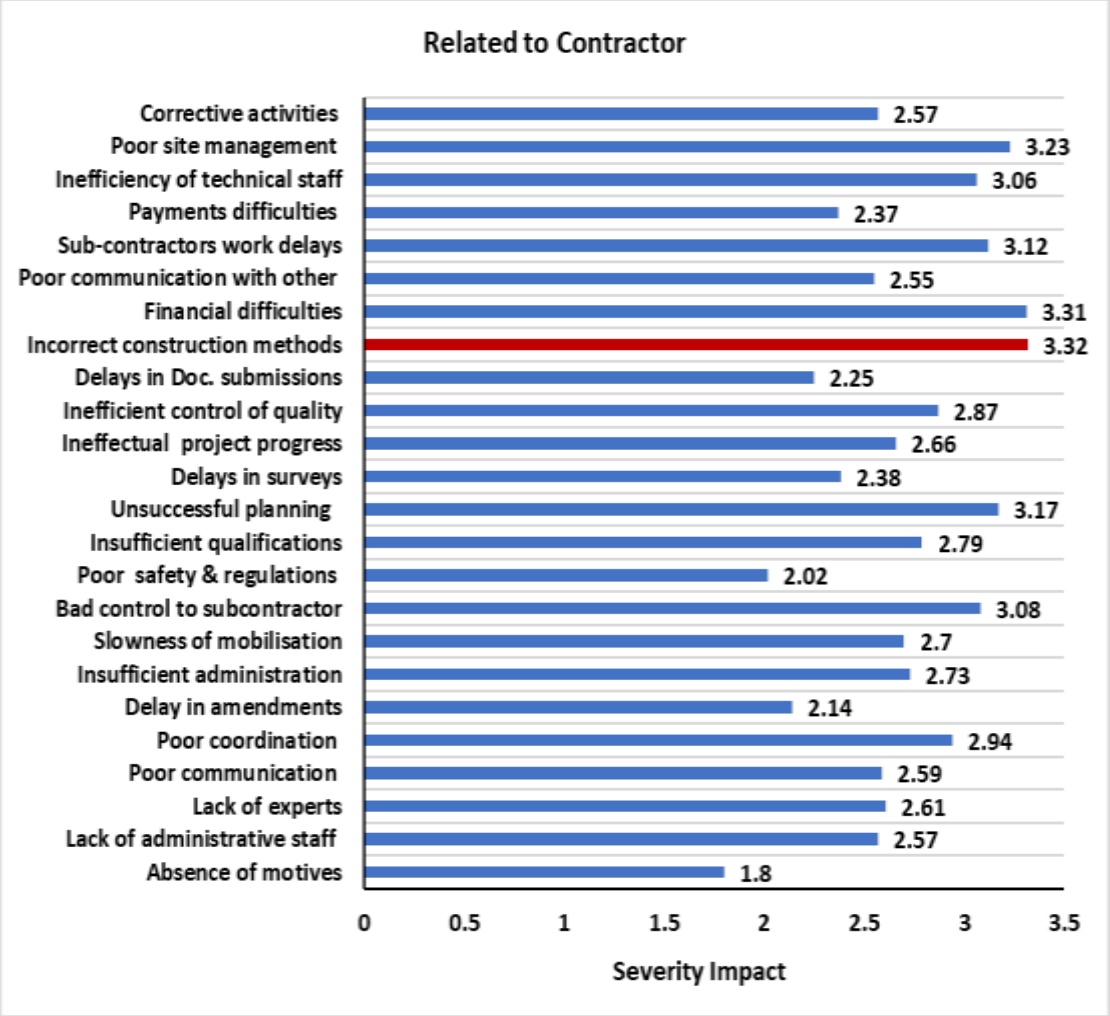

Figure 4.10: Level of severity of delay factors associated with the contractor

4.6.2 Delay Factors Related to the Client

The respondents considered that the ''Change orders'' (severity 3.43) were the main delay factor associated with the client, which significantly affected the activities related of the project (Table 4.3).

This group of delay factors with an impact on housing construction projects consisted of delay factors related to the client. More specifically, this group comprised 14 delay factors, the impact of which is shown in Figure 4.11.

Table 4.3: Delayed impact associated with the client

Ref.	Related to the Client	Impact	
		Severity	Rank
Q42	Change orders	3.43	1
Q49	Involvement in the construction process	3.26	2
Q37	Shortage in the construction experience	3.12	3
Q47	Delays by the client in issuing modifications orders	3.11	4
Q50	Slow payments to the contractor	3.08	5
Q38	Incorrect feasibility study	3.03	6
Q39	Lack of knowledge of the field	2.8	7
Q45	Unreasonable contract duration	2.61	8
Q48	Slow decision making by the head office	2.55	9
Q41	Slow coordination with the contractors	2.52	10
Q40	Delays in making decisions	2.42	11
Q43	Financial difficulties (with contractor)	2.16	12
Q44	Slow delivery of the site by the client	2.12	13
Q46	Slow settlement claims	2.08	14

Establishing the severity of the delay factors outlined above was challenging, but the factors still exhibited numerous differences, with a severity score in the range of 3.43-2.08. “Failure to deal with settlement claims quickly” was the factor that was attributed the lowest level of severity.

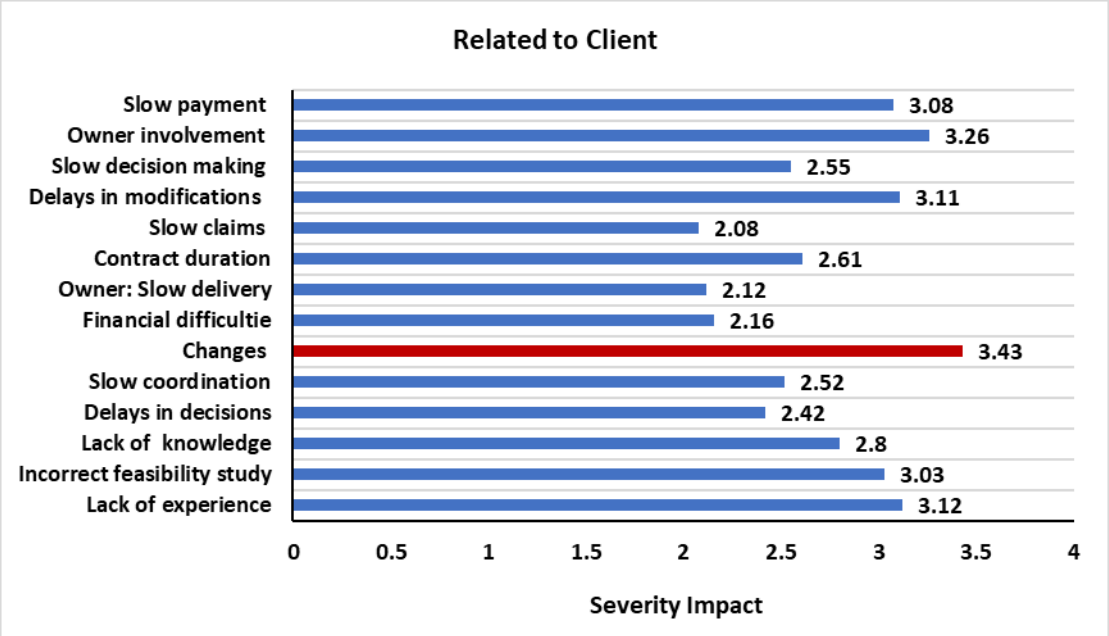

Figure 4.11: Level of impact of delay associated with the client

4.6.3 Delay Factors Related to the Consultant

A third group of delay factors consisted of a number of ten delay factors that were associated with the consultant. These factors are arranged according to how severe they were deemed to be by the survey respondents. Among these factors, the important role played by the consultant's team and communication with other project parties were particularly important factors (figure 4.12).

Table 4.4: Delayed impact associated with the consultant

Ref.	Related to the Consultant	Impact	
		Severity	Rank
Q55	Poor supervision and bad response	3.15	1
Q57	Delays in making decisions	3.12	2
Q56	Absence of consultant's staff on the site	2.88	3
Q59	Delays in giving instructions	2.66	4
Q60	Poor communication between the consultant and other parties	2.65	5
Q51	Low efficiency of consultant's staff in the project	2.58	6
Q58	Insufficient documentation	2.53	7
Q53	Delay in the agreement of contractor reports due to the consultant	2.17	8
Q52	Designing delays	2.03	9
Q54	Delays in drawings	1.89	10

As shown in Table 4.4, the delay factor that was considered by the majority of the respondents to have a severe impact on construction projects was "poor supervision and response" (3.15), while the factor deemed to have the least impact was "failure to supply drawings on time" (1.89). Given that the consultant occasionally makes decisions at certain stages of a project on the client's behalf, the entire project progress can be slowed down if those decisions are not made in timely fashion. Furthermore, the consultant's decisions have a direct impact on the contractor's financial dues.

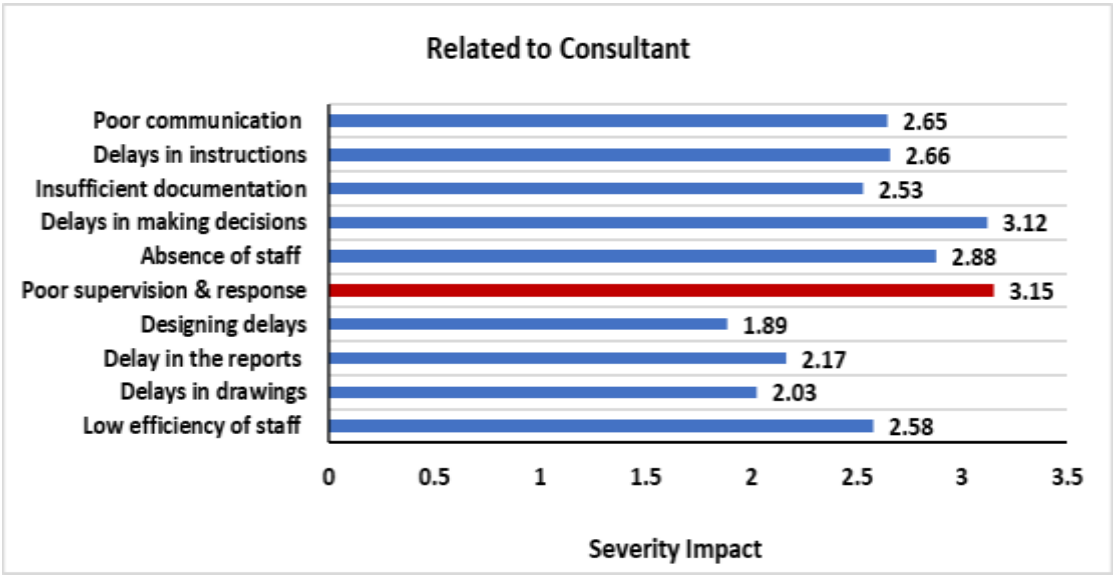

Figure 4.12: Level of impact of delay associated with the consultant

4.6.4 Delay Factors Related to Materials

This group of delay factors consisted of four delay factors that had various degrees of severity (3.39-2.76). A noteworthy proportion of the survey respondents concurred that, in any construction project, timely provision of the necessary materials was extremely important. Therefore, as can be seen in Table 4.5, the factors considered to pose the greatest threat to project progress were inadequate supplies of materials (3.39), price modifications (3.22), and delayed delivery (3.07). On the other hand, alterations to specifications was deemed to be the factor with the lowest impact on construction projects (2.76). It can be observed that the overall trend related to this group was higher compared to others, with a single downward trend, thus suggesting that the respondents placed great emphasis on the delay factors in this group.

Table 4.5: Delayed impact associated with the materials

Ref.	Related to materials	Impact	
		Severity	Rank
Q61	Shortage of materials	3.39	1
Q63	Changes in prices	3.22	2
Q62	Delay in delivery	3.07	3
Q64	Changes of specifications	2.76	4

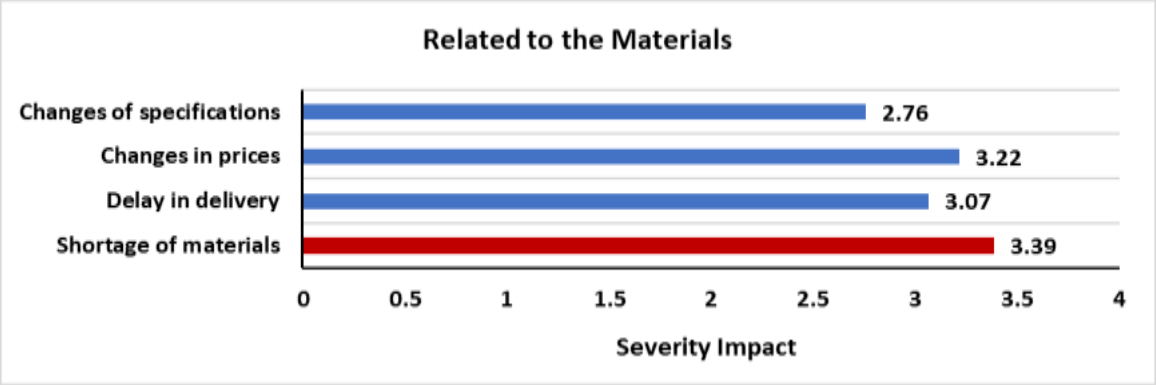

Figure 4.13: Level of impact of delay associated with the materials

4.6.5 Delay Factors Related to Equipment

The progress of a project can also be delayed if the equipment necessary for construction is not available or is not supplied on time. This is due to the fact that equipment constitutes an essential component of any construction project.

The group of delay factors associated with equipment consisted of four delay factors. With regard to these factors, most of the survey respondents considered that the unavailability of enough equipment would significantly disrupt the progress of a construction project. As can be seen in the graph below (Figure, 4.14), equipment deficiency and equipment delivery were convergent, the two factors having similar values of 2.88 and 2.82, respectively. However, by comparison to the group of delay factors associated with materials, the group of delay factors related to equipment posed a lower threat to construction projects. This was attested by the fact that the maximum value in the former group (3.39) was considerably higher than the maximum value in the latter group (2.88).

Table 4.6: Delayed impact associated with equipment

Ref.	Related to equipment	Impact	
		Severity	Rank
Q65	Shortage of equipment	2.88	1
Q66	Delay in delivery	2.82	2
Q67	Equipment's failure	2.6	3
Q68	Excavation problems	2.24	4

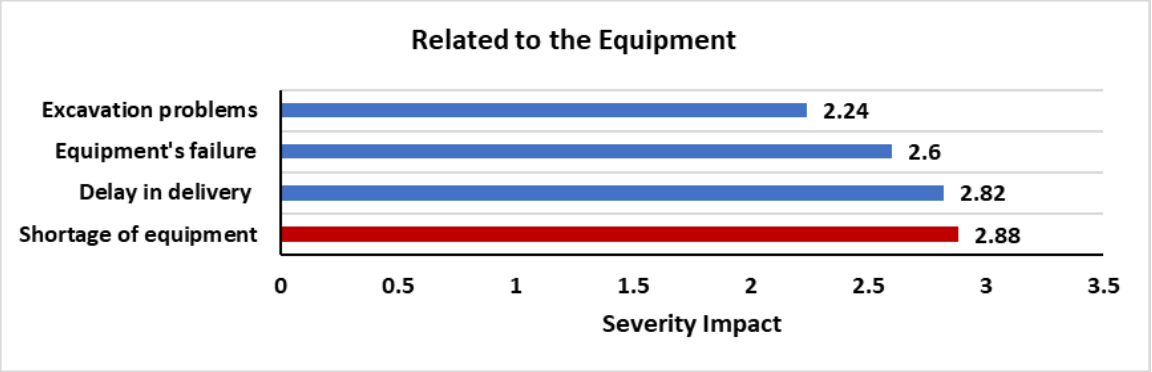

Figure 4.14: Level of impact of delay associated with equipment

4.6.6 Delay Factors Related to Manpower

The group of delay factors associated with manpower consisted of a number of three delay factors. These factors were confirmed by the survey respondents to have a major impact on construction projects. The factors related to the necessity to employ and unskilled workforce due to unavailability of skilled and qualified labourers was found to have a significant effect on the progress of a

construction project. At the same time, these factors also caused an important decrease in the overall quality of a construction project (Table 4.7).

Table 4.7: Delayed impact associated with manpower

Ref.	Related to manpower	Impact	
		severity	Rank
Q69	Manpower shortage	3.27	1
Q70	Poor manpower skills	2.95	2
Q71	Strikes or conflict	1.94	3

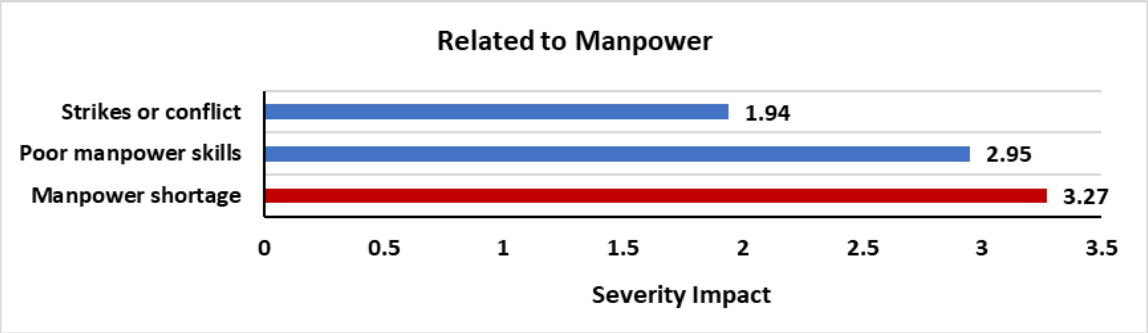

Figure 4.15: Level of impact of delay associated with manpower

4.6.7 Delay Factors Related to Design and Planning

This group consisted of a number of four delay factors. Of these factors, the first two delay factors, namely, modifications in work scope, with a value of 2.79, and site conditions, with a value of 2.77, were thought to have the greatest impact on the progress of a construction project. The importance that was attributed to these two delay factors serves to highlight the great significance that the operations of design and planning have for a construction project. On the other hand, the delay factor in this group that was considered to have the lowest impact on the progress of a construction project was drawing defects, which was given a value of 2.37.

Table 4.8: Delayed impact associated with design and planning

Ref.	Related to design and planning	Impact	
		Severity	Rank
Q72	Changes to the scope of work	2.79	1
Q74	Difference between the site conditions and the contract documents	2.77	2
Q75	Short contract duration	2.44	3
Q73	Errors and conflicting specifications and drawings	2.37	4

Drawing on the work experience they had accumulated in the context of the construction industry, the majority of the survey respondents decided that "modifications in work scope" was the major factor that could cause delay in the progress of a construction project. In Table 4.8, besides this factor, there were three other delay factors that were deemed to be important in relation to design and planning, namely, site conditions, insufficiently long contract duration and drawing defects.

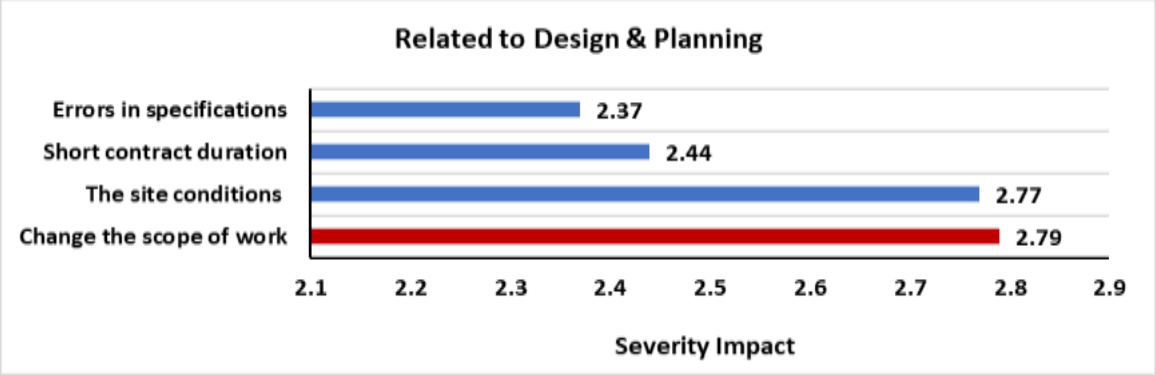

Figure 4.16: Level of impact of delay associated with design and planning

4.6.8 Delay Factors Related to External Factors

In order for a construction project to be successful, it is necessary to ensure that a favourable environment that is conducive to the achievement of the aims of a construction project is created. In the particular case of Saudi Arabia, which is of concern in the present study, such an environment can be affected by a number of external factors. These external factors can include the extremely hot weather, which can impact the health and safety of the different parties that are usually involved in a construction project, modifications in government regulations and orders that can have adverse implications for business, as well

as excessive inflation in the cost of materials and equipment (Figure 4.17). The group of delay factors associated with external factors consisted of a number of eleven delay factors. The external factors that the respondents considered to cause the most significant project delays were failure to coordinate with government agencies in a timely fashion and rectification of construction defects, which were ascribed the same value of 3.13, as can be seen in Table 4.9 below. Even though these two factors were deemed to have the greatest importance, the other nine factors also had a notable impact on project progress and therefore were considered worthy of attention.

Table 4.9: Delayed impact associated with external factors

Ref.	Related to external factors	Impact	
		Severity	**Rank**
Q82	Delay in the coordination with other government departments	3.13	1
Q86	Rework of defects in construction	3.13	2
Q77	Increase of materials prices	2.99	3
Q79	Poor site conditions (Soil, etc.)	2.77	4
Q78	Shortages in the market for tools & equipment	2.66	5
Q85	Unclear regulation	2.64	6
Q76	Weather conditions	2.61	7
Q83	Problems with neighbours	2.39	8
Q80	Poor economic conditions (inflation, etc.)	2.37	9
Q84	Delays in clearance	2.36	10
Q81	Delays in the test of materials samples	2	11

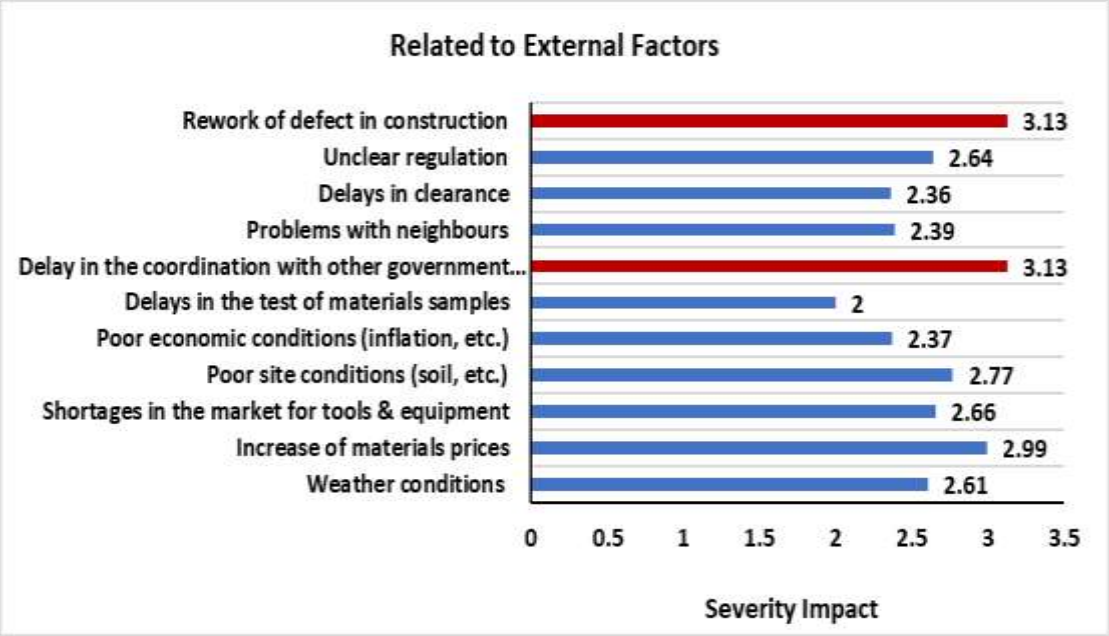

Figure 4.17: Level of impact of delay associated with external factor

4.6.9 Delay Factors Related to Contractual Relationship

This group of delay factors consisted of three delay factors that were related to contractual relationships. The survey respondents assessed these factors differently in terms of their impact on construction projects. Table 4.10 indicates how severe each of the delay factors related to contractual relationships was for the progress of a construction project.

Table 4.10: Delayed impact associated with contractual relationship

Ref.	Related to contractual relationship	Impact	
		Severity	Rank
Q89	Disputes	2.92	1
Q88	Overlap between different contractor's operations	2.74	2
Q87	Weak coordination and communication among all parties	2.69	3

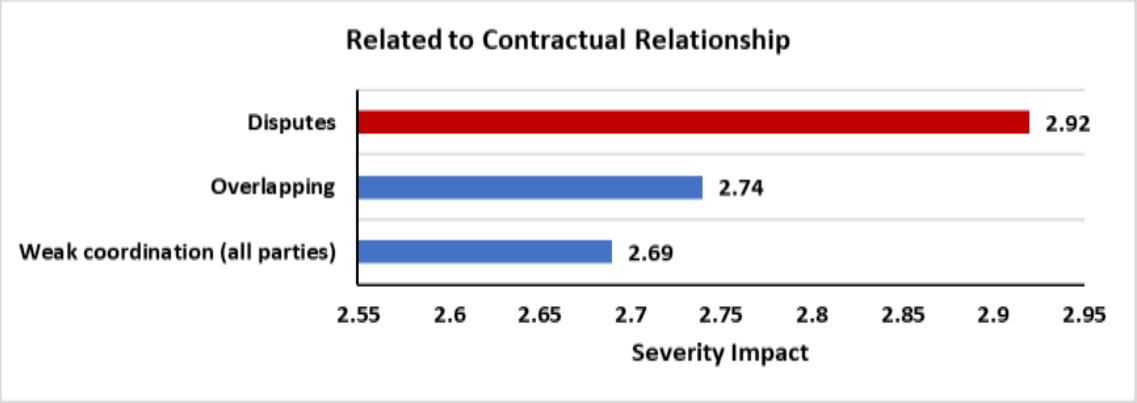

Figure 4.18: Level of impact of delay associated with contractual relationship

4.6.10 Delay Factors Related to Contract

The group of delay factors associated with the contract consisted of five delay factors. These factors were brought to the attention of the survey respondents in order to determine how the respondents ranked them in terms of how severe their impact on the progress of a construction project was. In table 4.11, these delay factors are listed, together with the value of severity that was assigned to them by the survey respondents.

Table 4.11: Delayed impact associated with the contract

Ref.	Related to contract	Impact	
		Severity	Rank
Q90	Complication of the design	2.64	1
Q91	Conflict in the specifications	2.63	2
Q94	Penalties	2.39	3
Q93	Insufficient detail in the construction contract	2.19	4
Q92	Errors in the drawings	2.18	5

As can be seen in the table above, most of the survey respondents considered that, among the different delay factors related to the contract, the delay factor of "difficulties and problems associated with the design" posed the greatest risk to the progress of a construction project, attributing a severity value of 2.64 to it. Furthermore, the delay factor with the second highest level of severity for a construction project was "lack of consistency and congruity in the specifications". With a value of 2.63, this factor was only one point below the previous delay factor.

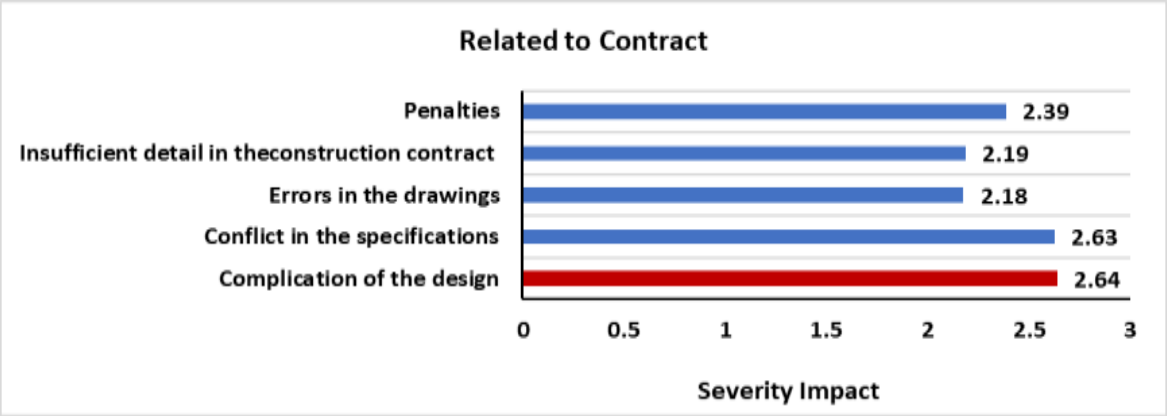

Figure 4.19: Level of impact of delay associated with contract

4.7 Highest Impact for Delay Groups

Table 4.12 provides a summary of the most severe delay factors from all 10 groups of delay factors (Appendix C) for which respondents attributed the greatest severity value in terms of their potential impact on the progress of the construction project. It must be noted that the arrangement of the delay factors in this table has been done in such way so as to reflect an average of the ratings of delay factor that were provided by the respondents, in descending order of importance regarding the magnitude of their impact on a construction project.

Table 4.12: Level of impact of every identified group of delay factor

Related group	Factors	Impact	
		Severity	Rank
Client	Change orders	3.43	1
Materials	Shortage of materials	3.39	2
Contractor	Incorrect construction methods by the contractor	3.32	3
Manpower	Manpower shortage	3.27	4
Consultant	Poor supervision and bad response	3.15	5
External Factors	Delay in the government departments	3.13	6
Contractual Relationship	Disputes	2.92	7
Equipment	Shortage of equipment	2.88	8
Design & Planning	Changes to the scope of work	2.79	9
Contract	Complication of the design	2.64	10

Thus, on the basis of such an arrangement, it can be clearly seen that the survey respondents ascribed the greatest importance to the main delay factor from the group of delay factors related to the client, with a severity value of 3.43, while they ascribed the second greatest importance to the delay factor from the group of delay factors related to materials, with a severity value of 3.39. The large number of the change orders during the project shows the client's involvement in the contractor's work which can directly contribute to the cumulative delay. Whereas the responsibility for providing the materials in the project rests on the contractor as mentioned in the contract. Some project owners want to contract directly with the financiers, while others place it within the responsibilities of the contractor, so defining the authorities from the beginning makes a clearer vision of the project governance.

Furthermore, the third most important delay factor from the perspective of the survey respondents was the delay factor from the group of delay factors associated with the contractor, which was given a severity value of 3.32, while the fourth most important delay factor was the delay factor from the group of delay factors associated with the manpower, which was attributed a severity value of 3.27.

In addition, the client’s interference may cause some problems with the contractor's activities. This interference may cause disputes with sub-contractors. Moreover, failure of the client to provide project details can lead to further problems that often cause delays in the project phases. Furthermore, unskilled workers can cause mistakes leading to defects. This is a close association between the main reasons for the delay.

On the other hand, the survey respondents ascribed the lowest level of importance to the delay factor from the group of delay factors associated with the construction contract, which was given a severity value of 2.64. It can be avoided by distributing responsibilities before the start and during the project operations, as well as by holding regular meetings and communications to keep the project on schedule.

Moreover, the respondents who took part in the survey were all representatives of the main stakeholders in a construction project, including contractors and clients. They all possessed relevant and extensive experience of the construction industry in Saudi Arabia. This experience proved to be invaluable to us in order to gain a comprehensive understanding of the current condition of that industry.

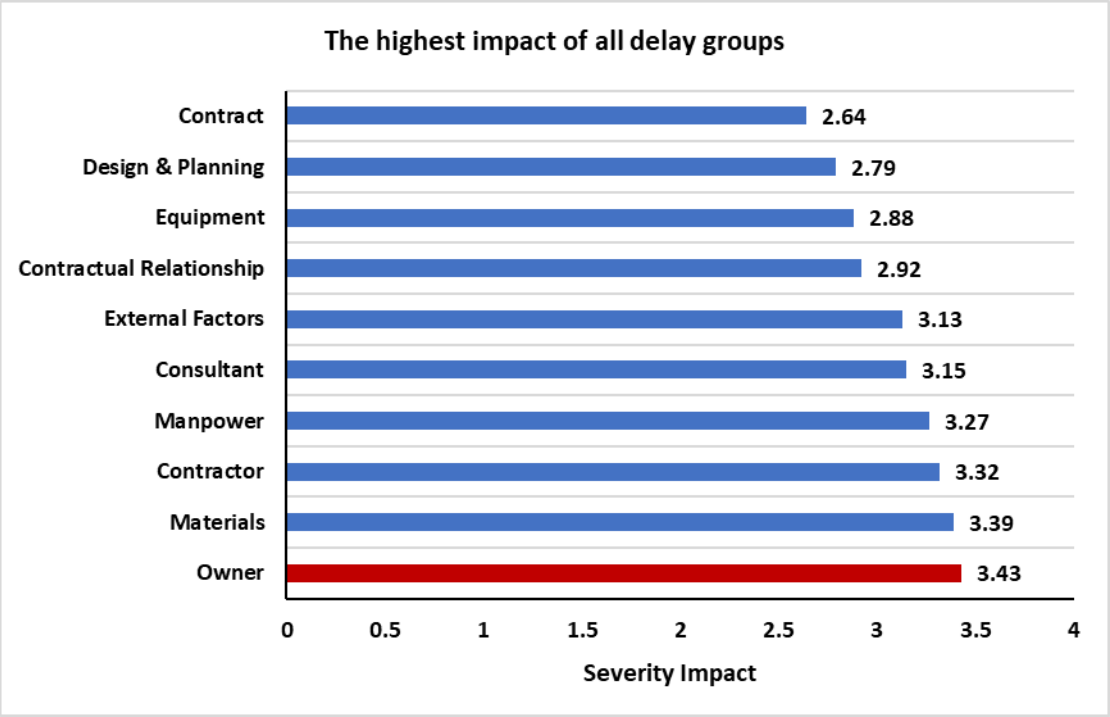

Figure 4.20: The highest level of delay effect associated with all groups

4.8 T Test Hypothesis

This part presents the results obtained from a series of two-sample Welch t-tests (also referred to as the unequal variances t-test) (Appendix D). As a location test, the purpose of Welch's t-test is to determine whether the null hypothesis (H0) holds that the means associated with two groups (i.e., μ_1 and μ_2) are the same. This hypothesis can be stated formally using the following equation:

$$H0: \mu_1 = \mu_2.$$

In the event that the null hypothesis is rejected, then the alternative hypothesis (H1) is confirmed. For each of the tests conducted in this chapter, the alternative hypothesis is that the mean associated with one group is not equivalent to the mean of the other group. The following equation provides a formal statement of the alternative hypothesis:

$$H1: \mu_1 \neq \mu_2.$$

The groups for which the mean values are compared, and thus the null and alternative hypotheses tested, are the severities of the following pairs of factors with respect to the issue of construction project delay: firstly, client and external factors; secondly, contractor and external factors; consultant and external factors; contractor and consultant factors; client and consultant factors; and finally, contractor and client factors.

For each statistical test, the alpha level (i.e., the level of significance) was set at 0.05. Whereas alpha is a threshold value used to judge the statistical significance (Lavrakas, 2008). The confidence interval for the statistical tests given throughout this chapter was set at 95%. Importantly, if the p-values generated from the two-sample Welch t-tests were greater than this alpha level, the null hypothesis was not rejected. At the same time, if the p-value was greater than the 5% significance level (i.e., the value of 0.05), the result was deemed to be statistically insignificant.

4.8.1 Client Factors and External Factors

The null hypothesis for the first two-sample Welch t-test conducted in this chapter was the following: namely, the mean level of severity for the client factors (μ_1) does not differ significantly from the mean level of severity associated with the external factors (μ_2). Stated formally, the null hypothesis was as follows: $\mu_1 = \mu_2$. Correspondingly, the alternative hypothesis was the following: namely, the value of μ_1 differs significantly from μ_2. Additionally, the formal statement of this hypothesis was as follows: $\mu_1 \neq \mu_2$.

The sizes of the first and second groups (client factors, n_1, and external factors, n_2, respectively) were $n_1 = 14$ and $n_2 = 11$ (Figure 4.21). Applying the equation used to calculate the degrees of freedom (DF) yielded $DF = n_1 + n_2 - 2 = 14 + 11 - 2 = 23$. The key results from applying the two-sample Welch test for these two groups were the following: firstly, $t = -0.589$; and secondly, $p = 0.561$. Since the p-value was greater than the level of significance stated above, the null hypothesis was not rejected. Additionally, for the same reason, it was concluded that the means associated with owner and external factors were not significantly different.

```
t.test(external_data$Severity,client_data$Severity)

##
##  Welch Two Sample t-test
##
## data:  external_data$Severity and client_data$Severity
## t = -0.58867, df = 22.994, p-value = 0.5618
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.4247428  0.2365609
## sample estimates:
## mean of x mean of y
##  2.640909  2.735000
```

Figure 4.21: Screenshot of T test between external factors and client factors

4.8.2 Contractor Factors and External Factors

Similar to the previous test, the null hypothesis for this t-test was that the mean level of severity for the contractor factors (μ_1) does not differ significantly from the mean level of severity associated with the external factors (μ_2). As before, the alternative hypothesis was the converse: namely, μ_1 and μ_2 are significantly different. After applying the equation in order to yield a value for the degrees of freedom (DF = 33), and after assessing the sizes of the sets of contractor and external factors (n_1 = 24 and n_2 = 11), the t-statistic formula given in Section 1 was applied. In turn, it was concluded that t = −0.446 and p = 0.660. Given that the p-value exceeds the alpha level of 0.05, the null hypothesis was not rejected (Figure 4.22). Furthermore, it was determined that no statistically difference existed between the mean level of severity for the two sets of factors.

```
t.test(external_data$Severity,contractor_data$Severity)

##
##  Welch Two Sample t-test
##
## data:  external_data$Severity and contractor_data$Severity
## t = -0.44551, df = 22.516, p-value = 0.6602
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.3408572  0.2201754
## sample estimates:
## mean of x mean of y
##  2.640909  2.701250
```

Figure 4.22: Screenshot of T test between external factors and contractor factors

4.8.3 Consultant Factors and External Factors

As before, the null hypothesis for this t-test was that the mean level of severity for the consultant factors (μ_1) does not differ significantly from the mean level of severity associated with the external factors (μ_2) (Figure 4.23). Correspondingly, the alternative hypothesis was that μ_1 and μ_2 are significantly different. Applying the same equation for DF from the previous sections, it was found that DF = 19. Additionally, the sizes of the two groups, n_1 and n_2, were 10 and 11, respectively. Once Welch's t-test had been performed, the value of the t-statistic was 0.434 and the p-value was 0.670. Given that the p-value was greater than 0.05, the null hypothesis was not rejected. Furthermore, for the same reason, it was observed that no statistically significant difference existed between the variances of the two groups.

```
t.test(external_data$Severity,consultant_data$Severity)

##
##  Welch Two Sample t-test
##
## data:  external_data$Severity and consultant_data$Severity
## t = 0.43385, df = 17.487, p-value = 0.6697
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.2886051  0.4384233
## sample estimates:
## mean of x mean of y
##  2.640909  2.566000
```

Figure 4.23: Screenshot of T test between external factors and consultant factors

4.8.4 Contractor Factors and Consultant Factors

The same process was followed in this test as was the case in the previous tests, with the only difference being the groups examined. Therefore, the null hypothesis was that the mean level of severity for the two sets of factors (μ_1 and μ_2) were not significantly different, while the alternative hypothesis was the converse. Here, the factors were contractor factors and consultant factors (Figure 4.24). In this case, DF = 32, and the sizes of the two groups, n_1 and n_2, were 24 and 10, respectively. The t-statistic and p-value derived from applying the two-sample Welch t-test were 0.845 and 0.410, respectively. Hence, the null hypothesis was not rejected because the p-value did not fall below the alpha

level, and it was determined that a statistically significant difference did not hold between the mean level of severity for the two sets of factors.

```
t.test(contractor_data$Severity,consultant_data$Severity)

##
##  Welch Two Sample t-test
##
## data:  contractor_data$Severity and consultant_data$Severity
## t = 0.84642, df = 16.226, p-value = 0.4096
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.2031095  0.4736095
## sample estimates:
## mean of x mean of y
##   2.70125   2.56600
```

Figure 4.24: Screenshot of T test between contractor factors and consultant factors

4.8.5 Client Factors and Consultant Factors

For this Welch t-test, the null hypothesis was that the mean level of severity for the contractor factors (μ_1) does not differ significantly from the mean level of severity associated with the external factors (μ_2). Correspondingly, the alternative hypothesis was that μ_1 and μ_2 are significantly different. In order to perform the t-test, it was noted that DF = 22, n_1 = 14, and n_2 = 10 (Figure 4.25). The results from the independent samples t-test demonstrated that t = 0.934 and p = 0.361. As such, the null hypothesis was not rejected, and no statistically significant difference was observed between the mean level of severity for the owner and consultant factors.

```
t.test(client_data$Severity,consultant_data$Severity)

##
##  Welch Two Sample t-test
##
## data:  client_data$Severity and consultant_data$Severity
## t = 0.93405, df = 19.987, p-value = 0.3614
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.2084338  0.5464338
## sample estimates:
## mean of x mean of y
##     2.735     2.566
```

Figure 4.25: Screenshot of T test between client factors and consultant factors

4.8.6 Contractor Factors and Client Factors

For the final test, the null and alternative hypothesis were again the same as they were for the previous tests. Applying the formula for DF yielded a value of 36, while $n_1 = 24$ and $n_2 = 14$ (Figure 4.26). After applying the t-test, the t-statistic was −0.231 and the p-value was 0.819. Hence, since the p-value was greater than the alpha level of 0.05, the null hypothesis was not rejected. Furthermore, this result indicates that the mean severity of factors related to contractors was not significantly different from the mean severity of factors related to owners.

```
t.test(contractor_data$Severity,client_data$Severity)

##
##  Welch Two Sample t-test
##
## data:  contractor_data$Severity and client_data$Severity
## t = -0.23142, df = 25.499, p-value = 0.8188
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.3338109  0.2663109
## sample estimates:
## mean of x mean of y
##   2.70125   2.73500
```

Figure 4.26: Screenshot of T test between contractor factors and client factors

4.8.7 Summary

As a result, for each of the two-sample Welch t-tests conducted in this chapter, the null hypothesis was not rejected. As such, no statistically significant differences were observed between any of the pairs of factors included in the research.

4.9 Discussion

One of the main objectives of the project is to complete the project on time. Also, the delay has negative repercussions on the contract value. Therefore, the delay is limited to the main parties to the project, namely the client and the contractor. In Figure 4.20, the client was rated first due to ''change orders'' and

the severity was 3.43, while the severity of contractor was 3.32 due to incorrect construction methods.

Moreover, during the construction project, there is a likelihood of a change order being issued and this can occur at any stage during the process. Consequently, many analysts have argued that, in the construction industry, alterations of this nature are a natural certainty (Mensah, Ayarkwa and Nani, 2015). Therefore, minor change orders are sometimes not an obstacle during project phases, but many of these orders result in critical delays in the project.

In addition, the significance of change orders in construction, as well as why these amendments are made, and the impact of doing so, have been analysed in multiple studies (Enshassi, Kumaraswamy and Al-Najjar, 2010). It has been argued by researchers that change orders within this industry are responsible for the majority of cases where project delivery is delayed or where there are incomplete activities according to the original agreement (the contract). Consequently, change orders in construction projects always affect both budget and schedule.

A study conducted by Anees et al. (2013), demonstrated that, out of 63% of project alterations, 14% could be deemed to be of no value to the project, and therefore considered as 'wastage'; especially among changes made to completed ventures. Thus, in order to reduce the possibility of a change order being issued, it is essential to ensure that greater consideration is adopted during the design and planning phase. It is crucial to minimise the probability of variation orders as they cause interruption to operations, and this subsequently leads to setbacks in the completion of activities while simultaneously risking an increase in expenditures.

Utilising logical models of change prediction and system dynamics, Motawa et al. (2007) emphasised that, one can become proactive in managing the chance of change orders being issued. For this reason, suggesting some controls designed to manage the occurrence of change orders as frameworks, by creating a link between customer specifications and project design. Also, in order to effectively control the possibility of any change orders, it is necessary to manage compliance in a manner that accurately covers the client's requirements from the start of the project.

From the survey results, the majority agreed that the changes were the main cause of the delay as the severity was 3.43. These changes require attention in

order not to exceed the limits allowed in the contract. Therefore, the project client bears the increase in costs, time and poor quality.

Furthermore, one of the most important elements in the commencement of any construction task, is the selection of a contractor (Anees et al., 2013). Thus, choosing a contractor for any undertaking requires a great deal of consideration in order to avoid any potential issues during the project phases. In practice, it can be argued that most errors (Workmanship defects) which occur during the project process are largely due to the contractor's failure to adhere to structural plans and methods; which will, of course, all lead to project delays and inaccuracies.

Consequently, disagreements and litigation often arise out of errors which occur during construction; even characterising something as an inaccuracy can, itself, be a subject of dispute. Analysing the results of a conducted survey, participants agreed that 'defects' can be defined as features such as poor craftsmanship, or the nature of implemented systems and materials, and other instances where damage has been caused to the structural integrity of a project leading to the injury of a person or damage to property; which often further results in financial prejudice to the client.

Not all deficiencies are readily apparent, albeit some are discernible upon inspection which are described as 'clear defects', others cannot be easily observed merely through a process of scrutiny; more unnoticeable errors of this kind are characterised as 'latent defects' (Jingmond and Ågren, 2015). However, it is crucial to make clear the distinction between defects which result from errors within the process of construction, and those which arise out of incorrect work. Construction defects concern aspects relating to foundational and support features of a project, such deficiencies put the integrity of the structure at risk and cause aesthetic inconsistencies and errors; for example, inadequately treated surfaces and poor finishing can cause deterioration in wood trimmings.

- **Concept of three principles:**

There are three principal players (like a triangle) in any construction activity, and it is essential that synergy exists between them: the client, the consultant, and the contractor. Fundamentally, the fact that the contractor is more often present on site in comparison to the others, leads to an assumption of responsibility for any defects; however, this is not always the case. In fact, the client is usually the player that causes the most disruptions to an undertaking

by requesting changes which result in delays and cost increases. In cases such as this, both the contractor and consultant are not accountable for such incurred delays or increases in expenditures. However, defects that the consultant can be held responsible such as errors in the technical and design elements, both the contractor and client are undoubtedly free from accountability.

It is essential to ensure that, from the beginning, the client's requirements are intelligible and clearly defined in order to manage and avoid any change orders that could delay the project or cause a rise in expenditure. It is further necessary to select a specialised consultant. For example, if the project has a sustainability scheme, it is important to appoint a consultant with experience in such projects. Furthermore, it is imperative that the chosen contractor is able to understand the concept of the project and has sufficient financial capabilities to complete the work by skilled labourers.

- **Values:**

The three players in the construction process, the client, the consultant and the contractor, can be represented by three points of an equilateral triangle, as illustrated in Figure 4.27. Differences arise between the two parties by not committing to their contract. This conflict leads to a lack of powers granted to each party, which negatively affects the quality of the project.

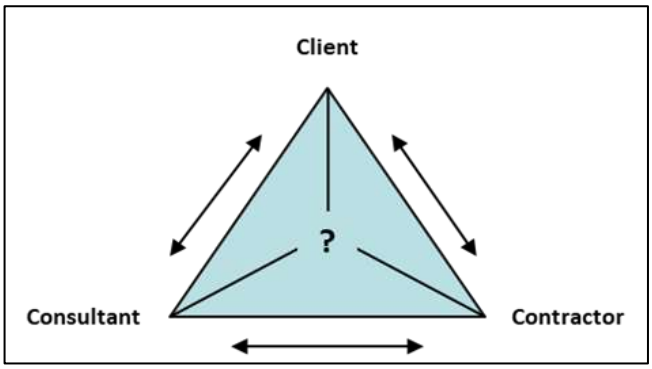

Figure 4.27: Equilateral triangle of players and relationship

Examining this interpretation of their relationships, each player can be taken to be equal in their contribution to the construction process, as illustrated in figure 4.28. If all members are deemed to have proportional contributions, then the weight of their participation will be equally distributed within that triangle.

Therefore, each player supplies a third of all contributions in a balanced project. Thus, upon commitment, the contributions to the project are equal, so the quality will be achieved. (Figure 4.29)

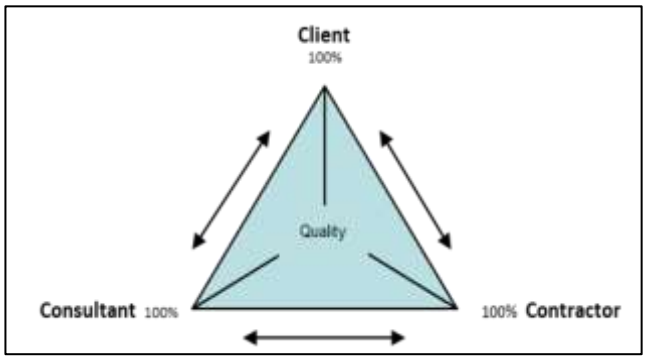

Figure 4.28: Contribution of the parties

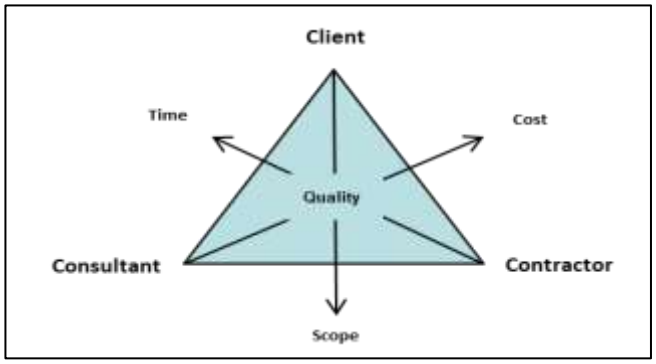

Figure 4.29: Commitment of the parties achieving the quality

However, not all projects are necessarily divided in a balanced manner, and in some instances, different points of the relational triangle will have varying degrees of contribution. Figure 4.25 demonstrates three severe sets of circumstances, where, either the client, the consultant or the contractor, bear more responsibility than their counterparts in the project. For instance, in larger ventures, it can be asserted that the client will deliver more input and therefore outweighs the other players in the triangle; this is due to the importance of functionality in such responsibility. Whilst, social housing will necessarily require greater input from the contractor, so as to ensure that designs are completed according to the plans and specifications to achieve conformity. Similarly, the contributions by the consultant, will be fundamentally important where the

project is designed to accommodate and provide facilities, and in the planning and implementation of a timely project.

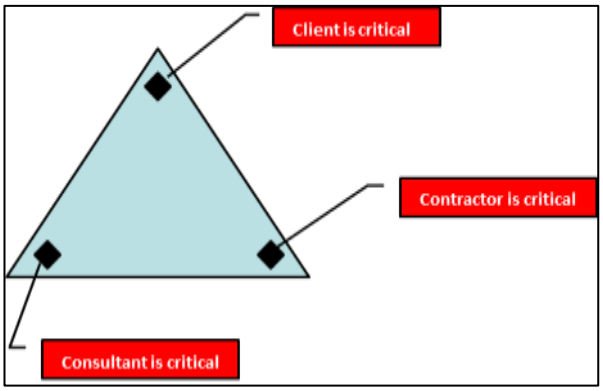

Figure 4.30: Critical groups

The real value of a construction project is calculated through an assessment between the benefits provided by contributing players and the value creation established as a result of a successful task. When establishing project objectives, it is important to allocate management authority to each of the players and define the resources available to them respectively. Therefore, it is presumed that the maximum amount of value will be achieved, by making clear the expectations between the participants in the project and ensuring sufficient resources.

- **Prioritisation:**

In any construction project, the main stages are the concept, design, construction and control. Following commencement, it must be noted that the weight of each player's input within the triangle (above) may alter during operations. Where a contractor may not be operating at full capacity during the design phase, he will have a much greater contribution to the project as the task moves into the construction phase. This is fundamental as, in order to avoid litigation and issues arising out of potential errors during the development process, and to ensure that proper implementation is achieved, the contractor must, at this point, have greater responsibility than his counterparts. Therefore, preference for management must be given to certain players at different stages in a project, so long as this does not affect the functioning of the venture, or

affect the performance of the other members of the triangle in the course of carrying out their duties.

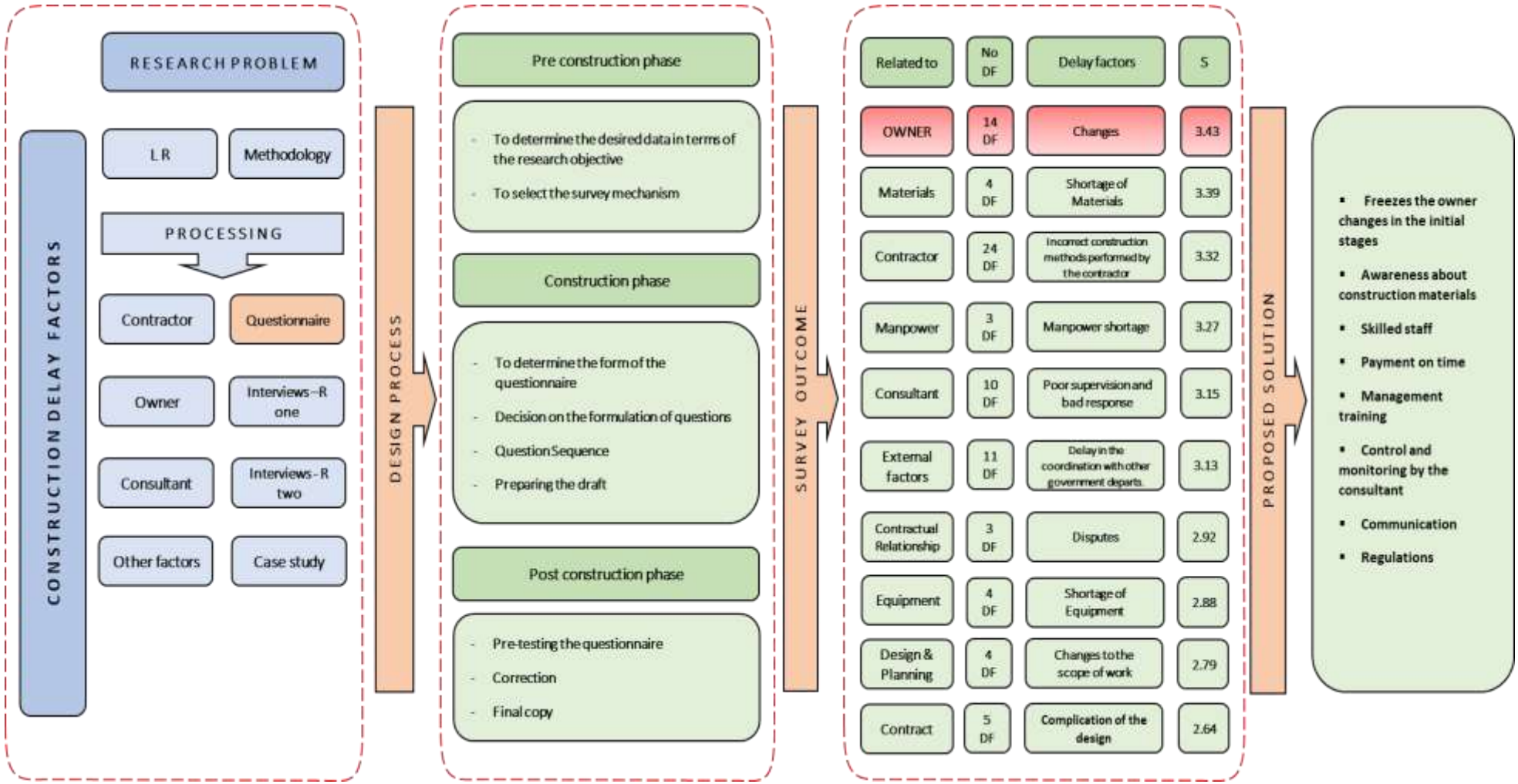

Figure 4.31: Summary of construction delay factors and survey outcomes with proposed solutions

4.10 Conclusion

The survey consists of three parts, the first and second parts, to determine the respondents' data and the status of delays in the projects in which they participated. The third part contains the main causes of the delay problem, to find out who is responsible for delaying construction projects. In addition, to increase the reliability of the results, the research sample (experts) was the basis for selection. Thus, the result of the above analysis revealed that the main reason for the delay was the client-related group, as the severity of 'change orders' was higher among all groups. This delay indicates significant deficiencies on the part of the client ranging from work processes to changing orders.

Disputes can occur during the project phases between the client and the contractor, but when there are no written orders, disputes will be substantial, resulting in a significant delay of the project and often this impacts all parties. In addition to the team's failure to follow up on such cases, it will increase the risks. In addition, the severity of the delay factors was very close to the all groups, but the difference was in the number of factors covered, so as a result of the T test, no significant differences were observed between any of the pairs of factors included in the research.

Figure 4.31 shows that the change orders due to the client were the highest and some solutions that might contribute to overcome or mitigate this problem. Some experts contributed to finding these solutions to avoid delays in construction projects such as freezing changes from the start.

Furthermore, these changes lead to a change in the terms of the original contract so that the project deviates from the planned and agreed target. Therefore, when the size of the changes is so large that the nature of the project changes, the original contract thus becomes inappropriate to cover these actions.

CHAPTER 5: CRITICAL DELAY FACTORS - QUALITATIVE ANALYSIS (PHASE ONE)

5.1 Introduction

The purpose of this chapter is to outline the outcomes of the interviews. Therefore, a critical analysis of the way in which it is possible to avoid delays in the implementation of housing initiatives in the KSA is presented, drawing on the existing interview findings. There was a crucial advice derived from the interviewees, regarding delays in construction project of how it is possible to mitigate them. Furthermore, it should be noted that during this process, the observations recorded in the context of interviewing respondents to the research attract attention where appropriate, thereby aiding in the data analysis procedure.

During the research for housing projects in the Ministry of Housing, it was found that no project contains sustainability factors. Therefore, the interviews were conducted in two phases: the first phase related to delay factors, while the second phase related to sustainability. Hence, it becomes necessary to research this issue to find out the reasons for this.

5.2 Interviews Process

The interview was undertaken over a period between February and March in the year 2018, in the location of Saudi Arabia. The semi-structured interview came after the questionnaire was submitted to verify the results of the survey.

The interview's sample consisted of nine respondents, divided into a trio of contractors, a trio of construction consultants, and a trio of clients. Of these respondents, 100% were working as specialists or had expert knowledge of the construction industry. This sample were chosen to confirm the academic legitimacy of their responses, whilst the respondents were not connected with one another via their various projects.

The questions (Appendix E) were constructed to maximise the focus on their respective construction histories within a Saudi Arabian context. To this end, various topics were covered by the interview in relation to the construction industry, including contracting, completion, and planning. The questions were posed within the context of the office of the respondent, with the audio recorded. Their direction was between 40 and 55 minutes each.

These group was chosen as respondents for the semi-structured interview, with the guidelines created in keeping with the objectives of the study and conforming to the needs of the University's Human Ethics Research Committee. The interviews were documented through a digital audio device, with the recordings made on-site in Saudi Arabia. Copies were made of the audio file, with transcriptions undertaken following the interviews to be used in the analysis (Appendix F), and connected symbolic elements isolated within the interview texts. Through this process, the evaluation could be undertaken with the conversation remaining unaffected.

5.3 Interviewees

The interviewees in this research were representatives of different aspects of the KSA's construction industry, including clients, consultants, and contractors. Based on the research specifications outlined in the previous chapters, practitioners were viable candidates for the interviews only if their experience in the industry ranged from 20 years and above. In the case of the present interviews, the respondent with the greatest number of years of experience had served in the KSA's construction industry for 26 years as a consultant. As for the contractor, this practitioner had 20 years of experience, while the client had experience amounting to 25 years. (Table 5.1)

The interviews took place in Riyadh. The interviewees gathered their professional experience throughout the kingdom such as Riyadh, Jeddah, Dammam, Qassim etc. The city of Riyadh is distinguished by the presence of all ministries and government bodies while regional branches are limited to coordination with the central departments in Riyadh. Therefore, projects and budgets are centralised in the capital.

Table 5.1: Sample participants

Ref.	Job	Place	Experience	Organasation size
Ct1	Consultant 1	Riyadh	22	Large
Ct2	Consultant 2	Riyadh	23	Large
Ct3	Consultant 3	Riyadh	26	Large
Cr1	Contractor 1	Riyadh	21	Large
Cr2	Contractor 2	Riyadh	23	Large
Cr3	Contractor 3	Riyadh	20	Large
Cl1	Client 1	Riyadh	20	Large
Cl2	Client 2	Riyadh	25	Large
Cl3	Client 3	Riyadh	22	Large

5.3.1 Semi-structured interview results - Consultants' point of views

The consultants, namely, Consultant Ct1, Ct2 and Ct3, were the first practitioners interviewed for the research. In terms of the background of the first practitioner, he embarked on a career in civil engineering after graduating from a prestigious institute of higher education in the United States of America (USA), while the other was from Saudi Arabia. In addition to the latter, graduated from Egypt in Architecture Engineering.

In the course of the interview, we drew attention to the main issues that can result in delays when implementing construction initiatives in KSA's environment. The purpose of this was to ensure that all consultants were familiar with the context of the research, as well as its primary aims. Specifically, the outset of the interview included highlighting that multiple limitations were associated with the establishment of public-sector construction initiatives in the KSA, and Consultant 1 (Ct1) was asked whether they had any recommendations as to how delays of this kind could be mitigated. In response, he explained that numerous approaches to avoiding these delays existed, the choice of which must be context dependent. In particular, the main variable that must be considered

when choosing how to avoid a delay is the issue of what caused the delay in the first place.

Based on this, it was asked whether there was a general approach to avoid delay. Consultant's response was that all projects are characterised by variable requirements, and so the key element that must be in place is a group of highly-skilled practitioners who can respond to the condition on the ground as per the changing nature of the site. In this way, it can be ensured that a project will satisfy the requirements relating to budget, quality, and time.

Following this, Consultant Ct1 was asked whether any measures can be taken by those in the contracting profession to alleviate delays in the KSA's construction industry. The key point highlighted was that of adaptable recruitment, namely, with respect to the contractor's ability to hire workers from abroad. In addition, he underlined the importance of accumulating the capital that is required to ensure that contractors are reimbursed for the work they provide. The response of the next question asked to Consultant Ct1 about his attitude towards the idea that contractors have insufficient strength, suggesting that labourers cooperate in establishing a more sizeable contingent. Although, Consultant Ct3 acknowledged that this would be ideal, he highlighted that this was not something that could be achieved in practice. There is also consensus among the views of all consultants.

Therefore, in response to the researcher's question about what measures can be taken by consultants to mitigate delays in the KSA's construction industry, Consultant Ct1 and Ct2 underlined the importance of revising every contractor summation at the earliest available opportunity, even when it is not possible to supervise them. Furthermore, the respondents emphasised that implementing a structured approach to delay monitoring could motivate the more efficient completion of work of contractors.

Regarding the viable approaches that can be applied by clients for the purpose of alleviating delays, Consultant Ct3 highlighted that the variable of management quality with respect to the client is one of the most frequent determinants of the degree to which the process is efficient. The consultant highlighted that the question of whether a client supervises their employees is a fact which directly affects the issue of delay. In certain cases, clients have inadequate capabilities to ensure that their employees on public-sector projects are of the highest calibre, a problem compounded by the fact that public-sector wages are typically not as a high as private-sector wages.

Another crucial issue highlighted by Consultant Ct1, is that clients are typically engaging with a minimum of three construction initiatives simultaneously, an overburden can lead to frequent delays. In view of this, an obvious way in which to mitigate delay in the KSA's construction industry would be to ensure that clients do not take on an excessive workload.

In the interview, the interviewer asked Consultant Ct2 about his opinion on the matter of one authoritative agency holding responsibility for the implementation of all the KSA's construction initiatives. He opined that if the whole system of working was changed, and an overarching strategy adopted (specially to determine how priorities should be balanced regarding the issue of which projects should be conducted first), such an authoritative agency could prove valuable in minimising delays. Based on this, the interviewer recommended that the calculation of the possible value of varying projects for contractors, paired with the establishment of a quota for all contractors (i.e., one which cannot be exceeded before fulfilling every aspect of the project), and could be an effective strategy.

From the point of view of the Consultants, it is possible to derive the following recommendations: firstly, the workload of supervisors should be restricted; secondly, an overarching strategy that encompasses every housing project currently in progress in the KSA should be designed; thirdly, creating a new layer of management to avoid delays by an independent team; and finally, contractors should be evaluated based on their experience in the field and completed projects.

5.3.2 Semi-structured interview results - Contractors' point of views

This interview was conducted with the first contractor, namely, Contractor Cr1, whose experience involved working for a Saudi contracting firm after graduating from university after acquiring a master's qualification in civil engineering. In addition, the interview was conducted with the second contractor Cr2 in the same month. His experience in the construction sector ranged from 22 to 24 years. Furthermore, the interview with Contractor (Cr3), was conducted in March 2018, and it lasted about 50 minutes. The contractor has an experience of over two decades in the construction industry. The interviews were characterized by more accurate knowledge of the Saudi market.

Similar to previous interviews, attention was first drawn to the main issues that could lead to delays when implementing construction initiatives in Saudi Arabia. The purpose of this, was to ensure that contractors were familiar with the context of the research, as well as its primary aims. Paired with this, the interviewer made it clear to contractors that they could call off the interview at any point and for no clear reason. Also, the interviewer ensured that contractors knew that they could ask for all data to be destroyed without processing or publication.

Following the above-mentioned preliminary measures, the interviewer sought to determine whether Contractor Cr1 agreed with the main factors causing delay identified from the literature review. The interviewee responded affirmatively, indicating that he agreed the interviewer's points were probably true. Nevertheless, he highlighted the theoretical nature of the research cited by the interviewer, emphasising that matters are not always the same in practice. Therefore, the interviewer asked the contractor what he thought were the primary factors causing delays, with the response highlighting the following: lack of experience, ineffective managerial approaches, unstructured supervision, insufficient labour, and late payments. In order to alleviate delays caused by these factors, the contractor drew attention to the importance of conforming to contract terms in providing supplemental labour and resources.

However, the interviewer made the argument that contractors are improbable to want to provide supplemental resources and owing to the government's Saudisation (Saudi nationalisation scheme) policies regarding the employment of non-Saudi nationals, manpower reserves would be difficult to augment. Furthermore, he suggested that the flexible allocation of manpower resources would be critical in view of the relatively low number of Saudi workers. Based on this, Cr1 highlighted the criticality of avoiding late payments to contractors and identified this as an area in which government intervention would be welcome as a way to minimise delays.

Additionally, Contractor Cr2 opined that current contracts are not equitable, and moreover, they are not conducive to the minimisation of delays. In view of this, the contractor suggested that the use of the International Federation of Consulting Engineers (FIDIC) contract could be utilised to solve many of the problems relating to delays in the KSA's construction industry. The third contractor Cr3 insisted on applying this matter to avoid problems and disputes between stakeholders.

'' FIDIC contracts are considered one of the most important, effective and widespread engineering contracts, and these contracts have an excellent practice because they are balanced contracts, which define the responsibilities of the parties clearly, accurately and fairly, so they take into account the interests of all parties in the contract.'' (Cr2)

According to the interviewee, the main causes of delays originate with clients rather than contractors, which stems from the fact that contractors have a greater financial incentive to ensure that delays do not occur. Based on this, Contractor Cr1 indicated that a Public Private Partnership (PPP) system could provide contractors with a way in which to conform to client specifications in a flexible way. However, as pointed out by the interviewer at this point in the interview, the PPP system is novel, and as such, the degree to which it is effective has yet to be assessed comprehensively. Based on this comment, the interviewee acknowledged that the PPP system may suffer from flaws but maintained that it does hold promise as a way to account for delays in the industry.

'' One of the important things is the partnership between the public and private sectors, as investment in public sector infrastructure is an important way to maintain economic activity.'' (Cr1)

With regard to the drawing of deficiencies, Contractor Cr2 indicated that an absence of drawings at a project's outset can delay proceedings when contractors must explain issues prior to commencement. Therefore, the interviewee suggested that one way in which to minimise delays could be to guarantee that plans are finished prior to the initiation of the project's bidding phase.

'' The absence of some drawings contributes to frequent changes during the project stages. At the same time, it reinforces the idea of the absence of decision makers on the site, which inevitably leads to delays.'' (Cr2)

According to Cr3, although every stakeholder in the process contributes to the emergence of delays to some extent, he regarded the government and clients

as the main issue. This was because the establishment of a project system characterised by effectiveness and efficiency would inevitably result in the effective and efficient fulfilment of projects. Regarding the issue of the strategies the government could use to alleviate delays, the contractor highlighted the importance of creating a public projects council, the purpose of which is to afford total control to government ministries. To reinforce this idea, the contractor argued that the Ministry of Housing allocated most of its manpower to chasing contractors and supervising construction projects, which detracted from its ability to manage the KSA's housing system. In view of this, Contractor 3 emphasised that a public projects council would have a beneficial impact in minimising delays.

Furthermore, Cr3 stated that it is possible that delays can arise when a client's workload is excessive, or when the client begins to intervene in the project's proceedings. As a case in point, efforts to limit the approval period are often pursued by clients by increasing the number of supervisors for various projects, but this can result in delays when quality concerns begin to emerge.

'' The client's involvement in the project stages leads to a significant delay.'' (Cr3)

In-depth examination of the construction industry was recommended by the interviewee to gain insight into its functioning. As a result, the contractor argued, it would become clear that the present approach by which contractors are chosen for a project gives rise to numerous issues, namely, because the contractor offering the lowest price is selected. Furthermore, this problem of quality and potentially lacking capabilities is compounded by the way in which project plans may not have been completed prior to the allocation of work to a contractor. Therefore, the interviewee suggested that the elimination of the lowest price bid approach could solve many of the problems that result from it, thereby minimising the likelihood of delay.

In addition, the contractor Cr3 suggested that if all clients have clear specifications for their projects, it is in turn possible for suppliers to gain an unambiguous sense of what is required of them. As a result, quality may no longer be an issue that causes delays since the key stakeholder will be on the same page in this respect. When viewed over the long term, this could have a significant effect on driving quality higher and minimising the incidence of delay.

With regard to statements made by contractors, it is reasonable to suggest that the following are worthy of consideration; firstly, paying contractors on a regular basis; secondly, applying FIDIC contracts; thirdly, rolling out the PPP system eventually; establishing a housing project council; approving extension time should be limited; training staff should be implemented; taking measures to promote flexible manpower; and finally, formulating uniform specifications for housing projects.

5.3.3 Semi-structured interview results - Clients' point of views

Interviews were held in the capital of Saudi Arabia, Riyadh, in March 2018. This interview consisted of three clients – the first with high credentials in business and architecture, the second an architect and the third a civil engineer – all of them have a great construction experience in the Saudi market. Each interview was conducted in under an hour.

During the interviews, the clients were asked whether they viewed the client as the main source of setbacks throughout the course of the project. In response they defended the client. Although there had been some delays on their part, they contended that the lack of engineers would not result in significant delays since the consultant was responsible for most of the project. Hence, the main issues were due to the contractor. The interviewees then gave recommendations for minimising delays in future, the foremost of which was to implement a database system whereby contractors could be evaluated. With the collaboration of clients, a contractor should be appraised at every stage of a project and the database updated, thus giving an overview of the project as a whole and the status of individual contractors and their history within each project.

Further questions were asked about the guidelines surrounding subcontractors. The clients confirmed that a key issue causing delays to the project was the lack of standards involved in this aspect of the work, enabling the contractor to allocate jobs to an unskilled workforce. In order to counteract this, subcontractors should also be held to account and required to observe stringent guidelines.

One specific client, blamed the consultant for most of the issues within the project, citing a lack of clarity in correspondence between the consultant and contractors, causing errors and confusion. This client was also of the opinion

that the client would be partly to blame, given that a quarter of all delays are a direct result of the client altering the scope of the project. However, the most significant cause for delay in this case could be under-resourcing, since both the clients' staff and the contractor's team lacked professional personnel.

Despite differences of opinion, all three clients agreed that the government would need to incorporate new directives into the process (such as BIM), and that an independent board of qualified professionals should be set up to transform the current system of tendering, in order to make investment in Saudi Arabia more appealing to international business.

5.3.3.1 Interviews Outcomes

The outcome of these interviews has been to reveal one shared solution to the issues of delayed construction projects in Saudi Arabia. Having acknowledged the substantial problems, the clients, who are experts in their fields, put forward their proposals for changes to the system. Many factors were identified as contributing to the problems, and many solutions were suggested, but the key outcome emerged that in order to deliver a sufficient workforce, greater adaptability is required within the procurement system. A solution such as this would help to motivate the construction teams despite the huge volume of labour required of them. Furthermore, it would benefit the many different investors in the projects, since it is in their interests to incentivize the workforce to make the project profitable for all stakeholders.

A further problem identified by the clients concerns the shortage of skilled workers in Saudi Arabia, which directly affects the nation's rate of growth and expansion. Contractors are unwilling to take on new projects as a result of lack of this, causing immediate delays to construction. In order to counteract these issues, a planning council must be established that has the power to manage and regulate all Saudi Arabia's construction projects. The council must have the ability to oversee all areas of the project, from initial concept to completion. Before creating a planning council, the most significant issues should be agreed on and research should be carried out as to which solutions have already been tested and the degree to which these findings have been put into operation. This study will investigate the chief concerns and evaluate suitable solutions and ways to apply them.

One further consideration to consider is the ethos of the workforce on each project, which can often be rooted in tradition and can be hard to change. Many

workers are reluctant to re-learn their working practices despite new processes bringing greater efficiency and increased productivity. This can be particularly risky on housing projects and should be included as a factor when seeking solutions to delays.

5.3.3.2 Suggestions of Interviewees

As a result of these interviews and the subsequent research, six main suggestions can be put forward. Firstly, that an independent planning council should be established for all housing projects. Secondly, that contractors should be evaluated across all projects with the help of a database. Thirdly, that strict regulations should be put in place for all parties, including the consultants, contractors, and subcontractors. The fourth suggestion is to build an appropriate team for each project that should include the architect, civil engineer, mechanical and electrical engineers, and any other appropriate parties involved in the project. The fifth point should be that no changes can be made to the scope of the project, once the process is underway. And lastly, every project should put into practice the Lean construction method and BIM as well. By following all the recommendations, delays to construction projects can be significantly reduced.

Despite these recommendations, delays to projects currently underway in Saudi Arabia have reached a critical point, therefore an immediate action is required. One suggestion would be to take back these projects from contractors who are not fulfilling their obligations to deliver the developments on time.

5.4 Summary

The interviews provide us with a wide range of data that may not be provided by other study samples, as the data provided by the interview is very deep. In general, the regulations of the Ministry of Housing contributed to the delay of projects, from accepting bids to executing projects. Most projects focus on low bids based on the procurement system. In addition, the selection of contractors without experience contributes to many modifications in the project. When the work has accumulated, the contractor is unable to complete the project, some of which withdraw during implementation. Furthermore, delays in the payment of contractor's dues, resulting in delayed sub-contractor dues.

Moreover, there were differences in the contracts and no final formula was adopted. This contributed to the lack of clarity on the role of some stakeholders

in how to bridge the deficit in case of any delay during the phases of the project. So, everyone insisted on applying FIDIC contracts. Also, the changes are due to a lack of details or additions not mentioned in the final specifications and drawings (Table 5.2).

Table 5.2: Samples of similar codes from the interviews

Consultants	Contractors	Clients
Comprehensive strategy by a special **board**	Establishment of an independent housing project **board**	A housing project **board** must be established
FIDIC contracts	Application of **FIDIC** contracts	Using **FIDIC** contracts
Regular visit and **acceptance**	Reduced **approval time**	**Bureaucracy**
Skilled staff	**Skilled** workforce	**Skilled** staff
Details of drawing	Avoid **absence** drawing	**No changes**
Payment to contractor	Regular **payment**	Clear **payment**

Therefore, the results contributed to identifying the important causes of the delay in the projects and who caused them, and then helped in finding solutions suggested by the respondents during the interviews that contribute to reducing these delays (Figure 5.1).

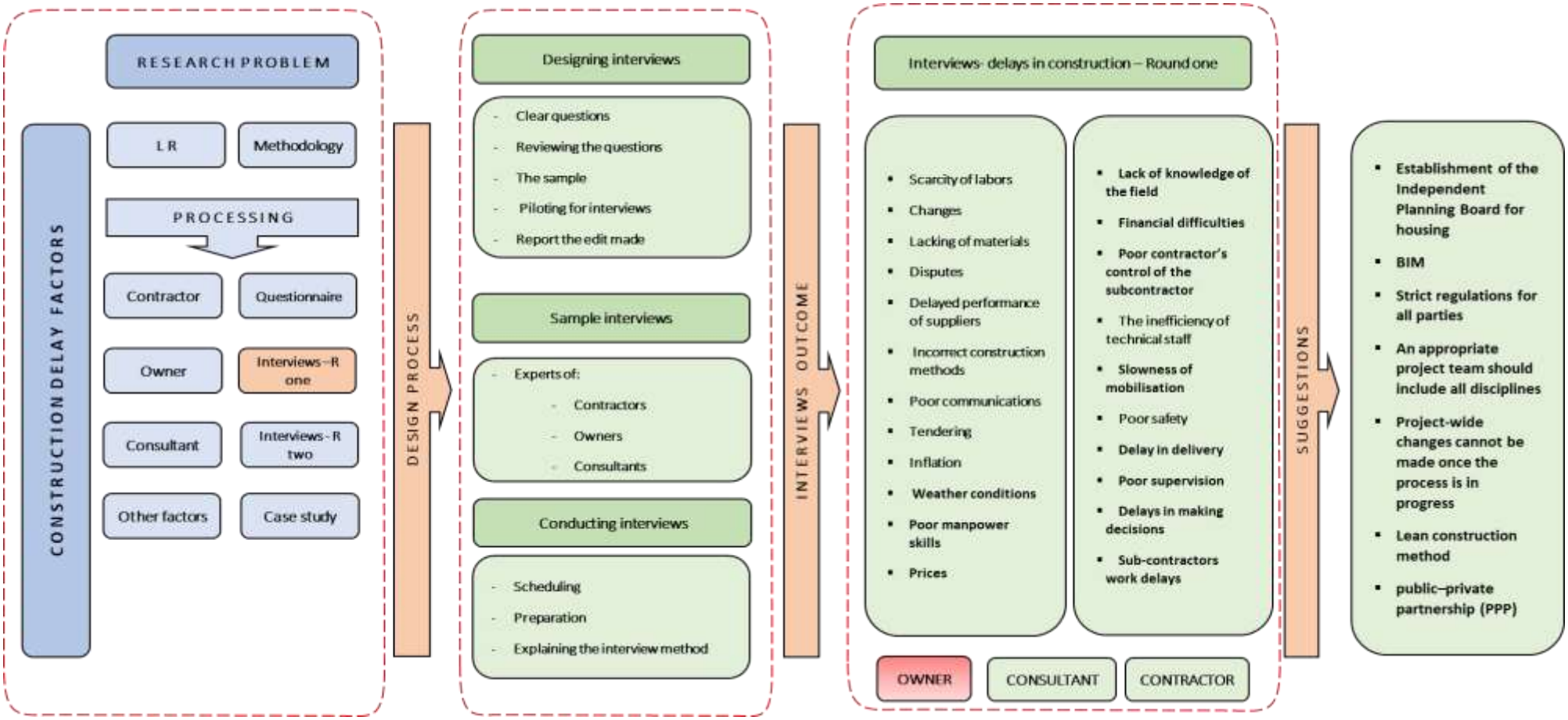

Figure 5.1: Summary of interviews (Phase One)

5.5 SUSTAINABILITY INTERVIEWS ANALYSIS (PHASE TWO)

5.5.1 Introduction

The construction industry tends to overlook the integrated idea of housing being a part of urban cities which is also a significant problem in the developing world. Throughout history, housing has played a major role in human settlement apart from being a mean of providing shelter.

Today, to ensure that housing stays sustainable, a holistic approach that incorporates factors such as providing social infrastructure including clinics, schools, urban greening, and urban design must be integrated into housing programmes. Sustainable housing has problems regarding formal as well as informal housing provision and their concerning policies. Moreover, housing, instead of being an empowering and enabling process, is considered as a product that must be fabricated and delivered.

Furthermore, preserving the local environment is an important condition for sustainable homes that involves a selection of sustainable building materials and a consideration of diverse issues around the life cycle impacts across the environmental, social and economic aspects of sustainability.

The interviews showed that the respondents held similar opinions and agreed on various issues including how important it is to educate people regarding sustainability and ensuring that the government plays a more active role in enforcing sustainability laws in the construction sector. In addition, there is no classification system that belongs to Saudi Arabia, but they use for the time being the LEED system for sustainable construction.

5.5.2 Interviews Sample

The second phase of interviews was conducted with experts in the KSA, on whether sustainability should be implemented in the construction projects. The participants gained their experiences from dealing with construction projects (about 20 years). Moreover, the interviews were conducted to assess the state of sustainability of construction projects in KSA, as well as the obstacles to their implementation. Also, to find out the appropriate specifications for home design in Saudi Arabia.

5.5.3 Interviews Discussion

First, the three interviewees were asked about their views on the current sustainability of houses in Saudi Arabia and the reasons for their opinions. They all stated that there was a lack of housing sustainability there. The first interviewee (ES1) noted that there is a lack of proper understanding regarding sustainability in Saudi Arabia and that though some people do aim to be as sustainable as possible concerning their houses, households in Saudi Arabia generally overlooks sustainability.

The second interviewee (ES2) stated that, for the most part, there is a lack of adequate information about sustainability resulting in failure of comprehensive understanding among Saudi households despite knowing that it concerns environment, wellbeing, and nature. The third interviewee (ES3) notes that, apart from lack of information and awareness, sustainability among households in Saudi Arabia is lacking because of lack of regulatory bodies in the field.

Then, the interviewees were asked if sustainable buildings would be accepted by the general public in Saudi Arabia. The three interviewees all agreed that if the right information was provided, the general public's acceptance could increase. ES1 stated that as there are households that want healthier living conditions for their families, using sustainable and natural elements for constructions would be considered as beneficial.

Moreover, ES2 said that Saudi households would like to adopt sustainable concepts including reduced water and energy consumption and thus support their families' wellbeing and confirmed that the general public would welcome sustainability once they better understood the concept. ES3 agreed that increased awareness was important and added that regulatory as well as legal structures are also important in people accepting sustainable housing, reaffirming that creating a natural and healthy living environment would of interest to the general public for not only themselves but also their families.

The interviewees were then asked about their opinion on the factors delaying sustainable housing development in Saudi Arabia. ES1 stated that while the lack of infrastructure was vital, there were also other problems such as lack of relevant laws being introduced as well as lack of awareness that were obstacles to the development of sustainable housing. ES2 agreed with ES1 about these factors and added that there was also a lack of comprehensive knowledge about sustainable housing construction as well as difficulty in accessing new building materials. ES2 further stated that the existing homes not only failed to meet

the sustainability criteria but also did not address the occupants' needs. Apart from reiterating ES1's and ES2's opinions, ES3 stated that inadequate equipment and material supply, no appropriate database, the lack of qualified as well as experienced construction professionals, and poor education and government support were also important factors.

When asked if they could suggest initiatives that would help improve Saudi households' energy and water efficiency, ES1 stated that insulation was crucial as it decreases the energy that is needed to maintain the home's appropriate energy because of heat-flow control, and added that the type of window in a house should also be considered as it can help keeping out direct sunlight and dust. ES1 also recommended using solar panels for Saudi households could be a very adequate option.

ES2 affirmed that using solar panels can provide renewable and clean energy source and suitable windows and doors can help reduce dust, and further stated that that, to ensure interior protection and effective heat-flow management, it is important to properly insulate the ceilings, floors, and walls, emphasising that the design and materials are both important. Similarly, ES3 also confirmed the advantages of installing solar panels and effective insulation to improve energy and water efficiency and stated that it is necessary for the Saudi government to legally enforce sustainability to ensure that it is widely implemented.

Then, they interviewees were asked whose responsibility it is to make sure that Saudi Arabia effectively implements sustainability and their reasons for it. All three interviewees agreed that the Saudi government was primarily responsible. ES1 stated that as the Saudi government had authority over every single part of the country, they were the major responsible part and that important government bodies such as the Council of Engineers and the Ministry of Housing should work together for raising awareness regarding housing concerns and environmental problems. ES1 noted that a collaboration like this could ensure that the building contractors are suitably skilled, and the designs and new materials implemented for sustainable housing projects can attain their goals.

Furthermore, ES2 emphasised that the government was the primary authority in enforcing sustainability laws not only on the general public but also on government bodies, and further stated that affordability should also be taken into consideration so that the entirety of the Saudi society could afford sustainable housing. ES3 also confirmed that government, laws and regulations as well as collaboration between ministries was important and particularly noted

that to ensure that the infrastructure as well as other necessary factors required for sustainable housing effectively develop, the government must provide adequate support to the public.

The interviews also noted the problem of regulatory action regarding which the three interviewees were asked if they believed enforcing government regulations could ensure sustainability and why. ES1 stated that the government is the major actor in the enforcing laws regarding sustainable housing and that the government can continuously educate Saudi society through the media. This indicates that ES1 believed that regulations can be positively effective only if they are enforced by the government.

Whereas the ES2 agreed with this view and highlighted the power the government has in terms of public compliance and that if the government clearly asserts sustainability standards, it can use through regulatory control to support sustainable housing.

Furthermore, ES2 suggested that the government should support home ownership and put into place sustainability schemes to promote sustainable homes. Moreover, while ES3 agreed regarding the power of the government in enforcing laws so they can penalise those who violate them, they stated that there should be more focus on enhancing peoples' knowledge and understanding about sustainability.

Finally, the interviewees were asked which strategies they would suggest for improving Saudi Arabian housing sector's sustainability. ES1 stated that among the various strategies that are available, public education of the importance of sustainability is the most important. In addition, he said, there should be frequent use of sustainable construction methods, including alternative energy options such as solar panels available to Saudi households.

ES2 emphasised how important innovation is and that it is necessary to examine environmentally friendly housing construction methods as well as practices and materials. He further suggested that it is important to assess the existing energy consumption models, building architecture, and construction methods and to adopt more innovative and progressive methods. ES3 recommended exploring new legislative frameworks and he particularly noted the necessity of developing a general framework along that focuses on sustainability in urban areas as well as better education and training with a clear framework that focuses on encouraging acceptance of sustainable construction principles. Moreover, ES3 stated that the development of frameworks should take into consideration the

interests as well as role of the different government agencies being compatible while clarifying the responsibilities of everyone.

5.5.4 Interviews Outcomes

There has been significant housing shortage in Saudi Arabia because of urbanisation and rapid growth. Moreover, the unavailability of affordable housing has had considerably negative impact on low- and mid-income residents. To address this, both low-cost housing and the peoples' cultural needs should be addressed. Hence, previous research stated that it is important to include sustainable and smart technologies into housing design which should also incorporate economic, environmental, and social goals.

The major factor affecting Saudi Arabia's sustainable housing construction is the lack of awareness among people regarding the advantages of sustainability. Moreover, the ignorance about the advantages as well as potential of smart technologies in achieving sustainability inhibit development, which further results in reduced interest among the major stakeholders concerning sustainable housing construction to incorporate sustainable housing as well as low levels of investment. To ensure that these barriers are surpassed, and sustainability implemented in housing development projects, educating the public about the advantages of smart technologies and sustainable housing is necessary. Encouraging the major project stakeholders to design sustainable housing and use smart technologies is also important. Further, government should support sustainability and be more involved by implementing laws to enforce sustainable methods and providing financial incentives and affordable sustainable housing incorporating smart technologies.

Consequently, the construction industry's problems can be addressed by successfully executing a plan that encourages enhanced quality of life today as well as in the future. Such a scheme should be pivoted in terms of the project's three constrains including cost, time, and quality and include social, economic, and environmental issues that impact the balance of sustainability.

5.5.5 Summary

These interviews showed that there is no direct relationship between the application of sustainability and delays in housing projects. But the delay could belong to one of the 10 delay groups (in the survey). For example, when there is a delay in the delivery of materials to the site such as double glazing or

insulating doors, which is a requirement for sustainability in the building, this falls under the delay factors related to materials. While the change of specifications falls under the budget lines of the project, this is the reasons for the client, while the provision is made by the contractor. So, the relationship of delay here is indirect.

During the interview, I noticed repeated terms related to sustainability, for example green spaces, green houses, solar energy, material efficiency, etc. (Figure 5.2), respondents mentioned the importance of their rapid implementation, because this creates an integrated community. On the other hand, everyone complained about ignoring the application of sustainability by the general public and the ministry as well. Moreover, the results contributed to find solutions through suggestions made by the respondents that contribute to enhance the role of sustainability.

Therefore, the ministry should start on its own and then educate people about its importance, as well as enacting strict laws and enforcing them strictly. It is necessary to include sustainable construction methods that incorporate smart technologies including solar energy panels, appropriate water preservation and wastewater treatment systems.

Additionally, the Saudi Ministry of Housing launched an online service to assess the sustainability of buildings (Mostadam, 2020). This will have a positive impact on lowering the operating costs and improving the indoor environment. However, the Ministry of Housing has not implemented the sustainability plan in its projects yet, as this program was launched at the beginning of 2020.

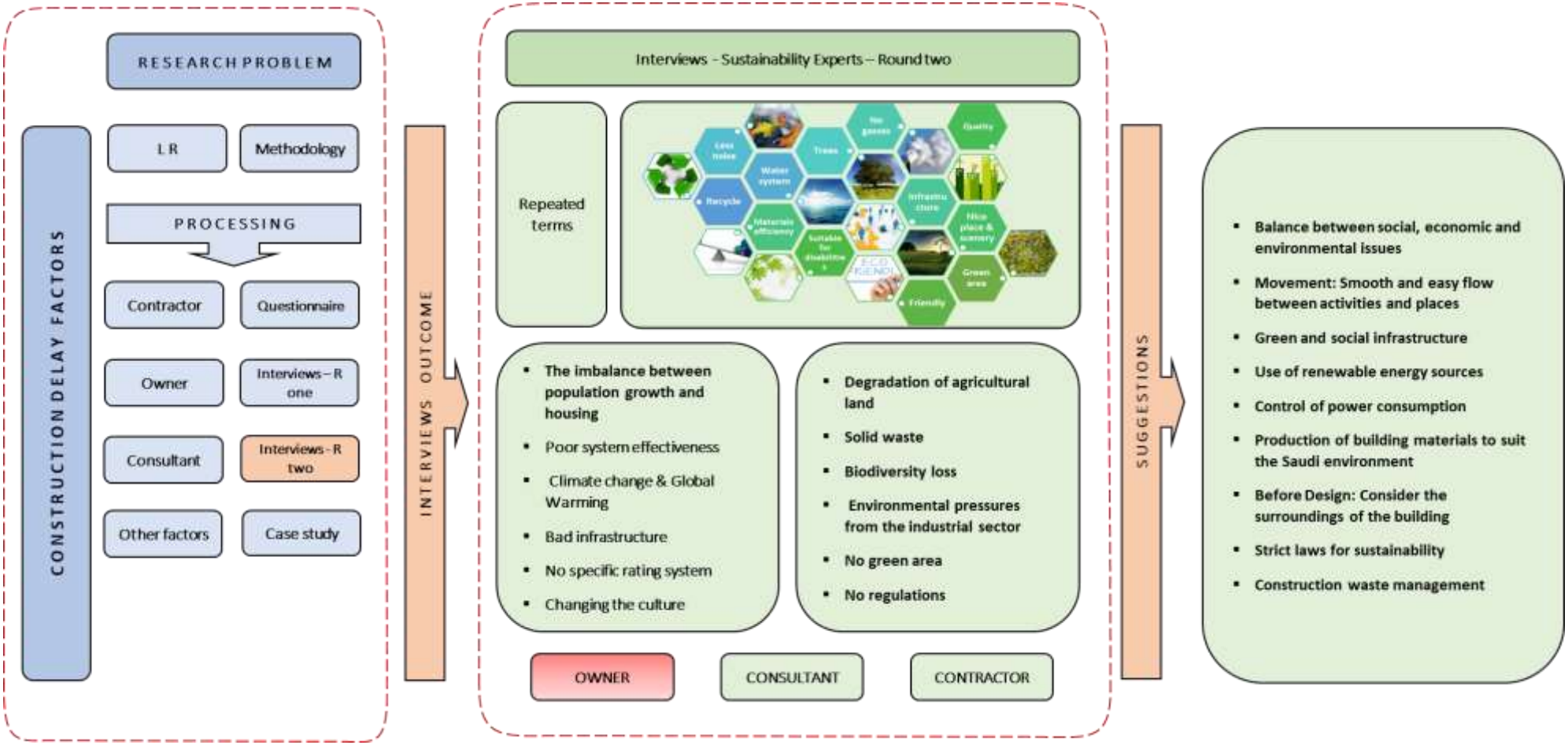

Figure 5.2: Summary of interviews (phase two)

5.6 Conclusion

According to the above analysis, first stage interviews revealed that the main reason for the delay is the client. The client has adopted many steps that led to this delay, the most important are the frequent changes during the project phases that led to direct intervention in the contractor's work. In addition, the lack of communication between the three parties, has increased the gap between them, which negatively affects the progress of the project.

In addition, other interviews confirmed that the government bore the responsibility. Their responsibility to educate people about the importance of sustainability through awareness programs and intensify training programs. Moreover, by qualifying the appropriate contractors for this issue and subsidising building materials for the public to achieve sustainability in an appropriate and rapid manner. Consequently, developing appropriate strategies for the general public in proportion to the Saudi market.

The need to develop a new housing strategy in Saudi Arabia is evolving from the current population needs. Moreover, if the problem persists and amplifies, the current population growth rates and development indicators will not help to improve the quality of life in Saudi Arabia. The strategy focuses on achieving a harmonious and cohesive society, as well as achieving a balance between the factors of population growth and the availability of natural resources. This leads to fulfilling the aspirations of citizens to obtain a better life and provide equal opportunities to obtain the same amount of basic services.

In fact, the beginning is from the establishment of an economic council that manages housing priorities and realizes sustainability factors through standards specific to Saudi housing. Secondly, attracting international companies for construction due to the delay and failure of the national contractor. Therefore, it must contribute to setting up a program for qualifying contractors and raising their efficiency.

Moreover, attracting people of expertise supports the new strategies in achieving them in an excellent way. Thus, experience contributes to achieving success criteria in projects and overcoming problems and differences, whatever they may be.

CHAPTER 6: DELAY FACTORS AND SUSTAINABILITY

6.1 Introduction

The energy consumption of buildings is a matter of great concern in hot countries such as Saudi Arabia. The fact that the housing sector is responsible for half of the country's entire electricity consumption highlights its importance in this regard. Suitable sustainable energy concepts must be employed in the construction sector, and it is considered that Zero-Energy Homes is a worthwhile option. Thus, energy demands will be lessened prior to any use of renewable energy, and this can be achieved with the use of modern building techniques and materials.

It should be noted that sustainable housing implementation necessitates a robust level of support from society, government and the housing sector itself. It is considered that if public awareness and understanding regarding sustainable housing and related terms are poor, then there will be limited support from the public. From the resource work of Salama and Hana (2007), it is said that sustainability and sustainable design are modernizations of traditional architecture and urbanism values".

Furthermore, since living costs are higher in sustainable housing, people are less motivated to adapt the concept. However, while there are questions raised about the up-front costs of green projects, the longer-term financial advantages are substantial.

As a result, this part attempts to showcase the Saudi Arabian housing sector's state of sustainability, with a focus on new housing. The research will additionally establish the level of public knowledge and awareness surrounding this matter, and then determine if there is a relationship between the implementation of sustainability and project delays. As the Kingdom of Saudi Arabia is still in its developmental infancy, sustainability concepts are more easily used in new construction projects, as there is no need to demolish old buildings or retrofitting current structures.

6.2 Sustainable Construction

Sustainable construction describes the procedures for building an environmentally responsible and resource-efficient building over the life of the structures (Sassi, 2015). Put differently, sustainable construction involves the

methods developers use to plan, develop and oversee projects which have as little effect on the environment and the public as possible (Nazirah, Nor'Aini and Ayman, 2013). Overall, sustainable construction involves a degree of natural materials involved throughout the building's life, as the resources are re-used and there is attention given to the effect seen on the immediate environment from design through to the construction, future operation, maintenance, renovation and even demolition stages. It can be said that the key aim of sustainable construction is to establish a healthy environment achieved through effective use of materials and resources, as well as sustainable and efficient building designs (Hwang, Zhao and Tan, 2015).

Hayles (2004) and Kats at el. (2003) state that the use of sustainable construction methodologies in project management leads to a number of environmental, social, and economic advantages. When it comes to environmental benefits, air and water quality are boosted, energy and water usage is limited alongside waste disposal, climate stabilization and ozone layer protection are achieved, and there is a degree of protection for natural resources, open spaces, habitats and biodiversity. From the perspective of economic advantages, there are less operation and maintenance expenditures, meaning there are greater revenues through sale prices or rental agreements, achieved through energy efficiency and conservation of resources and materials. Lastly, social benefits include greater occupant comfort and health and liability.

According to Luther (2005), however, a clear disadvantage is described for integrating sustainable construction, which is that sustainable buildings are costlier than traditional structures are to begin with. It is not the case that all projects have overall net increased costs in a short period of time, and to account for these issues, a life analysis cost must be undertaken to cover the reductions of operating costs. Some hurdles must be overcome related to the slow integration of sustainable construction in the building sector, such as a low level of relevant skill and knowledge being available.

6.3 Sustainable Buildings

Under sustainable building, structures are planned and built with methods and materials which use available resources more efficiently, with minimal impacts to the health and well-being of the building occupants, construction workers, and the residents. Many aspects are taken into account with sustainable building, such as site impacts, land use, indoor environment, energy and water use, the

lifecycle effects of building materials, and solid waste. Constructing these 'green' buildings in an environmentally responsible way is key to sustainable design.

Moreover, traditional ways of building do not account for the interrelationships between a building, its different parts, its environment and the residents. Buildings use a greater amount of resources, negatively affect the environment, and build up substantial amounts of waste. These structures are expensive with regards to energy and water usage, with poor indoor air quality leading to other health issues (Samari et al., 2013).

Through sustainable building practices, environmentally sound and resource-efficient structures can be constructed through an integrated design methodology. Green buildings consider environmental impacts and waste reduction, establish a healthy and comfortable environment, and lower expenses associated with operation and maintenance of said structures. Also, the building's design and components are taken into account, along with economic and environmental performance as well as impacts. Overall, sustainable building designs and strategies are closely linked with resource efficiency and can be a part of all of Saudi Arabian building projects, to some extent.

In general, 'green' buildings are considered the cornerstone of any sustainable construction task (Samari et al., 2013). These structures are even able to have a positive effect on a population's health, through their healthy internal environment (Allen et al., 2015).

6.4 Sustainable Design

Sustainable design is described as the integration of architecture and electrical, mechanical, and structural projects, and includes planning and implementation of environmentally conscious operations considering natural habitats (Williams, 2003).

Through sustainable design, the negative effects on the environment, health and comfort of building residents are limited, which raises the structure's overall performance. The key aims of these efforts are to limit the use of non-renewable resources, lower waste, and establish healthy and productive environments.

Certain sustainable design principles are involved, which are to improve the target location, lower non-renewable energy usage, employ environmentally responsible products, consider water protection and conservation, raise the

internal environment quality, and boost operation and maintenance operations (GSA, 2019).

Through employing this type of sustainable design approach, decisions made during the design process can reduce any negative impacts on the environment and the health of the population, while still achieving the end targets. This is an inclusive and holistic methodology, which allows for compromises to be made efficiently. In addition, there are positive effects seen in the decisions made throughout the building's life cycle, such as during the design, construction, operation and decommissioning stages.

Furthermore, green building rating systems like LEED and BREEAM now use numerous passive design approaches, involving building layout, envelope thermos physics, building geometry, and air tightness and infiltration (Chen, Yang, & Lu, 2015).

6.5 Environmental Assessment Tools

In order to reliably evaluate a construction's performance and calculate the effects it has on the environment; clear performance criteria and indicators are necessary in the field of sustainable construction. These standards must be detailed enough to deal with environmental matters. In many cases, availability of natural resources, global warming, water, urbanisation, pollution, soil erosion, acid deposition, wastes, and the indoor environment are factors playing an important role. It is clear that sufficient standards of wellbeing must be met from the start of any such undertaking, and this can be achieved through official policy implementation.

In the KSA, the Saudi Green Building Council (SGBC) has developed its official evaluation methods for the measurement of building performance by using the U.S. Green Building Council's (USGBC) LEED criteria (see chapter 2) (SGBC, 2019). As a result, the criteria described were used in case study two, in order to conform to the comfort criteria of the building's residents.

6.6 Sustainable and Traditional Buildings

The environment and the economy are obviously affected by the design and construction of buildings, meaning that green construction methodologies consider more than just the structure itself. The aim of sustainable construction is the develop and maintain a healthy environment, with effective use of resources and ecological design. In more traditional buildings, the major factors

are cost, performance and quality objectives, whereas sustainable building projects also give attention to limiting resource usage, avoiding environmental degradation, and establishing a healthy environment (Gorgulu and Koman, 2013). Sustainable structures are the result of sustainability and sustainable development throughout the construction sector. There are three key sustainability indicators for these buildings, which are ecological sustainability, economic sustainability and social / cultural sustainability.

There is substantial variation seen in traditional buildings based on climatic conditions, building materials which are locally available or strongly preferred, traditions, income levels of clients and their social habits. These historic buildings have a wide range of forms, and exist across the entire country (Un.org, 2017).

Using the indicators and sustainability criteria described earlier, an appropriate environment for the population can be established. Different factors must also be taken into account, as discussed below.

6.6.1 Sustainable Site Design

Green construction designs consider the structure itself as well as the surrounding environment. Prior to any construction starting, the site choice is decided upon based on whether resources can be used efficiently, and if there will be a benefit to human and environmental health. Major cornerstones in this regard are efficient space use, protection of wetlands and other important natural features, making best use of natural dynamics (insulation, airflow) and limiting light pollution. Leading technologies in this respect are daylighting, ventilation, and green walls and roofs.

On the other hand, there are much more limited options for existing structures. Landscaping is a potentially beneficial choice, where strategically placed trees and plants can offer shade, windbreaks and generally assist a building's energy footprint, among other benefits.

6.6.2 Water Quality and Conservation

Water from the surrounding environment is a key part of any construction project and increases in urban water use have substantially affected water tables, meaning that larger projects take supplies from agriculture (Roodman, Lenssen and Peterson, 1995). The water employed in building operations is a

major factor in national water usage, and there are many forms of water consumption during a structure's life cycle.

With this in mind, water use must be efficient, and water quality maintained. Green building designers will focus on upholding the site's natural water cycle equilibrium, by using rainwater catchment, gradual stormwater management techniques including permeable sidewalks, native landscaping, and water-saving devices. However, issues arise in this regard when traditional structures and surrounding infrastructure need to accommodate more recent conservation mandates.

However, new technologies or workarounds can help reach the intended results, despite any such limitations. Solutions can be found primarily through research into new technologies which will allow current property constraints to be overcome. The second case study discussed includes a client who is worries about techniques used for water conservation in homes and other sites and will provide important data in this regard.

6.6.3 Energy and Environment

A key environmental matter is energy consumption, inherent in any modern society, with buildings being significant users of energy. When 'green' strategies are mentioned, most people will think about energy usage. This element presents major cost-saving opportunities, involving new technologies, and specific designs which can boost building performance in order to increase input without greater energy consumptions. Strategies such as shell measures (e.g. high-efficiency glazing), passive heating and cooling, effective illumination, renewable energy, and effective HVAC and sanitation technologies are all commonly implemented.

Buildings use energy and other resources throughout the entire building project, starting with the design stage and continuing throughout construction, operation and decommissioning (Schimschar et al., 2011). Lenzen and Treloar (2002) state that the type energy used throughout a building material's lifecycle, as well as how much, impacts the release of greenhouse gases (GHGs) to varying degrees during this time span. If efficiency is improved in a structure, then energy use can be lowered, thus reducing greenhouse gas emissions and consumption of non-renewable energy resources (Lee, 2010). As a result, it is recommended that greater focus is given to boosting energy conservation in the building sector, as there is great potential for primary energy saving and

lowering emissions which otherwise would harm the surrounding, and wider, environment.

6.6.4 Indoor Environmental Quality

Indoor Environmental Quality (IEQ) is a critical element of the population's state of health, particularly in homes. The green building approach gives great importance to constructing buildings which facilitate human health and wellbeing. For one of these 'green' buildings to remain 'green', a certain level of maintenance is required.

A number of problems exist in this regard, such as limiting exposure to internal environmental toxins like VOCs and life risks such as mold, making sure there is enough air flow and quality, offering optimal levels and quality of light (particularly with day lighting), and make sure there is a pleasant atmosphere to reduce stress and enhance the efficiency of workers. In addition, it is considered that cleaning products are key contributors to poor-indoor environmental quality.

Overall, a high-quality indoor environment necessitates a high-quality building, which is holistically created through a rating system such as LEED. The systems running within a building need to be tailored to the structure, and there cannot be any level of comfort in this indoor environment if it is making the heat effect worse. These are all important factors when it comes to the LEED rating system, and they can all establish a building as being high performance from the inside out. In case study 2, it is clear why the client wanted to implement the above elements.

6.6.5 Materials and Resources

The level of impact a building has on the environment is closely tied with the construction materials use, and if these use resources more efficiently, then the harm is minimised. Recycled materials, local materials and materials which are developed to last the longest time possible raise a structures efficiency and longevity, while bio-materials which can break down safely in the environment once discarded are also preferred. A cradle-to-cradle approach is used to appraise the materials and systems used in the life cycle of a structure, extending from the sourcing of materials to their disposal. Maintenance and use issues (e.g. recycling, waste disposal, transportation) are also considered.

In turn, green building materials must be considered when trying to ensure health and environmental impacts are minimised throughout their life cycle phases. Choosing green materials can be based on a few criteria, including environmental, socio-economic, and technical viewpoints (Akadiri & Olomolaiye, 2012).

Also, a key resource in a green building is the residents inside. Each green building should provide a level of education, training and encouragement for its residents to employ ideal management practices to sustain optimal sustainability. If implemented effectively, these plans establish a strong sense of pride, cooperation and ownership.

6.7 Challenges of Sustainable Housing in KSA

Increased housing opportunities constitute a support factor for achieving the sustainable development goals. Therefore, the challenges of sustainable housing differ from place to place.

6.7.1 Climate Difficulties

Climate change is one of the leading issues of the modern world, and is discussed at international, national and local levels. Scientists unanimously believe that rising temperatures and abrupt climate alterations have an instant and long-lasting impact on the environment and urban makeup of society and its people. The climate in the KSA is considered harsh, with dry desert environments and risky temperature variances from -11^{o}C to 51.1 ^{o}C.

On the other hand, the effects of climate change impact urban as well as rural regions. In KSA, the environmental system is sensitive because of its dry climate and lack of water resources, meaning that agricultural land is affected substantially by any environmental changes. As a result, Saudi Arabia and other countries in that region must deal with this lack of water, and a number of these nations lean heavily on non-renewable groundwater supplies to deal with growing demand (Swain, 1998).

6.7.2 Rapid Growth

The rate of expansion seen throughout the KSA region has a clear impact on the environment. Saudi Arabia must deal with problems related to rapid growth and urbanization rates, and so the various government departments must be conscious of sustainability and apply policies and standards accordingly.

There are significant hurdles to overcome for management in the public sector when dealing with extensive urban growth, especially when the rate of expansion is particularly high. Making sure that the provision of services increases at the rate of the growing population, as well as ensuring any developments are sustainably facilitated, are two major challenges (Gamboa, 2008). Henderson and Page (2007) shows that nations which have seen urbanization developments and growth now must deal with a greater number of problems. Furthermore, Riyadh's quick growth has, in part, been down to the central government's implementation of a policy which provides interest free loans through real estate development funds and provides land to citizens free of charge.

6.7.3 Sustainability Application

Establishing sustainability involves more than simply using sustainable materials. Governments are encouraged to find sustainability strategies currently in place in the business world, and develop their own approach from there, rather than creating a fresh strategy and attempting to enforce it on all levels. In this content, a more widely spread understanding of sustainability and its value can be achieved, and there will be greater acceptance. In turn, sustainability strategies can then be built upon and improved thereafter, allowing society to realise the benefits of sustainability to a greater level.

There are some barriers for the implementation of housing construction methods in Saudi Arabia. These include high initial costs of sustainable housing, limited stakeholder interest, poor awareness of sustainable housing's benefits, lack of sustainable building materials and low-quality alternative housing designs.

Many success factors were identified by the participants' statements, including enforcing policies, educating companies, protecting the environment, limiting expenses, rainwater harvesting, energy saving with solar energy and greywater treatment.

6.8 Achieving Sustainability and Vision 2030

King Salman bin Abdelaziz stated that, as part of the modern world, the new challenges presenting themselves must be faced responsibly, with solutions being developed to tackle these issues and particularly those affecting the

environment and sustainable development, through collaborations with global groups, foundations and partners (MEP, 2019).

Sustainable development goals are of the highest importance in Saudi Arabia, made clear by the Kingdom's specific policies and national principles. Through Royal Order, the Minister of Economy and Planning has been given the responsibility of enacting the mandate to work towards the Sustainable Development Goals and cooperate with a number of entities. This mandate states that the Ministry of Economy and Planning (MEP) will support stakeholders and government agencies in their strategic planning and implementation of sustainable growth efforts (MEP, 2019).

Also, the MEP gives various responsibilities to government agencies related to overseeing goals which come under their jurisdictions. From this perspective, the General Authority for Statistics (GAS) created indicators which can be used to evaluate progress relating to these goals, with expansions of statistical work undertaken to offer the required information and data.

Mohammad bin Salman (The crown prince) stated that the special environmental properties of the area can be protected through sustainability laws, and related processes be undertaken, with natural resources protected in line with global standards of practice (MEP,2019).

The Kingdom of Saudi Arabia has been going through a substantial change with its Saudi Vision 2030 plan, with its twelve implementation programs aimed at creating a solid economy with a diversified production base and greater competitiveness. There are three key themes to the Vision, which are a lively society, a strong economy and an ambitious country. The Vision and its various implementation programs (e.g. National Transformation Program 2020) offer a base from which sustainable development goals can be involved in national planning process. Life quality is one of the major programs of the Vision, and this is closely tied with sustainable development goals.

Under Vision 2030, the Future Saudi Cities Program (Figure 6.1) is a technical cooperation program involving the Ministry of Municipal and Rural Affairs and the United Nations Human Settlements Program. The main goal is to establish a new vision and strategic planning framework, from which sustainable urban development can be achieved in the KSA. This will bring the country up to world-class standards and in line with MOMRA's new strategic transformation plan. Major targets for the program are to create successful, efficient, just, socially inclusive and environmentally sustainable cities, which have a level of

infrastructure and quality of life which is considered appropriate. The program also attempts to boost sustainable urbanization by creating an in-depth strategic plan and subsequently implement pilot projects related to sustainability, by examining urban legislation and institutional agreements in Saudi cities and how suitable policies can be implemented, and by evaluating the abilities of cities to maintain a sustainable urban environment.

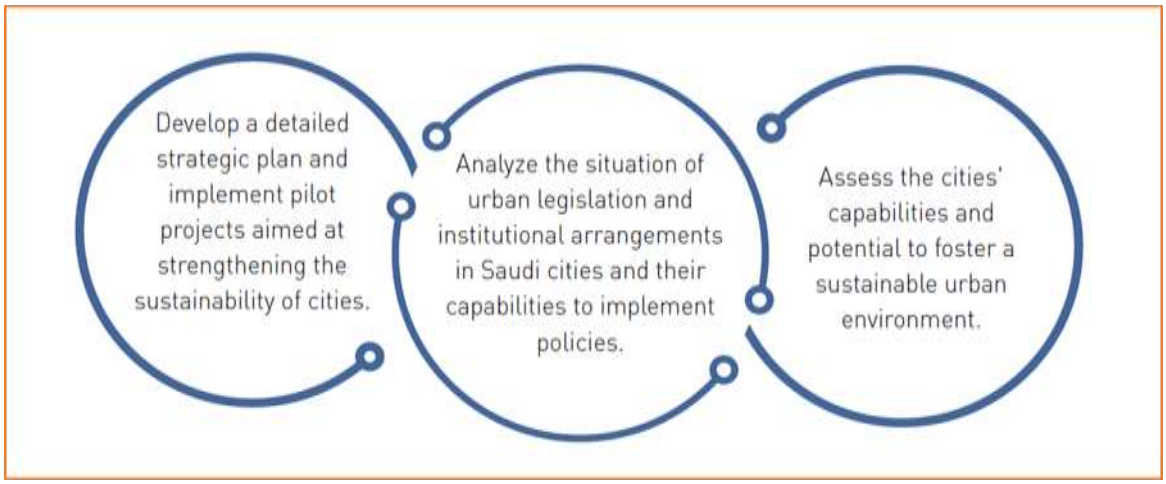

Figure 6.1: Future Saudi cities programme by MEP (MEP, 2019)

GAS reported that the 2017 Population and Housing Survey presented the number of households occupied by Saudi households as 3,504,690 units, which is a clear contrast with the 3,417,788 units found for 2016. The average Saudi family size was 5.97, whereas this figure was 6.24 in 2016. The average number of people residing in these units was 20. Saudi households were most occupied in Mecca (24.8%) and Riyadh (23.6%). (Figure 6.2)

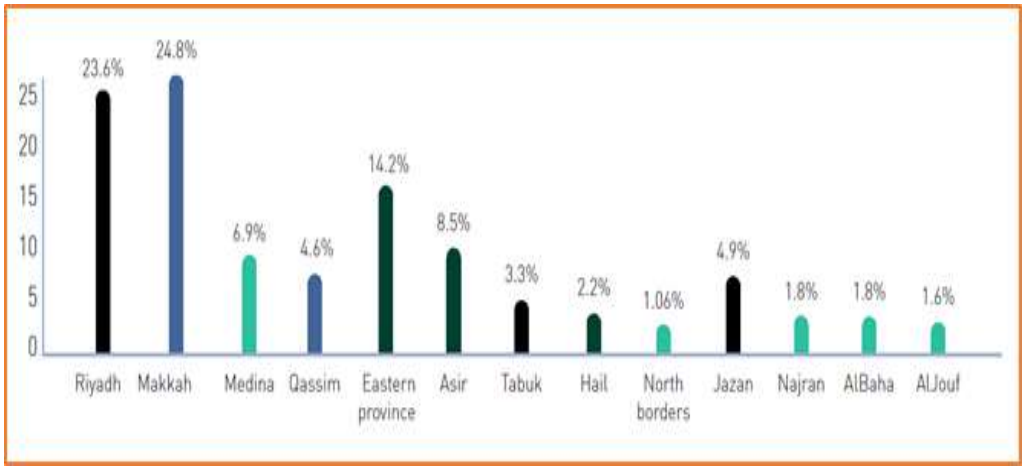

Figure 6.2: Distribution of Number of Housing Units Occupied by Saudi Households by Governorate (MEP, 2018)

In addition, 74.8% of households occupied by Saudi residents were shown to rely on the water supply of the public water network, whereas 99.8% of households rely on the public electricity system as their major electricity source. These are important findings which should be accounted for in further sustainability plans (MEP, 2019).

Through governments and stakeholders working together, developing nations can achieve sustainability effectively. Leading Saudi developers are considering sustainable construction as efficient choices, and through greater political interest, green guidelines are soon going to be compulsory (AlFadl, 2010). In the construction sector, there have been complaints regarding the poor availability of resources for investments in technological developments necessary for sustainable application, as well as lower profits (Reffat, 2004). The US Green Buildings Council report showed that green buildings save an average of 70% electricity, 50-60% water and 36% energy.

In turn, homeowners, designers and all stakeholders in the housing sector are encouraged to strongly consider the concept and practices of sustainability in order to lower their household running costs. There are a number of major actions stakeholders can take in order to facilitate sustainable building works. These include the formation of a government stakeholder advisory board, increasing awareness, implementing a supervisory framework for sustainable building, initiating compulsory qualified education, offering subsidy for developing businesses and advanced tasks, supply capital for training, and supporting sustainable construction efforts which bring about the expansion of new market places with regards to services, materials and tools.

6.9 Case Studies Approach

The case studies were undertaken in Riyadh and Hafr Albatin in Saudi Arabia (Figure 6.3), which are areas with extensive construction activities going on. The two projects were chosen to establish the gap between the standard engineering specifications and the sustainability requirements. Numerous construction projects for housing exist in these cities and since more buildings are required, there is an additional need for houses and infrastructure because of the rising population. In turn, more water, land, energy and air resources are used, raising the amount of waste produced in a life cycle across the entire construction project these in the cities examined. Both state and private construction projects were researched.

For these case studies, a qualitative method was used to collect data and know the strengths and weaknesses of the two cases. Through this approach, it is possible to compare the two cases to find out how to activate the success factors in the project. Also, to reveal the reasons leading to the delay and lack of use of sustainability by the Saudi Ministry of Housing. Consequently, the approach was considered ideal to raise the validity and range of data collection achieved, and it is also the most suitable for the examined circumstances as they provide a more realistic view of the conditions of the ministry or company involved, and related limitations.

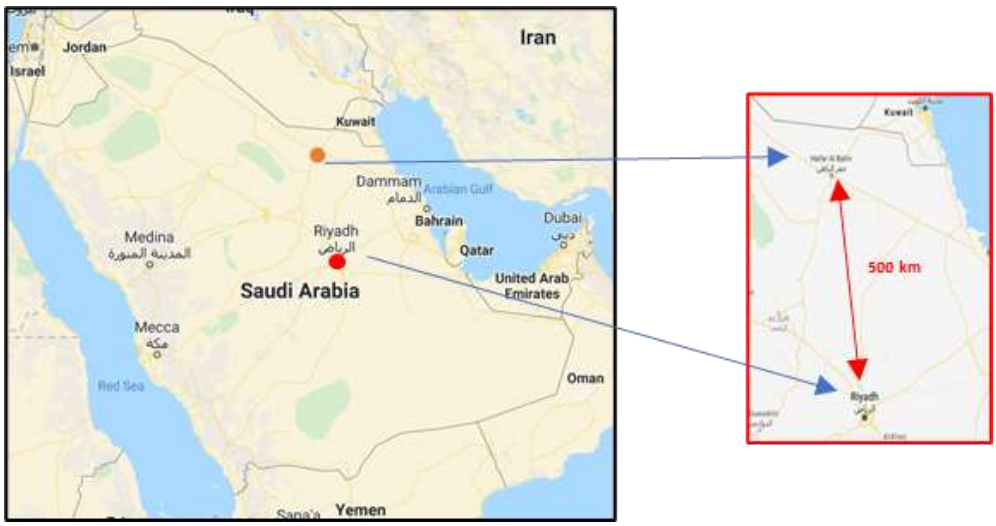

Figure 6.3: Case studies locations (Google Map, 2020)

6.9.1 Hafr Albatin Case Study

In this study, we set out to protect the privacy of the project and the individuals involved, so any details which have been provided are intended to establish a context rather than describe a specific project. To ensure a high degree of confidentiality, generic terms have been used in place of any terminology which could reveal the identity of the project in question.

6.9.1.1 Case Study Background

The government assistance offered by the MOH, as part of the Housing Development Program, aims to tackle the problem of overcrowding in family houses and poor housing conditions in the KSA. To this end, the grants which are being awarded are intended for the construction of new housing units and the infrastructure needed to make them habitable.

This project, based in the city of Hafr Albatin, east of Saudi Arabia, was launched in August 2009 to build 900 family homes. The housing project covered a total area of 1159950 square meters (Figure 6.4).

The project was broken down into some constituent parts:

- Deciding where to build the housing,
- Technical specifications,
- Bidding,
- Constructing the 900 houses and the essential infrastructure,
- Choosing tenants for the new development.

Figure 6.4: Housing overview in Hafr Al-Batin (Source: Almowaten, 2020)

The Ministry of Housing approved the construction grant in August 2009, and a national contractor was chosen to undertake the work. The latter took on five sub-contractors, who agreed to build the villas' structural frames. The contract specified that work would be completed within 36 months - namely, by August 2012 –but actually, only 43 percent of the project was completed at that point (Figure 6.5).

In order to guarantee that all 900 homes were built, the Ministry of Housing agreed to extend the project by 18 months. This decision increased the budget by $7 million, on top of the additional $1.6 million which had been added to cover project modifications- raising the cost to $95.6 million from the original $87 million. In 2015, the housing, including the infrastructure which had been put in simultaneously, was handed over to the Ministry of Housing, two years after the planned date of completion. This substantial delay stemmed from two factors: changes to the orders and a lack of materials.

In May 2016, the Ministry of Housing started to allocate the homes to eligible Saudi Arabian citizens. This did not unfold smoothly since, in the process of handing over the housing, the Ministry altered the terms of the distribution entitlement, moving away from the right to home to income criteria. Apart from this, most families declined the offer to move into the new housing due to lack of schools, health centres, security and an increase in pricing. To date, 700 units remain empty, and only 200 are inhabited.

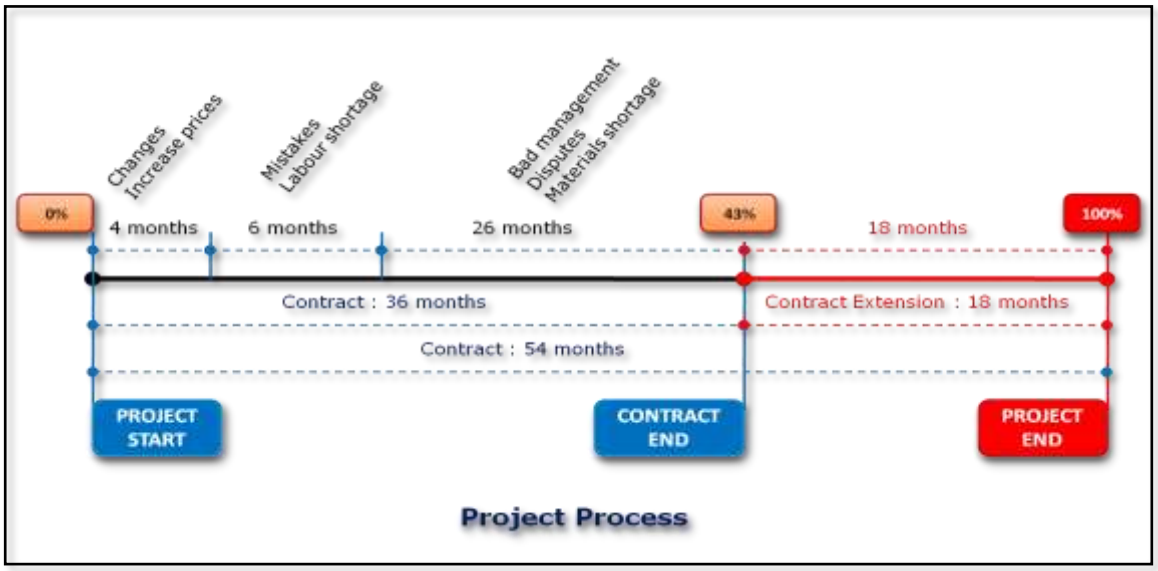

Figure 6.5: Hafr Al Batin Housing Project

6.9.1.2 Project Phases

The first phase consisted of building the homes. The second phase of construction involved building a water supply system, a sewerage system, a sewerage plant, the roads needed to access the development and an enormous mosque.

General information about the project phases, before construction:

- Inadequate planning and an ill-defined overall goal both during the study and design phases,
- Neglect of project documentation before submission of the bidding competition,
- A limited and non-comprehensive study of the land, its suitability and location,
- The indifference to the need for licenses and necessary soil reports,
- A reduction in the amount of time allocated for estimating and pricing, affecting all the potential construction companies,
- The emphasis is firmly placed on cost and the level of bids submitted while disregarding how technical data could impact on the project and the bidders involved,
- The chosen subcontractors do not have the financial and technical background to carry out the work successfully.

6.9.1.3 During the Project

Many events and factors cause rise to delays in construction projects. Contractors who are apathetic and non-adherent to the schedule inadvertently impede the progress of the project. In addition, equipment can break down, and the workforce can also slow down or stop the work if disputes erupt. Environmental issues, such as severe weather and topographic challenges on the construction site, further hinder the achievement of project deadlines. A raft of changes can also influence the project. Furthermore, these changes range from modifications to zoning laws and the construction plans, to late payment issues. The major factors are listed below:

- Lack of sufficient supervisory procedures on the part of the Ministry of Housing (MOH),
- The absence of coordination between the services agencies involved in the project,
- Changes in project orders under implementation,
- Lack of materials,
- Price rises,

- The taking on of extra subcontractors or expanding their responsibilities, without securing agreement from the client,
- The contractor's team is not competent and sufficiently trained to oversee the project,
- Government spending delays,
- A labour force which is too small for the job,
- Some projects are given to a single contractor.

6.9.1.4 After the Project

There are some reasons behind the delay of construction projects, some of which can be ascribed to the client, and some of which are caused by the contractor. It is often difficult to disentangle liability in these complex processes, where actions spark off reactions, but beyond the conflict is the fact that delay leads to abandonment, lawsuits and negotiations. In the end, construction delays have to be dealt with by every party in the contract, who must agree on additional funds and extra time if they are faced with a delay.

Delays inevitably lead to loss of money and time. Clients cannot use facilities they have commissioned and suffered a loss of income as a result. Contractors face financial loss due to wasted time, organising of additional material, labour, and equipment as well as a disruption of their long-term plans. This also causes a delay in paying sub-contractors their due fees.

- Poor construction quality (cracks, unfinished jobs),
- Arguments and disagreements between the contractor and the sub-contractors (in the Ministry of Housing).

Figure 6.6: Homes at Hafr Al-Batin housing project (Source: Almowaten, 2020)

A review meeting was organised to analyse the issues which had affected the construction project and to draw up a list of critical delay features which were involved. The project consultant who participated in the meeting highlighted that the pivotal issue faced in the construction phase was the lack of skilled local workers as well as materials (Figure 6.6). Furthermore, scorching weather and fluctuations in temperature severely affected the project. Since the project had been put up for bids, the winning contractor took on all the risks involved with the work. The review produced a lot of comments.

Observations on construction materials:

- Variations in pricing,
- Inadequate transport,
- Lack of materials,
- Poor storage,
- Quality of the materials.

Observations associated with workforce:

- The majority of the workforce were sub-contractors and were unskilled,
- Poor execution (working practices),
- Not acting in accordance with the project plan,
- Casual workers were recruited from the local market to carry out tasks,
- Visas took a great deal of time to be issued,
- Inadequate safety regulations and procedures.

Observations associated with the delay factors:

Six significant factors were recognised as key to creating delays in the housing construction project. The conclusions reached the meeting on this subject are as follows:

- Leadership (client) did not execute a timely change of instructions in the project,
- Too few skilled workers,
- Lack of materials,
- Extreme weather conditions on site,
- Contractor’s financial problems,
- Disputes between the contractor and the sub-contractors.

The case study revealed that the most substantial reason for the delay was the lack of skilled leadership from the client, resulting in a lack of involvement with

the team and an absence of pro-active response to the circumstances that arose (Figure 6.7). Consequently, the contractor took over in the absence of leadership and influenced the direction of the project. Subsequently, this led to arguments between the parties involved. Also, fundamental failings included an incomplete understanding of the client's priorities and objectives, and the absence of comprehensive information on the project.

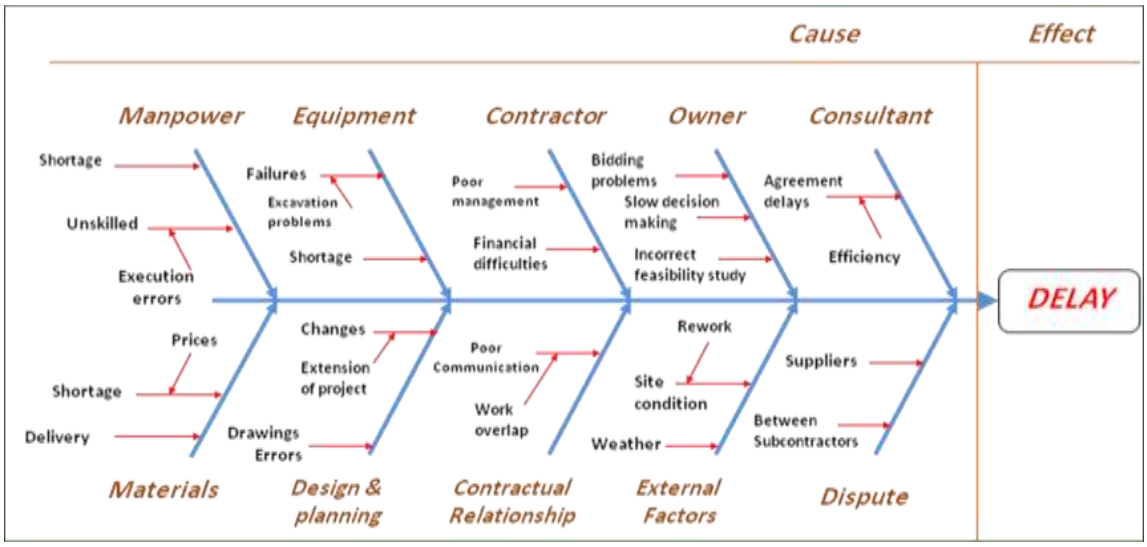

Figure 6.7: The causes of delays in the case study

In conclusion it is apparently evidence that the observations made during the site visits of this research and the inference reached on the reasons for delays in the housing project are as illustrated by the factors discussed in the literature review on the construction industry in KSA. It was also discussed in the previous chapters (survey and interviews).

Moreover, the contractor needs to be mindful of the delay factors discussed above and incorporate them appropriately into the planning of the next venture. If these factors are borne in mind and factored into the construction schedule, the project should be completed on time and comply with the terms of the contract.

6.9.2 SABIC: Al Waseel Hill Case Study

6.9.2.1 Overview

SABIC has based its business model on a comprehensive approach to sustainability, and not simply environmental safeguarding. By placing sustainability at the heart of the business, the company not only lowers costs, but also appeals to customers who value environmentally-friendly products. SABIC has set some goals, to be met by 2025, namely cutting down significantly on greenhouse gas emissions and reducing water and energy consumption by 25 per cent, when compared with 2010 levels. The company encourages its employees to implement the changes necessary to meet these aims and to ensure the environmental impact of the business is minimised.

Housing projects can be made sustainable if their design incorporates many features, such as:

- Renewable energy sources,
- Natural ventilation,
- The recycling of grey water,
- Non-wasteful and ecologically-aware sanitary installations,
- The inclusion of green surfaces.

Therefore, SABIC chose to instruct a global construction company to design and build Al Waseel Hills, the company's housing complex in Riyadh, Saudi Arabia.

6.9.2.2 Al Waseel Hill Housing Project

The Al Waseel Hills residential project houses in Riyadh (Figure 6.8), is made up of 685 villas situated at Shams Al-Riyadh, and includes the infrastructure and landscaping along the WadiHanifa, a valley which cuts through the complex. The contract was for three years and the total project area covers just over one million square meters. Furthermore, the contractor and consultant were international and huge companies.

Figure 6.8: Al Waseel hills site plan (Source: Saudi Projects, 2017)

Al Waseel's complex includes a range of community and commercial services, such as mosques, a community market, schools, clubs and a number of leisure areas for men and women, as well as incorporating gardens and public squares .The residential buildings aim to meet the criteria of the LEED home rating system – created by USGBC-USA –and achieve a Silver rating. The engineering and project management department of SABIC is responsible for the drive forwards achieving LEED certification. Hence the project came in on time and all quality criteria were met.

Energy efficiency is a main factor in the complex's sustainability approach and supports its credentials for obtaining LEED Silver certification.

The main sustainability features were as follows (Figure 6.9, 6.10, 6.11):

Energy efficiency which was the key factor:

- Continuous expanded polystyrene sheets (EPS) were fixed to walls, slab and roof (Thermal barrier), to insulate the villas,
- The high-performance insulated windows let in light, while ensuring most infrared radiation heat is kept away from the interior,

- The villas' air-conditioning systems are powered by high-efficiency electric heat pump systems (To reduce energy consumption and improve indoor air quality).

Figure 6.9: Thermal insulation materials (Source: DMC, 2019)

Figure 6.10: Thermal insulation materials - Coating system (Source: DMC, 2019)

Figure 6.11: External finishing of insulators (Source: DMC, 2019)

Water conservation: Is a key issue, given the aridity of the local setting.

- A highly efficient irrigation system decreases the need to water the plants which have been included in the landscaping scheme,
- Water wastage in the bathroom is counteracted by the incorporation of dual-flush toilets, and extremely efficient taps and showerheads,
- Landscaping schemes which take note of the dry environment and include innovative turf grasses and drought-tolerant plants.

Green landscape features:

- Planting schemes based on native species and plants which have adapted to the climate of Saudi Arabia,
- Reflective driveways and walkways to counteract the urban heat island effect.

Healthy Indoor Air Quality:

- The interiors of the villas have been finished using Low/No-VOC paints, adhesives and sealants,
- Hard flooring has been installed, instead of fitted carpeting,
- The HVAC systems all contain air filters, to reduce allergens,
- Every bath exhaust goes outside.

Environmentally smart building materials:

- The concrete mix used for construction will include slag, in order to maximise recycled materials. The aggregate and the slag used on the

project will be sourced locally, thereby ensuring the minimum amount of fuel is used to deliver the materials,
- The external insulation system is made locally,
- Recycled aluminium is used to make window frames.

In conclusion, Al Waseel Hills (Figure 6.12) epitomises the best of adapting green building practises to a local environment, while making sure that the villas are both aesthetically attractive and afford SABIC employees a practical, healthy, easy to maintain home. The environmentally-conscious design has prioritised energy efficiency and water conservation throughout the construction processes.

Figure 6.12: View of the residential complex (Source: Saudi Projects, 2017)

6.9.3 Discussion

In the past there was a tendency to choose bidders who put in low estimates, but value is increasingly becoming important during the tendering process. Globally, construction companies are now being evaluated in terms of the value they offer, as opposed to the long-established preference for choosing the lowest price. Simply looking at a budget does not allow for essential factors to

be taken into consideration – such as the constructor's record for bringing in projects on time, their experience and the quality of their work. It is clear that sustainability is now becoming equally important and joining the list of selection criteria when tenders are being considered.

SABIC case study research demonstrated that broad differences existed between the Ministry of Housing and SABIC's relationships with the contractors, and how the latter were picked. The ministry favoured finishing the work by applying traditional methods, as well as choosing the lowest price tendered – while SABIC emphasised the importance of providing quality homes, and good insulation and energy-saving measures (Table 6.1).

Delay in project payments by the Ministry of Housing, the case study shows that this is the main factor causing delays in the project – and a potential source of future conflict. This arose as a result of bureaucratic measures in the payment system, changes to plans and commands, and weak provisions in the original contract for putting timely payments into effect. The original contract failed to provide applicable methods and strategies for resolving the conflict between the contractor and the subcontractor, and both parties found themselves having to resolve the delay by conceding their contractual rights, in order to find a solution. While the client in the second case study (SABIC) was committed to the value of the contract and disbursed to the contractor without any problems.

Moreover, other factors also caused delay, namely: limited thinking of lack of knowledge; insufficient experience; and the contractor's misunderstanding of the client requirements. Unlike companies that wish to avoid these types of issues, they attract project managers with background and experience in construction as well as skilled workers.

In conclusion, from the above analysis, it was found that delay factors may occur directly or indirectly for any project, regardless of the nature of the project as well. However, how to deal with delays varies from client to client and from contractor to contractor. So, there are two main themes: stakeholders and knowledge (Figure 6.13).

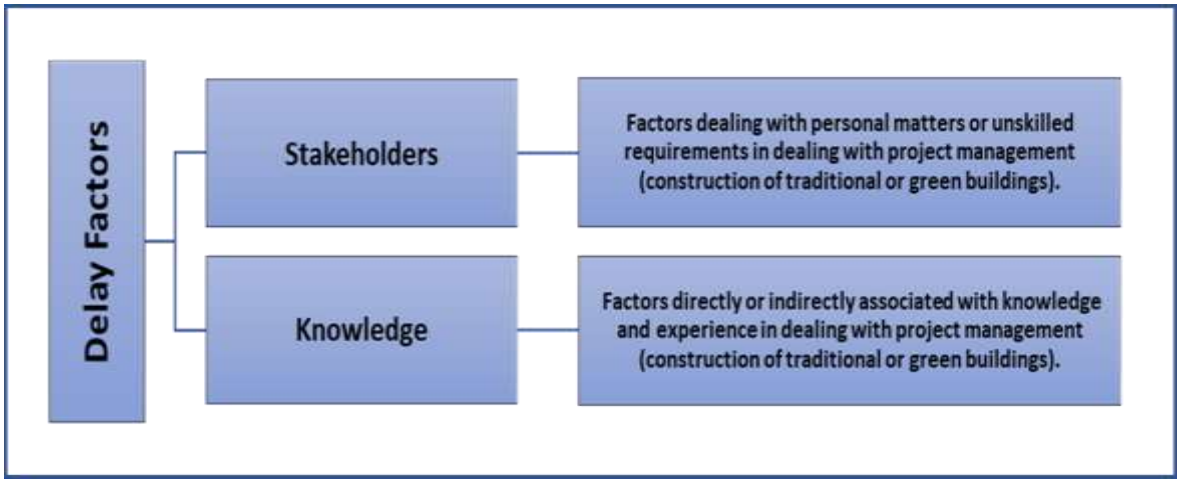

Figure 6.13: Main themes of delay factors

6.9.3.1 Stakeholders

In this section, the delay in traditional or green building projects is that of stakeholders. Delay factors are directly or indirectly related to the practices and relationships of project participants. In addition, unskilled laborers who contribute to project delays. On the other hand, there are skills that contribute to the success of projects, especially when all parties agree on certain tasks during the project phases. These factors include client response, communication between all parties and team workers.

- **Client Response**

The success of the project depends on what the stakeholders do during the different project phases. Response speed must be present all the time, especially by the client. Therefore, the primary responsibility of the client is to respond promptly to all project orders received from the consultant or contractor. When something is delayed, it confuses the project schedule. It also delays the completion of some phases due to the speed of response.

In addition, there are internal goals of the client in the project that must be achieved, which requires rapid response, namely the quality of the project and the duration of time, as well as safety on site. As for the external goals, which must be dealt with quickly, laws and regulations governing the work. All of the above must be dealt with quickly to avoid any delays will occur in the future. Therefore, in the second case study, the client was intense to make decisions quickly and overcome any problem that would delay the project.

- **Communication Between Parties**

Communication in the projects is a major challenge, and communication between all parties is a prerequisite for the success of projects, especially in the construction industry. Furthermore, given the enormous data needs of the project phases and stakeholder, strong communication channels are essential for the effective operation of the construction industry. Communication contributes to the division of works during the phases of the project, which leads to the completion of the work smoothly, in addition to making it hierarchically sequential can be implemented with ease. Even the problems that occur during these stages can be overcome in quick coordination with other parties. In fact, the highest standards of the project are achieved through real communication between all parties.

- **Team Workers**

It is generally understood that teamwork is the desire of a set of people to achieve a common goal by working together. During the project phases, teamwork is increasingly important in team collaboration and the ability to overcome difficulties. In addition to reducing conflicts among themselves and supporting each other in making the right decisions. This helps to acquire skills in the speedy completion of the project. In fact, motivating, training and properly preparing the team is the basis for the success of each project this is what happened in Case Study two. While the opposite was in Case Study one, the lack of a working team caused delays in many phases of the project.

6.9.3.2 Knowledge

In this section, the delay is directly related to this group. So, the most common topic is knowledge. When knowledge disappears in the project phases, most of the work will stop. Furthermore, the common factor in the various phases that have been repeatedly stressed in delaying the project is that contractors lack awareness (case study one). For example, not all contractors know green buildings, as well as how to deal with them. This may also happen with the client and the consultant, so disputes arise during the project.

Moreover, when staff lacks knowledge, problems can occur at any time during the project stages. There is also a lack of effective project planning, resulting in significant losses for all parties. Start from small differences until the project

itself is stopped. This indicates their inability to manage the team. This applies to all project parties (consultant, client and contractor).

- **Experiences and Skills**

Expertise is essential for each of the project parties, as well as skills. They are also the basis of knowledge in each project. So, the lack of such things during project phases inevitably delays the project. Financial and time compensation for some contractors will also increase at the expense of the client. furthermore, the inexperience of the consultant contributes to the delay.

What was noticed in the first case study is that all parties to the project are not familiar with the full knowledge. Defects at all stages came from each party, once from the contractor and again from the client. In addition to the presence of unskilled labor and this leads to errors in the execution process. By contrast, in the second case study, all teams were professional (international contractor and consultant).

Table 6.1: Comparison between MOH & SABIC Housing

Categories	SABIC Housing	MOH Housing
Dwelling units	685 dwelling (Phase 1)	900 dwelling
Duration of contract	36 months	36 months
Project status	Complete on time	Delayed & extended 18 months
Project rating	LEED – Silver certificate	N/A
Sustainable site	Prime factor: - Sustainable site planning - Landscaping - Site use efficiency - Reducing environmental impact	N/A
Energy efficiency	Prime factor: - High efficiency envelopes (efficient windows, doors & high R-value insulation) - High efficiency AC system - High efficiency lighting - Lower operating coasts	N/A
Water conservation	Prime factor: - Water saving fixtures - Rainwater harvesting system (Lower operating costs)	N/A
Environment – Materials	Prime factor - Green supplies & materials (Locally sourced) - Construction waste management - Recycled content materials	N/A
Indoor environment quality	Prime factor - Daylighting - High efficiency lighting	N/A

6.10 Conclusion

The analysis showed a clear imbalance between the case studies and the main reason was for the large number of change orders in the Hafr AlBatin project. Furthermore, in the first case, the method of construction was purely traditional without achieving any of the sustainability requirements. However, the delay was directly related to the client and the contractor.

In the second case, all parties sought to achieve sustainability criteria from the beginning of planning, design and construction. The project is fully integrated for LEED (silver certification). Team cohesion and collaboration contributed to the success of the project. All the problems in the project were overcome as each party understood what was required from them and complied with the terms of the contract and the time limit. Delays may also be normal in some phases of the project due to the nature of factors, but the dealing with them varies from contractor to another. Hence, all parties contributed directly to the completion of the project on time.

Moreover, projects aim is to be delivered on time, to fit the budget and to meet or exceed quality standards. The aim of this study is to highlight and isolate the most important factors which play a part in making a project a success. Firstly, it is essential for all participating organisations to have technical skills. Secondly, the parameters and the work scope need to be clearly defined and understood. Moreover, each party to the contract must be aware of its responsibilities, and thus the project will be managed transparently and effectively. It is vital to ensure that changes and arguments which could result in significant delays and spiralling costs, are avoided. Afterwards, the control system comes to the fore, since effective project management ensures that any unanticipated changes are identified, and potential fresh options are considered as remedial measures to keep the project on target. The fourth factor is the efficient site management where site managers and supervisors have a crucial role to play in driving and overseeing the project. Lastly, the project manager has a key role to play by leading and controlling the project operations. However, project managers must be capable, engaged, experienced and committed to bringing the project on time while ensuring the quality standards to be met.

Housing construction projects need to focus on five necessary factors to ensure successful housing construction projects where delays are not experienced:

- Organisation’s technical skills,
- Scope of the work,
- Effectiveness of the control system,
- Excellent site management system,
- Preserving the environment.

In addition, the preservation of the environment for humans is essential, so Vision 2030 should be implemented in Saudi Arabia properly to avoid any future problems. The Ministry of Housing must fulfill its vision urgently. Furthermore,

it is better for the Ministry to learn from delays in previous projects in order to develop successful housing projects. Furthermore, the government should enforce sustainability in all projects by training construction professionals, educating people through ongoing awareness programs, as well as setting sustainability standards for the Saudi environment.

CHAPTER 7: CONCEPTUAL FRAMEWORK

7.1 Introduction

Conceptual framework can be considered a schematic diagram of the proposed relationships between a set of concepts, factors, or variables around the hypothesis, context, or specific topic. In this regard, conceptual frameworks are used regularly in construction project management studies, often with the aim of determining how and why delays occur in specific contexts, or how specific processes can be improved (Leshem and Trafford, 2007). Furthermore, triangulation contributes to the validation of data extracted from two sources and more, as it tests the consistency of data. Therefore, not only validation, but also helps to deepen and broaden the understanding of researchers. It also helps to produce a conceptual framework.

Since conceptual frameworks are useful and versatile tools with which practitioners in the construction industry can improve project performance throughout the project's lifecycle, this section presents and discusses a conceptual framework for delay prevention and mitigation in housing projects in the KSA's construction industry.

The conceptual framework was designed based on the findings from the literature review, the quantitative data extracted from the completed questionnaires submitted for consideration, and the qualitative data gathered from interviews with contractors, consultants, and clients. Therefore, the conceptual framework presented in this chapter synthesises a substantial body of empirical evidence regarding the factors contributing to delays in housing projects in the KSA, and it outlines a process by which these delays can be prevented or mitigated through the promotion of effective management methods, quality work and planning. It is also worth emphasising that since diverse stakeholders' viewpoints and statements, were used to develop this conceptual framework, taking in to account the perspectives of the major participants and stakeholders.

7.2 Purpose of the Conceptual Framework

As previously noted, the proposed framework uses the theoretical and empirical findings, literature review, surveys and interviews to provide a diagrammatic overview of the factors, variables and overarching process that stakeholders in the KSA should pursue to mitigate or prevent delays in housing projects.

Therefore, the purpose of the conceptual framework is multidimensional, since it is expected to yield benefits for all major participants and stakeholders in the construction industry (e.g., contractors, subcontractors, clients, design teams, researchers, and the Saudi government).

For example, given the important and well-documented economic costs associated with construction projects delay (Hazim, Salem, and Ahmad, 2017; Gebrehiwet and Luo, 2018), which amounted to around US$147 billion in the KSA in 2011 alone (Albogamy, Scott, and Dawood, 2013), one purpose of the proposed framework is to minimise the financial costs to the greatest possible extent.

In addition, given that the Saudi government, in an attempt to facilitate the economic diversification against the drop of unstable oil prices (Pierru, Smith, and Zamrik, 2018), has recently been making extremely large investments across the KSA's construction industry (Banafea and Ibnrubbian, 2018). The government and private sector's firms can use the proposed framework in future housing projects and potentially improve the efficiency of these investments. Hence, another purpose of the framework is to aid the Saudi government's ability to satisfy its end of the so-called "social contract" (Kinninmont, 2017), namely, by improving the country current shortage of adequate and modern housing (Albogamy, Scott, and Dawood, 2013). Since this conceptual framework synthesises findings drawn from the study's primary data obtained. Furthermore, the framework will enhance the theoretical literature regarding the factors that cause delays in the construction industry, as well as providing viable solutions to these issues.

7.2 Conceptual Framework

7.2.1 Overview

The diagram in Figure 7.1 presents the conceptual framework for delay mitigation and prevention in housing projects in the KSA. At the outset, it is worth drawing attention to the general features of the conceptual framework, including its four-stage structure and the meaning of the various shapes it contains (e.g., circles, ovals, rectangles, and one-directional and bi-directional arrows).

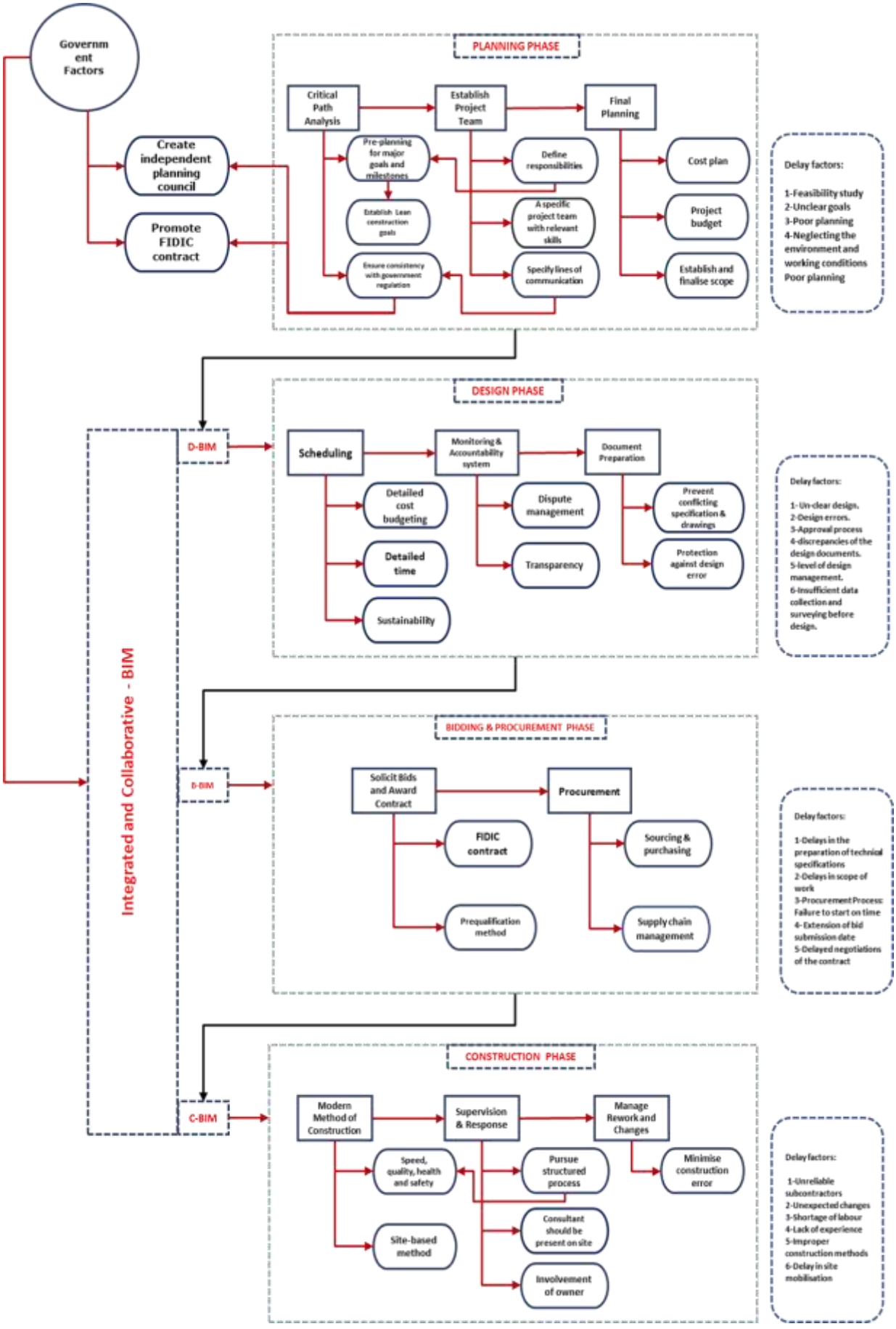

Figure 7.1: Conceptual Framework for Delay Mitigation and Prevention in Housing Projects in the KSA's Construction Industry

The use of a four-stage structure for the framework is consistent with the Project Management Institute's (PMI, 2018) definition of the construction project phases, which the organisation conceptualises as involving a planning phase, a design phase, a bidding and procurement phase and a construction phase. Significantly, rather than adopting a single-stage structure by focusing on only one phase of the construction project lifecycle, as previous researchers have done (Abdou, 1996; Uher and Toakley, 1999; Chapman, 2001), the multi-stage approach was chosen to provide holistic guidance for practitioners' delay mitigation and prevention activities. Additionally, while other definitions for the construction project phases could have been adopted, this four-stage structure was chosen for the framework since the findings from existing studies, surveys, and interviews slotted conveniently into it. Notably, other viable definitions include three-stage definitions (e.g., engineering phase, procurement phase, and construction phase) (Habibi, Kermanshachi, and Safapour, 2018) and four-stage definitions (e.g., feasibility, design, construction, and operation) (Zhou, Zhang, and Wang, 2014).

In terms of the visual details of the framework, different points should be noted. First, dotted rectangles are used to assemble the factors, variables, and elements of the process which are particular to a specific part of the construction project lifecycle (i.e., planning, design, bidding and procurement, or construction). The only elements of the framework which are not contained inside one of the four dotted rectangles are the government factors. This shows that these factors, although they interface with elements of the delay mitigation and prevention process at every stage of the construction project, are not in themselves part of any specific stage of the project. The isolated nature of the government factors, in this respect, is also emphasised using a circle, which is the only circle on the entire framework.

Rectangles with solid lines (e.g., critical path analysis and final planning) are used to illustrate the key aspects of the process and activities flow for each phase of the construction project phases for housing projects in the KSA's construction industry. In addition, the bold arrows linking these rectangles indicate the direction of the overall activity flow, with bi-directional arrows indicating an interchangeable order. It should be noted that, at present, this activity flow is not actually a feature of all housing projects in the KSA, as

indicated by the survey and interview findings. As such, the process and activity flow presented in the conceptual framework is optimised with respect to the aim of mitigating and preventing delays. Also, some construction projects are linear and relatively simple (Eriksson, 2017), others are dynamic and complex (Cristóbal et al., 2018), which means that – in reality – two activities linked by a one-directional arrow (e.g., scheduling and document preparation) may take place concurrently.

Finally, ovals are linked to solid rectangles with arrows, are occasionally connected to each other with arrows, they outline specific actionable measures that can considered to contribute to delay's mitigation or prevention. As an example, definition of responsibilities is one of the actionable measures that should be taken when establishing a project team in the planning phase of a housing project. In the case of this actionable measure, it is closely related to another actionable measure, namely, that of engaging in pre-planning for major goals and milestones, which is itself most closely associated with a critical path analysis.

7.2.2 Framework Approach

The methodological approach to formulating this conceptual framework was that adopted by Yap, Abdul-Rahman, and Wang (2016). Therefore, the first step involved the problem identification, which in the present case was the delays in housing projects in the KSA. Thus, key factors contributing to construction project delays, as revealed by this research, were collected into a concept diagram (Conceição, Samuel, and Biniecki, 2017), along with relevant solutions to each of the delay factors. The interrelationships between these factors and solutions were identified (Yap, Abdul-Rahman, and Wang, 2016). Finally, once the decision was made to use the PMI's (2018) definition of the construction project phases as the structure for the conceptual framework (see Section 7.2.1), the elements of the concept diagram were inserted into the most relevant stage of the project.

7.2.3 Framework Development

This section justifies each component of the framework with reference to either the literature or the research findings. At the outset, the value of building information modelling (BIM), which features at the beginning of the design, bidding and procurement, and construction stages, is examined. This is followed

by a discussion of government-level initiatives, which lie outside the four stages of the construction project phases, but which interface with every level of the activity flow throughout the conceptual framework. Finally, four sections are presented which investigate the core features of the planning, design, bidding and procurement, and construction phases of the conceptual framework, in each case detailing how the components of the activity flow (i.e., solid rectangles), as well as the associated actionable measures (i.e., ovals), contribute to delay prevention and mitigation in housing projects in the KSA's construction industry.

7.2.3.1 Building Information Modelling

Building information modelling (BIM) refers to a set of processes used in architecture, engineering, and construction to generate three-dimensional building models through the effective management of geometric, semantic, and topological information (Xu, Ma, and Ding, 2014; Li et al., 2014). Although there are significant barriers to the adoption of this novel approach to the management of construction projects, not least due to the need to draw on complex software such as SAP2000 and Midas (Li et al., 2014), the advantage that BIM provides in simulating and visualising every aspect of the project in a virtual environment and well-documented (Dunston and Wang, 2005; Azhar, 2009; Xu, Ma, and Ding, 2014; Li et al., 2014). In particular, the benefits associated with BIM for delay management have been extensively documented in the literature in a variety of settings (Eastman et al., 2011; Alenazi and Adamu, 2017).

With the above considerations in mind, three crucial elements in the present conceptual framework's activity flow are design-BIM (D-BIM), bidding-and-procurement-BIM (B-BIM) and construction-BIM (C-BIM). For example, to achieve more effective results, especially with respect to timely project completion, it is produced when BIM is used to manage information throughout the project phases (Xu, Ma, and Ding, 2014; Alenazi and Adamu, 2017). This is because new information emerges continually as a construction project progresses, and so updating the BIM model at the outset of each new phase (i.e., through D-BIM, B-BIM, and – finally – C-BIM) ensures that project stakeholders have access to the most relevant information framework (Xu, Ma, and Ding, 2014).

- **D-BIM**

In the construction industry, "Design Phases" are used as key milestones to measure the completeness of the overall design of construction projects (Xu, Ma, and Ding, 2014; Wei, 2017). And more specifically, but not limited to, the full differences and percentages of schematic design documents and the development of design and construction. During the design phase, scheduling, monitoring, and evaluation really begin with participation. The scheduling should ensure that the building can be built on time and carefully monitored, as well as needs assessment to ensure that it continuously tracks the cost of the project.

Scheduling is very important for many reasons. First, the schedules must be filtered correctly so they can be considered in the estimate. Second, project elements need sufficient information so that the estimate can identify the type, size, etc. This is particularly important in major projects on the practical side. It is a very arduous process for estimating the attempt to calculate all elements of a project from a two-dimensional plan. Therefore, BIM enabled the design to be 3D models and perspective, as well as to be more collaborative in the whole design process (Lee and Yu, 2013).

- **B-BIM**

Bidding-and-procurement-BIM (B-BIM), while defined inconsistently and not discussed extensively in the literature (Bolpagni, 2013; Costa and Grilo, 2015; Wei, 2017), is viewed from the perspective of this conceptual framework as the set of all information components which come into being and are relevant during the bidding and procurement phase of a construction project (Xu, Ma, and Ding, 2014; Wei, 2017). This mean, as the project phases progress to the beginning of the bidding and procurement phase, the BIM model initially constructed at the outset of the design phase of the construction project, which at that point contained only D-BIM, is updated with the information components relevant to B-BIM.

As detailed by Xu, Ma, and Ding (2014), the information components relevant to B-BIM include the design-related information inputted into the BIM model for D-BIM, in addition to bidding and contract information (e.g., prequalification documents, letter of acceptance, survey and design contracts, and survey and design tenders), economic information (e.g., labour quotas, market prices on material resources, machine resources, human resources, construction budget and design estimates) and information related to similar projects (e.g., cost

structure, usage of new materials and new technology, economic indicators and the scale of the construction initiative).

In terms of the benefits associated with the updating of the construction project's BIM model with the information components relevant to B-BIM at the beginning of the bidding and procurement phase, these are wide-ranging. For example, as noted by Wei (2017), errors in calculating bidding and contract information, economic information, and information related to similar projects can contribute to delays in later parts of the project's activity flow, while the inclusion of these into the BIM model, paired with the distribution of this model to relevant stakeholders, can optimise the process, thereby reducing the likelihood of errors. Additionally, in a research project focusing on the Australian construction industry, underestimates of project cost and incomplete procurement processes were identified as significant delay factors, which B-BIM can play a role in minimising (Shah, 2016).

- **C-BIM**

Just as B-BIM is viewed from the perspective of this study's conceptual framework as the set of all information components that are relevant throughout the bidding and procurement phase of a construction project (previous part). C-BIM is the related set that correspond to the construction phase (Xu, Ma, and Ding, 2014). Given the cost of material and human resources that are procured for the construction phase at the end of the bidding and procurement phase (Lee and Yu, 2013). As well as the dynamic nature of the activity flow that characterises the construction phase itself (i.e., reflecting in this conceptual framework's bi-directional arrows, as discussed in above, the number of information components in C-BIM is greater than is the case for D-BIM or B-BIM (Xu, Ma, and Ding, 2014).

According to Dawood, Akinsola, and Hobbs (2002) and Xu, Ma, and Ding (2014), there are three broad categories of information relevant to C-BIM, namely general data, project-specific data and organisation-specific data. General data relates to publicly-available data such as construction products, the natural environment that surrounds the construction site, legal and regulatory information that pertains to the project design, and standard procedures, while organisation-specific information is concerned with the details of the past projects that have been conducted by relevant stakeholders (i.e., which can be used as reference cases) (Shah, 2016; Eriksson, 2017). Finally, project-specific

information is concerned with situational information, construction management information, resource information, and technical information, which are shared with every stakeholder involved in the construction phase (Xu, Ma, and Ding, 2014).

As was the case with B-BIM, C-BIM is associated with a range of benefits, particularly for the alleviation and prevention of construction project delays for housing projects in the KSA. For example, although knowledge about BIM, the method in which BIM can be integrated into a construction project by means of D-BIM, B-BIM, and C-BIM, and understanding of the technologies required to use BIM effectively are currently limited in the KSA (Alhumayn, Chinyio, and Ndekugri, 2017), BIM application throughout the project lifecycle has been associated with the timely and effective completion of projects in different studies (Bryde, Broquetas, and Volm, 2013; Xu, Ma, and Ding, 2014). A more detailed discussion of the benefits associated with BIM application throughout the project phases is presented in the following section.

- **Advantages Derived from BIM**

Significantly, the successive D-BIM, B-BIM and C-BIM stages of the activity flow, are expected to solve many of the delay factors identified throughout the literature review, survey, and interviews. For example, design and contract quality tends to increase when BIM is applied (Holness, 2008; Alenazi and Adamu, 2017), which means that D-BIM and C-BIM in this conceptual framework would safeguard against the design-related and contract-related delay factors identified in the interviews and survey (e.g., conflicting specifications, errors in the drawings, and changes to scope of work). At the same time, since BIM utilisation throughout the project phases supports decision-making, aids in clash detection, and enhances communication between all project stakeholders (Alenazi and Adamu, 2017), it would address the client-related, consultant-related and contractor-related delays factors revealed by the interviews and survey (e.g., decision-making delays, delays in giving instructions, poor communication, poor coordination). This would especially be the case if collaborative viewing sessions were scheduled at the beginning of each phase, involving all project stakeholders, thereby having clear and efficient communication (Azhar, 2009).

7.2.3.2 Role of Government

The two government-level initiatives presented in the conceptual framework are to create an independent planning council and to promote FIDIC contracts. Regarding the first initiative, this was included in the conceptual framework based on the recommendations made by the interview participants. In particular, it was stated that in order to address the problem of manpower scarcity in the KSA, which lowers the willingness of contractors to take on new projects, an independent planning council with broad regulatory and managerial powers for the country's construction projects should be established. Although increased government involvement may undermine anti-corruption initiatives in the KSA (Locatelli et al., 2017), and although some professionals suggest that government involvement in decision-making can increase project delay (APMG, 2018). Therefore, the Ministry of Housing in KSA considers government participation necessary and a good initiative. The second initiative, namely, the promotion of FIDIC contracts, was highlighted by a group of interviewees to solve housing project delays in the KSA via the reduction of disputes. Based on the literature suggesting that such contracts effectively balance the interests of construction project stakeholders (Solimene, 2014; Besaiso et al., 2016), this government-level initiative was included in the framework as a way to mitigate the contract-related delay factors highlighted in the survey. In particular, the most severe contract-related delay factor (i.e., complication of contract design) is expected to benefit from the introduction and promotion of FIDIC contracts. However, it is worth emphasising that the standardised nature of these contracts could produce difficulties when attempting to tailor content to each party's interests, thereby increasing the time required for the bidding and procurement phase (Solimene, 2014).

In addition, through the two initiatives above, a significant achievement can be achieved at the level of construction projects. For example, imposing sustainability through the Advisory Council in residential buildings and educating the public about its benefits and then mentioned as a basic condition in contracts in terms of specifications and standards, as well as to the provision of building materials from nature.

Finally, it is worth drawing attention to the fact that, as indicated by the framework, delay prevention and mitigation in housing projects in the KSA can be promoted by continuous coordination with the government throughout the process of project. Importantly, the survey results indicated that untimely

coordination with other government departments was perceived to be the most severe external factor affecting project delay. Therefore, through the continual involvement of relevant government departments, and through the immediate creation of ways of communication with these departments during the planning phase, the likelihood of delay is expected to fall significantly.

7.2.3.3 Planning Phase

In a construction project, practitioners should apply the critical path method (CPM) to develop a sequence of activities, to assign resources for each activity's implementation and to attach a time-bound parameter to each activity (e.g., earliest and latest start and finish times) (Nafkha and Wilinski, 2016). This facilitates pre-planning for major goals and milestones and given the central nature of time for the CPM, would positively affect the delay factors highlighted by the survey results. Alongside this, a related element of the planning phase for this conceptual framework is to engage in Lean construction, which is concerned with minimising physical and process waste, and improving value generation to the client (Dave et al., 2013; Issa, 2013). Since Lean processes lay the groundwork for the introduction of BIM once the planning stage has been completed (Dave et al., 2013), Lean construction and the application of the CPM will have project-wide benefits in terms of minimising the likelihood of delay.

Other crucial actionable measures for the planning phase relate to the establishment of a project team. As highlighted by the questionnaire results, design-related, contractor-related, and planning-related delay factors are closely associated with incompetent technical staff, including the contractor themselves. Therefore, it is important at this early stage of the project to recruit qualified personnel and to ensure that responsibilities are clearly identified and defined, thereby facilitating an effective coordination, communication and setting a mechanism accountability. It is particularly important to recognise that the suitability of a project team for the activities sequence identified by the CPM should be ensured, since this has an impact on the overall project success (Assaf, Hassanain, and Mughal, 2014; Kumara and Warnakulasooriya, 2016).

In addition to the issue of creating a project team, it is not just about individuals, but also worth paying attention to how to manage the project, from start to finish. For example, in the study recently conducted by Stewart (2017), the researcher highlighted the importance of various considerations when establishing a project team, including individual and group behaviour, person-

group fit, cohesion, and diversity, as well as the selection strategies that can be employed to ensure that the effective team is established (e.g., psychological testing and assessments, integrity tests, evaluations of educational background and job experience, personal reference tests and personality assessment). Given that this study's conceptual framework was designed to address the issue of delay for housing projects in the KSA's construction industry, most of the selection strategies that should be pursued when establishing a project team are those aimed at evaluating employees for team assignments, eliminating bias in the selection process, and assessing individual technical competencies (Stewart, 2017).

The literature has also extensively addressed the matter of establishing an effective project team specifically for construction projects, including the issue of selecting suitable individuals for specific roles (e.g., contractor) (Huang, 2011; Safa et al., 2014), as well as the issue of creating teams in which essential forms of collaboration between numerous parties can occur (Rahman et al., 2014). As noted in the study conducted by Safa et al. (2014), despite the complex, challenging, multidisciplinary and multi-party nature of construction projects, all of which have been identified as potential contributing factors to project delay, state-of-the-art techniques for recruiting personnel into key positions have yet to be applied broadly across the industry. In response to this observation, Safa et al. (2014) developed a competitive intelligence (CI) model, the purpose of which is to ensure that the contractor selection process adopted during the planning phase of a construction project yields optimal outcomes. It is worth mentioning that the use of comparable models to recruit the entire project team during the planning phase (Figure 7.2) of the conceptual framework of this study will efficiently promote housing projects in Saudi Arabia.

Additionally, as the framework indicates, finalisation of activities during the planning stage should reaffirm the cost plan, project budget, and establish and confirm the scope of the project in preparation for D-BIM. All project stakeholders, including the client, should be involved in this part of the activity flow. As the survey demonstrated, changes to the scope of work represented the most severe design-related and planning-related delay factor from the perspective of the participants. Similarly, the results of the interviews were consistent with the above statement of clients and attributed about a quarter of all quantified delays in the project, the latter being the reason for decision-

making. Therefore, the last component of the planning phase directly addresses many of the severe delay factors identified in this study.

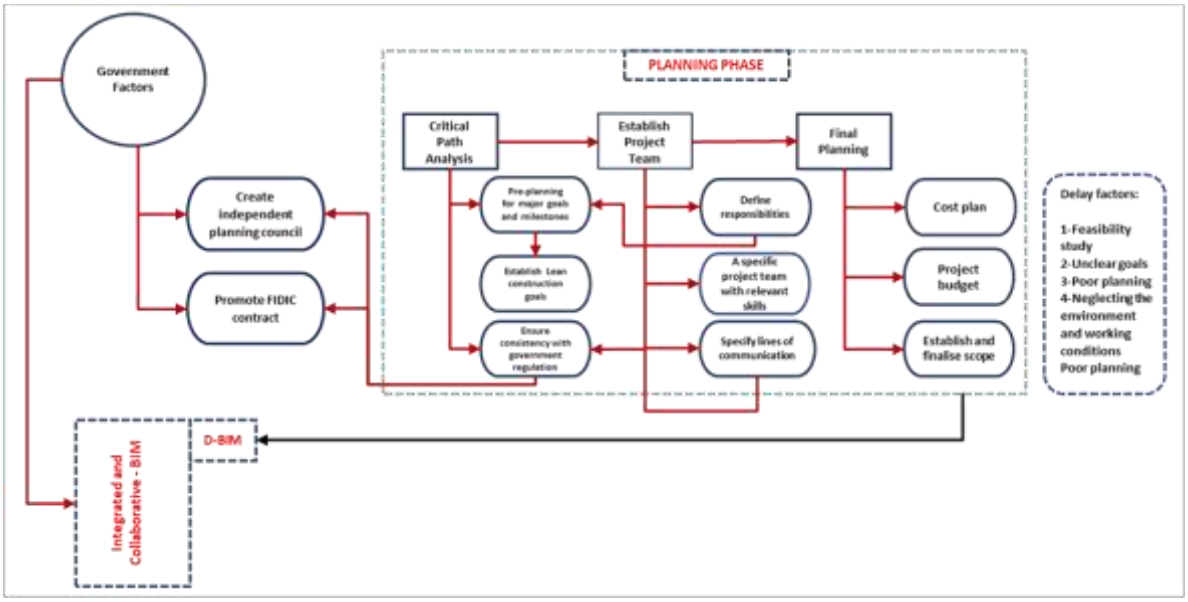

Figure 7.2: Planning phase of the framework

Given the existence of a strong relationship between the variable of a project's budget and the critical success factors for the project, as observed in multiple studies addressing the construction industries of both developing and developed countries (Aggor, 2017; Vasista, 2017; Saeed, 2018), the project budget is highly-consequential in the developed framework. It is therefore significant to note that the accuracy and effectiveness of the project budget which emerges during the planning phase is ultimately the product of the accuracy and effectiveness of the cost estimation strategies employed by the project team (Elfaki, Alatawi, and Abushandi, 2014). To eliminate issues such as cognitive biases, subjectivity and a lack of comprehensiveness when estimating costs, have been identified as key predictors of the accuracy of the project budget (Shane et al., 2009) and specific measures should be undertaken to safeguard against these eventualities.

According to Elfaki, Alatawi, and Abushandi (2014), a proven way in which to complete project budgeting in a way that avoids bias and subjectivity while ensuring comprehensiveness, is to ensure that the process is organised and guided by specific parameters. Drawing on the earlier research conducted by Akinci and Fischer (1998), a reasonable approach involves classifying these parameters into one of two groups: firstly, design and project-specific parameters; and secondly, estimator-specific parameters. Relevant

considerations in the first group include the type of client, the type of project and the project's duration (for which valid formulas should be applied) (Brmelow, Hinds, and Moody, 1988; Elfaki, Alatawi, and Abushandi, 2014); whereas the key consideration for the second group of parameters is the question of which party is performing the cost estimation (e.g., the contractor, the client, or the consultant).

7.2.3.4 Design Phase

Through the literature, the absence of proper administrative and engineering planning for the projects was a major reason for the contractor's failure during the project phases. In addition, the lack of planning and good management contributed to the loss of control over cost and quality. Therefore, planning and scheduling issues cannot be minimised since the consequences will lead to increased disputes among stakeholders.

Following D-BIM, another round of detailed cost budgeting and time budgeting should take place in the design phase, since this consolidates the critical aspects of the construction project's organisation, thus minimising the likelihood of unforeseen delays (PMI, 2018). Similarly, to aid in addressing delays that might be caused by contract disputes in the next phase, as well as the dangers associated with the lack of transparency, as highlighted in both survey and interviews result, monitoring and accountability systems should be designed and implemented (Figure 7.3).

For example, the most severe consultant factor revealed by the survey was inadequate supervision and response, thus justifying the creation of a results-based monitoring and evaluation system (Kusek and Rist, 2004; Xue et al., 2013). In addition, an independent team could be assigned to oversee and apply the monitoring and evaluation system, as recommended by one of the interviewed consultants.

Finally, document preparation, which should be completed before the bidding and procurement phase begins, should take place in such a way as to minimise design error and conflicting specifications, which were identified as major causes of delay in the questionnaire. Strategies for error mitigation should focus on both knowledge-based errors and intentional violations and noncompliance, seeking to remedy these by applying frameworks such as Lopez et al.'s (2010) people, organisation, and project (POP) model.

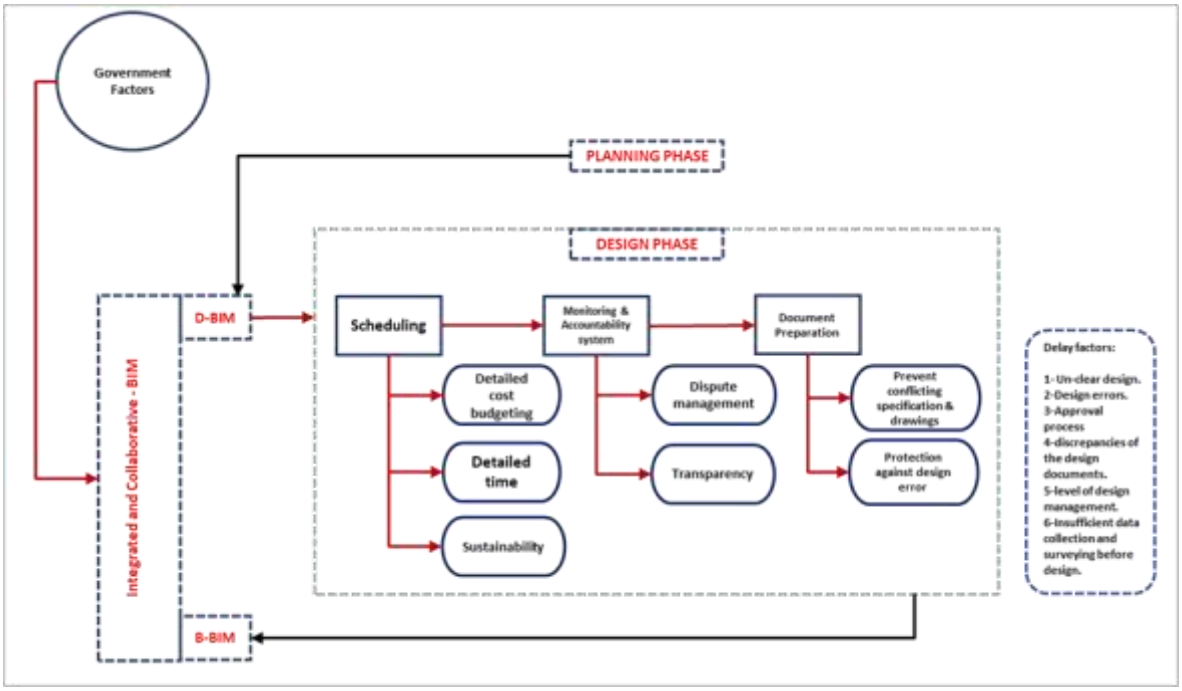

Figure 7.3: Design phase of the framework

Further to the dispute management actionable measure of the activity flow in the design phase, it is notable that Alshahrani's (2017) recent KSA-based qualitative study, which focused on both private-sector and public-sector construction projects, identified a range of disputes resolution strategies, as well as some barriers to dispute resolution. Therefore, when utilising this conceptual framework, it would be worthwhile for construction teams to take into consideration these strategies and barriers during the project's design phase. Specifically, the dispute resolution strategies identified by Alshahrani (2017) included litigation, negotiation, mediation and arbitration, while the most commonly-observed barriers to disputes resolution in KSA-based construction projects included governmental, contractual, cultural and developmental barriers. In the KSA, given the prevalence of conflicts, claims and disputes relating to construction projects, which have been identified as significant contributors to delay and cost overruns (Elziny et al., 2016; Seddeeq et al., 2019), establishing effective frameworks which streamline and standardise the dispute management process within each construction project, which is essential.

Both Elziny et al. (2016) and Alshahrani (2017) designed dispute resolution frameworks to facilitate the effective management of construction project conflicts, claims, and disputes in Middle Eastern countries, namely Egypt and the KSA, respectively. In Alshahrani's (2017) study, the researcher noted that

because dispute resolution strategies such as litigation are associated with significant project delays, primarily due to the small number of courts and judges within the KSA that have the capability to deal swiftly and efficiently with these matters (Ansary, 2015), a fundamental aim of a construction project's dispute resolution framework should be to avoid these time-consuming and inefficient approaches. In particular, Alshahrani's (2017) dispute resolution framework for construction projects in the KSA, which could be employed for housing projects in the KSA regarding the present study's conceptual framework, involves the following: firstly, identifying what caused the dispute (e.g., financial, contractual, client-related, or project-related related factors, among others); secondly, identifying the available dispute resolution strategies (e.g., negotiation, mediation, and litigation, among others); and finally, ranking the identified strategies in relation to critical success factors (e.g., speed and economy), based on the cause of the dispute and project-specific variables.

Regarding the issue of preparing documents in such a way as to safeguard against design error, thereby minimising project delay, scholars have highlighted the importance of preventing design errors, principally due to negative effects these errors have on project cost and activities scheduling (Lopez et al., 2010; Li and Taylor, 2011). Additionally, other researchers have noted that when documents are not prepared in a way that minimises the likelihood of design errors, the prevalence of design error increases, which can also undermine the safety performance of the structure (Peansupap and Rothmony, 2015). As previously noted, one of the helpful ways in which design errors can be minimised in construction projects, and thus one of the approaches that should be applied by the Saudi practitioners who use this study's framework, initially involves classifying different design errors and, alongside this, determining what their principal causes are (Love et al., 2008; Lopez et al., 2010). Knowledge-based errors and intentional violations and noncompliance were identified earlier in this section, but other important categories of design error that practitioners, particularly within the design team, should know about when preparing design documents include performance-based errors (i.e., relating to memory lapses and other human errors) (Sasou and Reason, 1999). Ultimately, factors such as ensuring sufficient time for document preparation can contribute significantly to the reduction of design errors, but when applying this study's conceptual framework, practitioners who are participating in housing projects in the KSA's construction should consider

utilising structured frameworks such as the aforementioned POP model (Lopez et al., 2010).

7.2.3.5 Bidding and Procurement Phase

Since the most severe delay factor identified across all 10 questionnaire groups, was the client factor, contract changes, communication between the client, contractor, and subcontractors during the solicitation of bids and the award of the contract is fundamental. Throughout this part of the activity workflow, it is expected that the utilisation of FIDIC contracts, as previously discussed, would play a positive role. It is also noteworthy that because the selection of unsuitable contractors, both in terms of their technical and interpersonal competence, plays a critical role in producing contractor-related delay during the construction phase, the limitations of the lowest bidder system must be acknowledged (Huang, 2011). Ideally, alternatives to the lowest bidder system should be applied, including the prequalification method, in which initial screening criteria are performed to determine who can submit a bid for any given bid packages (e.g., responsiveness, ability to meet deadlines, and responsibility in complying with regulations) (Russel, 1996; Palaneeswaran and Kumaraswamy, 2001).

Material shortage was the second most severe factor identified from the 10 questionnaire groups, consistent with the previous literature (Sambasivan and Soon, 2007; Kermanshachi et al., 2017). This underlines the criticality of an effective procurement strategy, the core elements of which are outlined in the framework (Figure 7.4). At the same time, equipment shortages and manpower shortages were identified as particularly crucial problems in the Saudi context from both the survey and interviews. In this context, supply chain management is essential (Naoum and Egbu, 2015), while resource management, informed by Lean principles, represents an effective way to mitigate or prevent these delay factors (Dave et al., 2013).

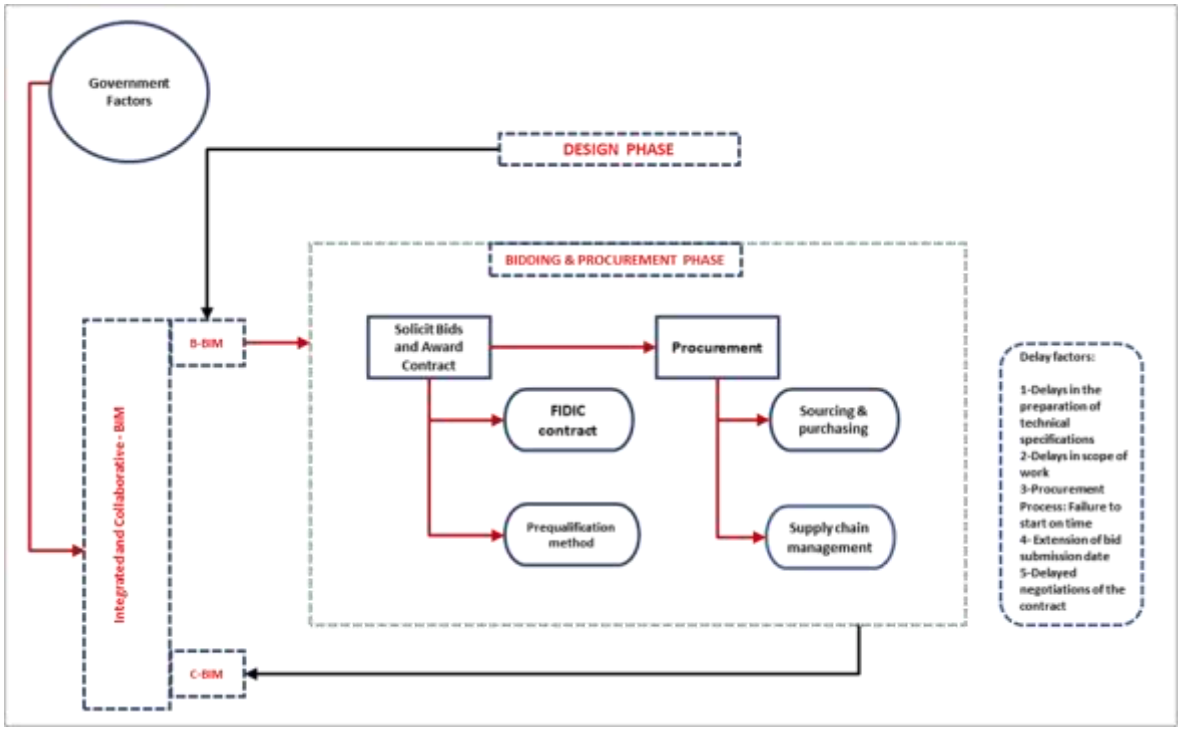

Figure 7.4: Bidding & procurement phase of the framework

In terms of the sourcing and purchasing actionable measure in the framework's bidding and procurement phase, it is worth noting that, for housing projects in the KSA, there are a range of strategies by which this can be achieved effectively to minimise delays. For example, electronic procurement (e-procurement) and the establishment of an electronic supply, which is characterised by the reduction of costs and time associated with information acquisition for sourcing and purchasing activities, could be applied by Saudi practitioners (Piera et al., 2014; Altayyar, 2017; Alfolabi et al., 2019), particularly in light of Indonesian evidence to suggest that e-procurement aids in minimising delays in the completion of construction projects (Lewis-Faupel et al., 2014). Given that e-procurement moves the whole procurement process for a construction project online, significant efficiencies can be achieved, and costs can be maintained (Peira et al., 2014).

However, it is important not to overlook the fact that as a relatively novel collection of tools and techniques, barriers to the adoption of e-procurement and electronic supply chains in Saudi construction projects may exist and have in fact been documented in the literature (Altayyar, 2017). These barriers, as reported by Afolabi et al. (2019) in their investigation of e-procurement adoption in the Nigerian construction industry, include awareness of e-procurement and availability of required technological infrastructure. Therefore,

since it is known that different companies and projects can derive contrasting benefits even from the implementation of an identical e-procurement system (Mahbubur and Kurnia, 2014), it may be worthwhile for procurement and logistics experts within the project team to estimate what the effects of an e-procurement system would be (i.e., in terms of the reduction of project delay, and this should occur prior to the adoption of the system). The strategy that could be applied for the purposes of evaluation, is the e-procurement adoption motivation scenarios model, which could systematically illuminate the viability of integrating e-procurement into the project's sourcing and purchasing activities (Mahbubur and Kurnia, 2014; Reunis and Santema, 2019).

7.2.3.6 Construction Phase

The survey and interviews revealed that in the absence of modern methods of construction (MMC), the degree to which a housing project in the KSA can be completed on time is undermined significantly. Therefore, to promote speed, and alongside this, to maximise safety during the phases, quality (ISO9001), and post-project client satisfaction, modern methods of construction (e.g., the site-based method) should be employed, as illustrated in the conceptual framework (Hashemi, 2006). It is also worthwhile to note that, according to some practitioners, the problematic condition in the KSA, specifically regarding the availability of modern, adequate, and affordable housing (Banafea and Ibnrubbian, 2018), could be solved through the application of modern MMC (Thomas, Farrell, and Auchterlounie, 2006).

According to Oliveira et al. (2017), the critical parameters that the UK government seeks to satisfy when utilising MMC for social housing projects, which could be promoted by the KSA government and private firms by means of policy borrowing (Steiner-Khamsi, 2016), include speed, quality, and health and safety. That is to say that measures are taken during the construction phase of every social housing project in the UK to maximise build quality and health and safety performance and, at the same time, to ensure that MMC are chosen that can lower the time taken for the project (Oliveira et al., 2017). For the conceptual framework, the site-based method is advocated as the MMC which project managers should utilise for housing projects in the KSA. The MMC has been found to maximise speed, quality (ISO 9001), and health and safety (Hashemi, 2006). In terms of how the site-based method can be defined, Hertfordshire LEP (2019) referred to it as being characterised by the

undertaking of the following activities at the development site rather than a factory setting: firstly, volumetric construction; secondly, the creation of fully-assembled components, which are then craned into the superstructure of the building; and finally, panelled systems.

While the site-based method is recommended in this conceptual framework as the MMC that practitioners should apply, it is important to recognise that methods such as this cannot be applied effectively without viable information management strategies (e.g., through BIM) (Xu, Ma, and Ding, 2014; Alenazi and Adamu, 2017), reasonable cost planning and budgeting (e.g., through the use of machine learning or evolutionary systems) (Elfaki, Alatawi, and Abushandi, 2014), and the establishment of suitable procurement routes and supply chains (e.g., through e-procurement and electronic supply chains) (Mahbubur and Kurnia, 2014; Reunis and Santema, 2019). Nevertheless, since each of these issues are addressed through previous practical measures in the proposal framework, close adherence by Saudi practitioners to the core elements of this conceptual framework should contribute to the formation of an appropriate platform on which MMC can be applied during the construction phase (Figure 7.5), thereby promoting speed, quality, health and safety, and – ultimately – minimising the likelihood of delay (Oliveira et al., 2017).

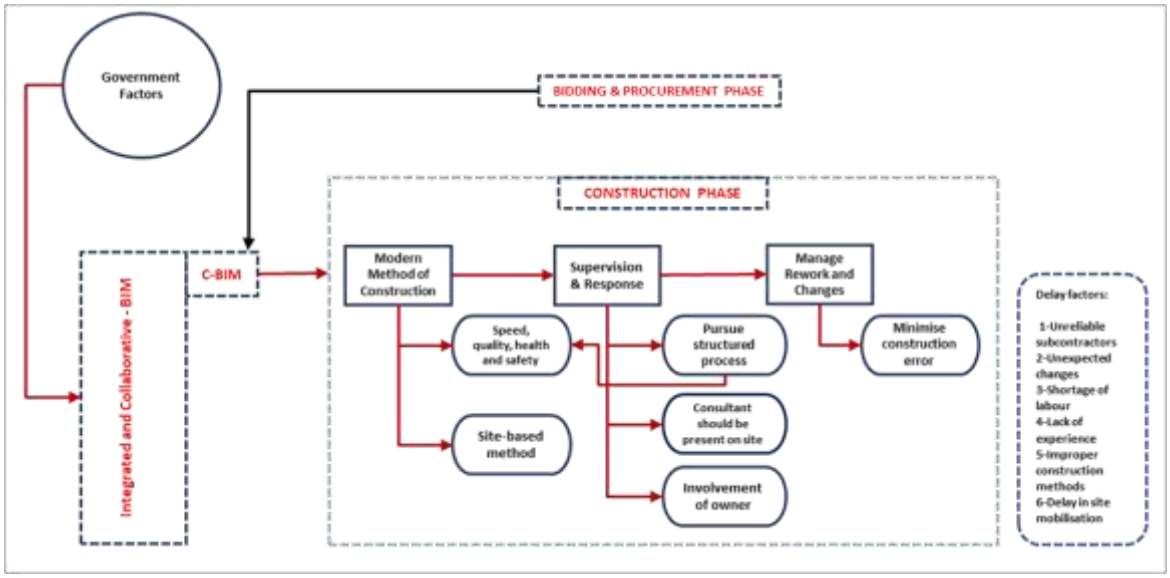

Figure 7.5: Construction phase of the framework

In addition, the management methods devised for monitoring and accountability (that is, during the design phase) should be applied during the construction

phase to facilitate comprehensive supervision and suitable responses to on-site defects, thus minimising delay-causing errors. Furthermore, as indicated by the questionnaire responses, the consultant should be present on the site, while the client should be involved across the construction phase. Finally, in the event that rework and design change are unavoidable, a structured process should be applied to minimise the time and cost overruns that stem from this. For example, Yap, Abdul-Rahman, and Wang's (2016) framework could be used to guide necessary rework.

Although, some studies have found that client involvement during the planning, design and bidding and procurement phases of a construction project can serve as a form of interference, thus increasing the likelihood of delay (Jaffar, Tharim, and Shuib, 2011), both the empirical findings from the literature and the results from this study's survey responses indicate that client involvement across the construction phase is desirable and, in many cases, essential for minimising delay (Serpella et al., 2014). Considerably, interdependences exist among the numerous actors who participate in a construction project, and given that the construction phase represents the point at which these actors' activities converge (Eriksson, 2017), consistent involvement of the client can increase safety, reduce delay, maximise value to the client, promote innovation, provide a source of authoritative feedback, streamline decision-making, and lower the risk that client requirements may not be satisfied (Hartford LCD, 2002; Serpella et al., 2014; Hall et al., 2014). One of the core reasons that these delay-mitigating benefits may emerge as a result of client involvement stems from the status of a project client as the stakeholder with the greatest ability to enforce decisions (Trigunarsyah, 2004).

Notably, in the KSA-based study conducted by Trigunarsyah and Al Solaiman (2016), the researchers distributed a questionnaire survey to 315 participants in 21 government agencies, the purpose of the study being to evaluate the impact of client involvement on project performance in the construction industry. The results were conclusive in demonstrating that inadequate levels of client involvement during the construction phase of projects were associated with poor project outcomes in terms of the number of disputes that arose, the project cost, the timeliness of the project's completion, and other critical success factors. Given the high methodological quality of the study, as well as its recent publication date, it is reasonable to stress the importance of the involvement of the client in this conceptual framework, which represents a key actionable

measure for improving supervision and response, and ultimately lowering the likelihood of project delay.

7.3 Findings of the Construction Phase Activities

To ensure project success, communication among project parties consists of many steps within the stage of construction. Major aspects include knowledge about the way the delay factors and the project phases are correlated as well as approaches to managing an issue prior to becoming worse.

7.3.1 Delay Factors Structure (DFS)

Figure 7.8 shows the ten groups, which are the clients, contractors, consultants, materials, equipment, workforce, contractual relationship, design and planning, external factors and contracts. To establish how the project parties related to one another, 3-5 delay factors were gathered in every group. In particular, it was important to find out if the relationship was hierarchical or horizontal in nature.

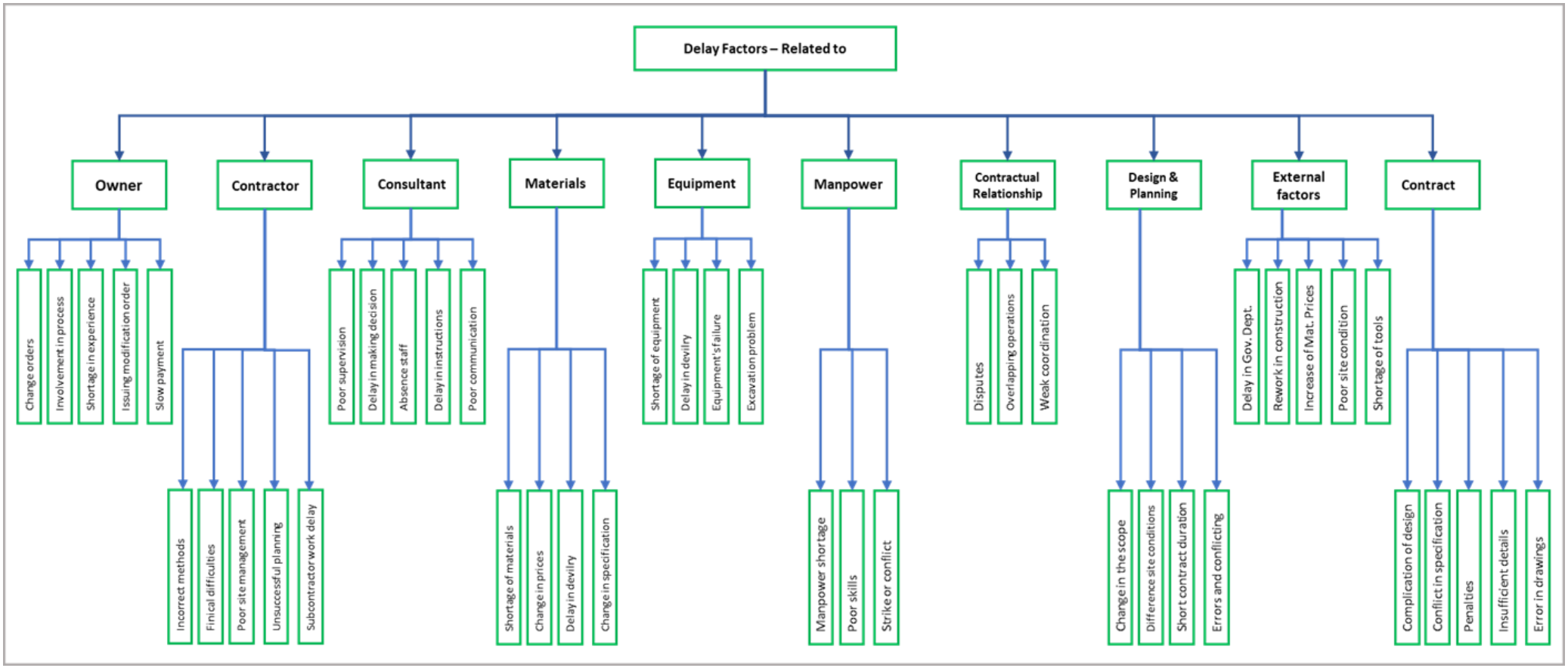

Figure 7.6: Groups and associated delay factors

Figure 7.7 illustrates the project stakeholders, which include the client, contractor, consultant, sub-contractor and suppliers. To ensure that all parties are equal in power, every party has an its specific role. Furthermore, it is necessary for every party to comply not only with the timeframe and budget of the project but also with the scope of work that is allowed. Defects can be prevented in the construction stage by implementing the BIM between the parties.

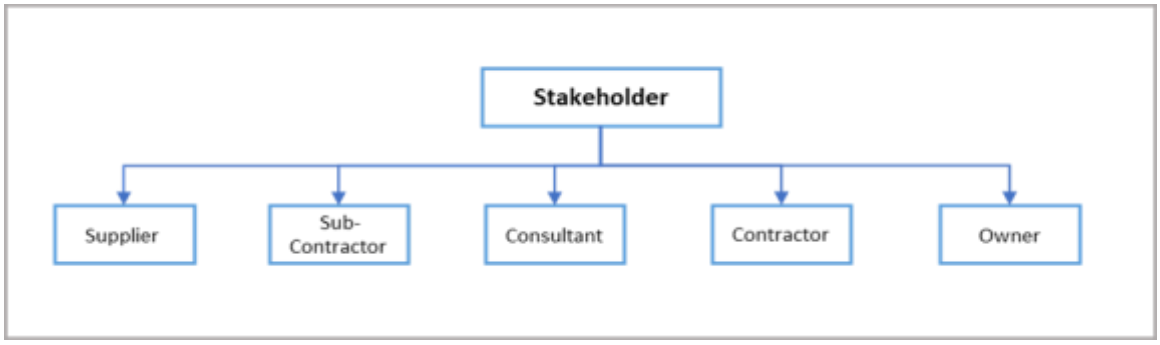

Figure 7.7: Organisation of stakeholders

7.3.2 Construction Activities (CAs)

It is essential for the construction activities (CAs) to be carried out within the established timeframe and budget and the work quality must be ensured. Furthermore, every step is prioritised according to the dedication to the work scope. Figure 7.8 illustrates how the structure was organised into ten groups. The initial activity and the final activity were groundwork and project delivery, respectively.

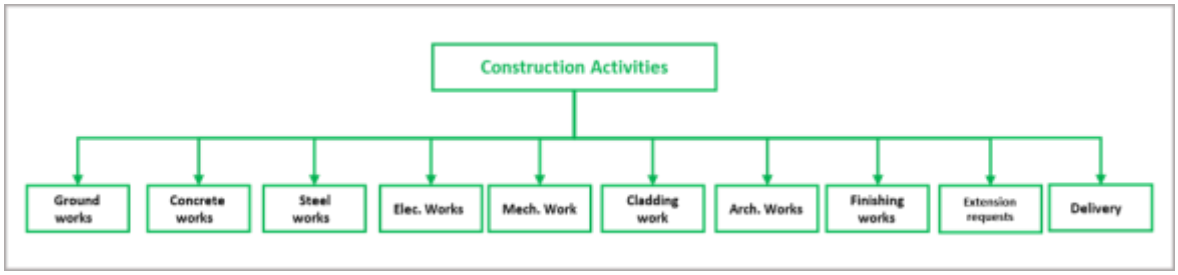

Figure 7.8: Construction activities

Each construction activity has its own scope of work from contract specifications to implementation (Figure 7.9). These actions shall be in a specific and agreed time between the stakeholders. The contractor shall comply with the terms of the contract during the execution phase. In addition, there are phases that take place on time and in accordance with the agreed specifications, where the completion rate is high. However, the phases where the imbalance begins, are in the stage of warning or delay must be addressed quickly to avoid the accumulation of work. Therefore, the contractor should pay attention to each construction activity.

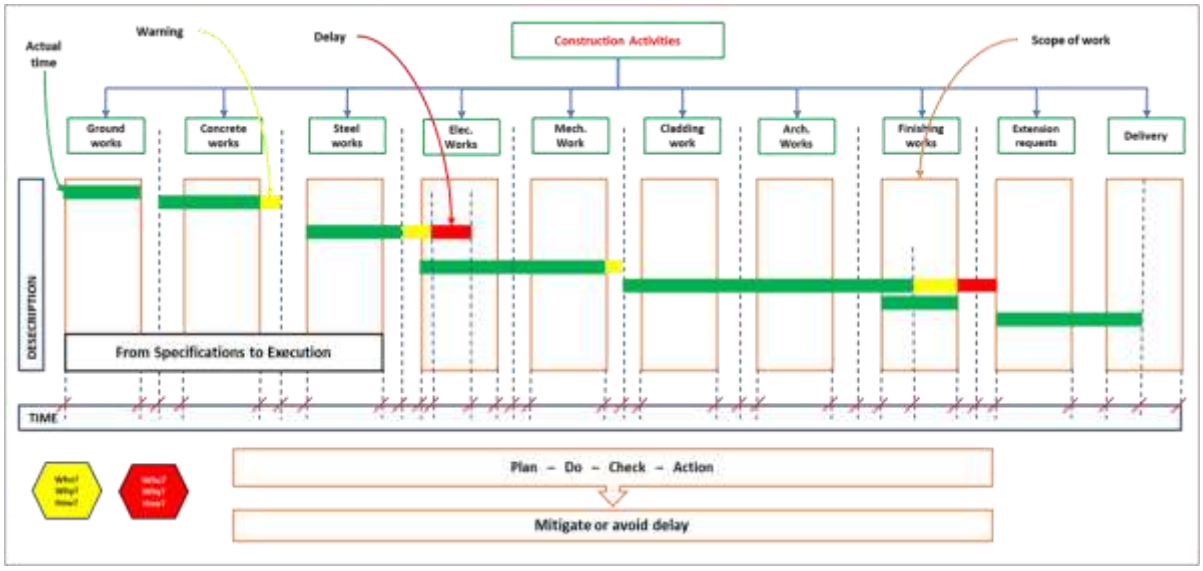

Figure 7.9: Commitment to time and specifications

7.3.3 Actions

A successful project depends on honest communication among parties and solving disagreements. It also depends on the project manager, as some events need urgent intervention in order to avoid the backlog of business over each other, with a power are absolute to remove obstacles during the project phases. As shown in Figure 7.10, the actions employed with the greatest frequency in the project were the basis for the organisation of the structure.

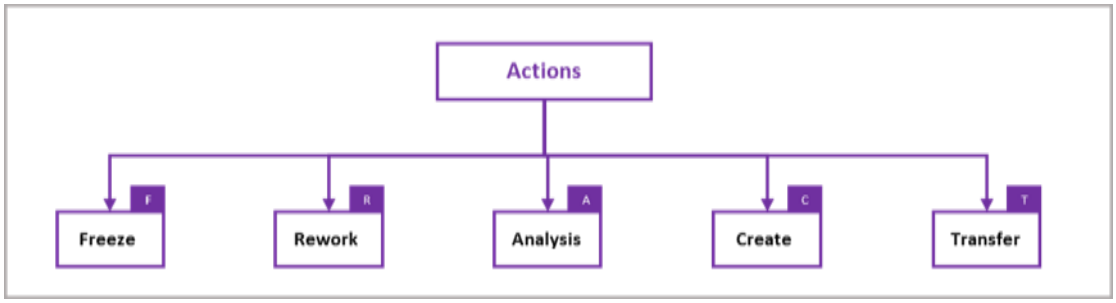

Figure 7.10: Configuration of actions

In addition, the importance of each phase must be placed, meaning there are tasks that require urgent work, and this does not bear any delay. Tasks will be very important but not urgent, and this estimate is up to the project manager. The estimates are based on the status of the project. It is possible to leave some work and delegate someone to complete it. Also, the project manager can act at every phase but within the scope of work available (figure 7.11). So, each stage is different depending on the events at the time.

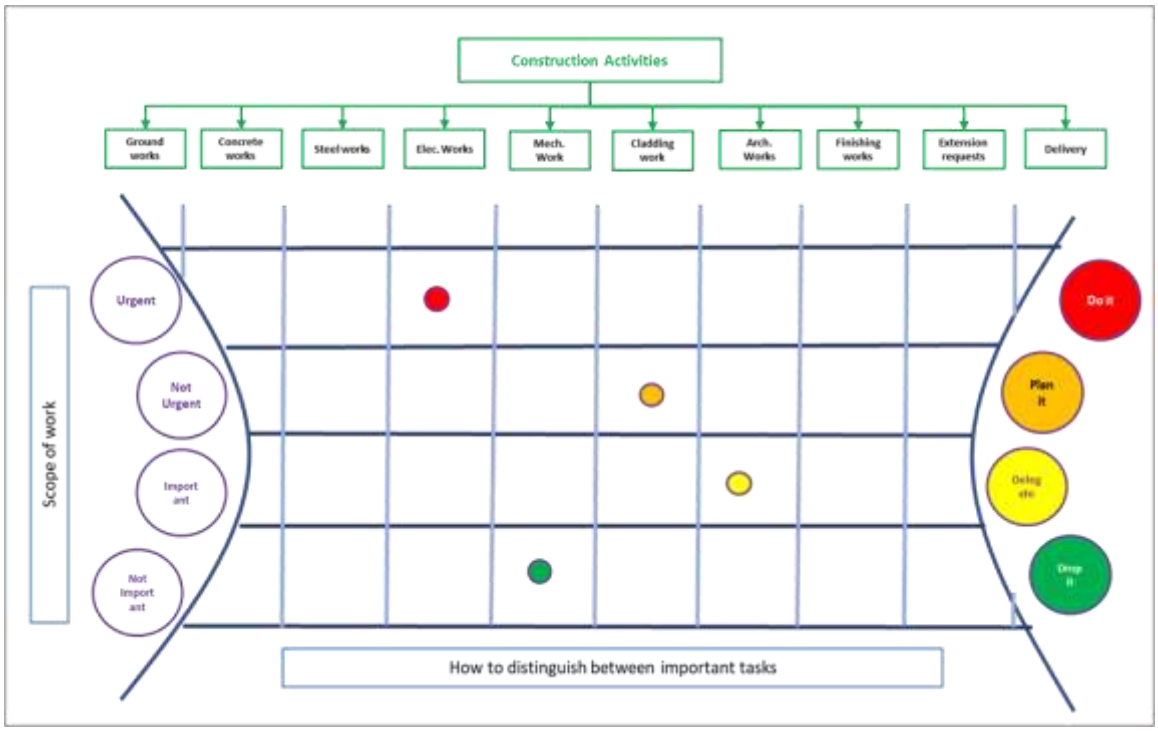

Figure 7.11: Difference between important tasks

7.3.4 Overview

To sum up, the success of the project depends on cooperation between all the structures. They must comply with the timeframe, budget, quality and scope of work. Consequently, adherence to the timetable is committed by all stakeholders to the steps and phases of the project. In addition, the budget may change by the client provided that they are within the limits available. But quality, the contractor must adhere to them and will be monitored by the consultant continuously for an integrated and residential environment. Therefore, they have to apply BIM at each phase (Figure 7.12).

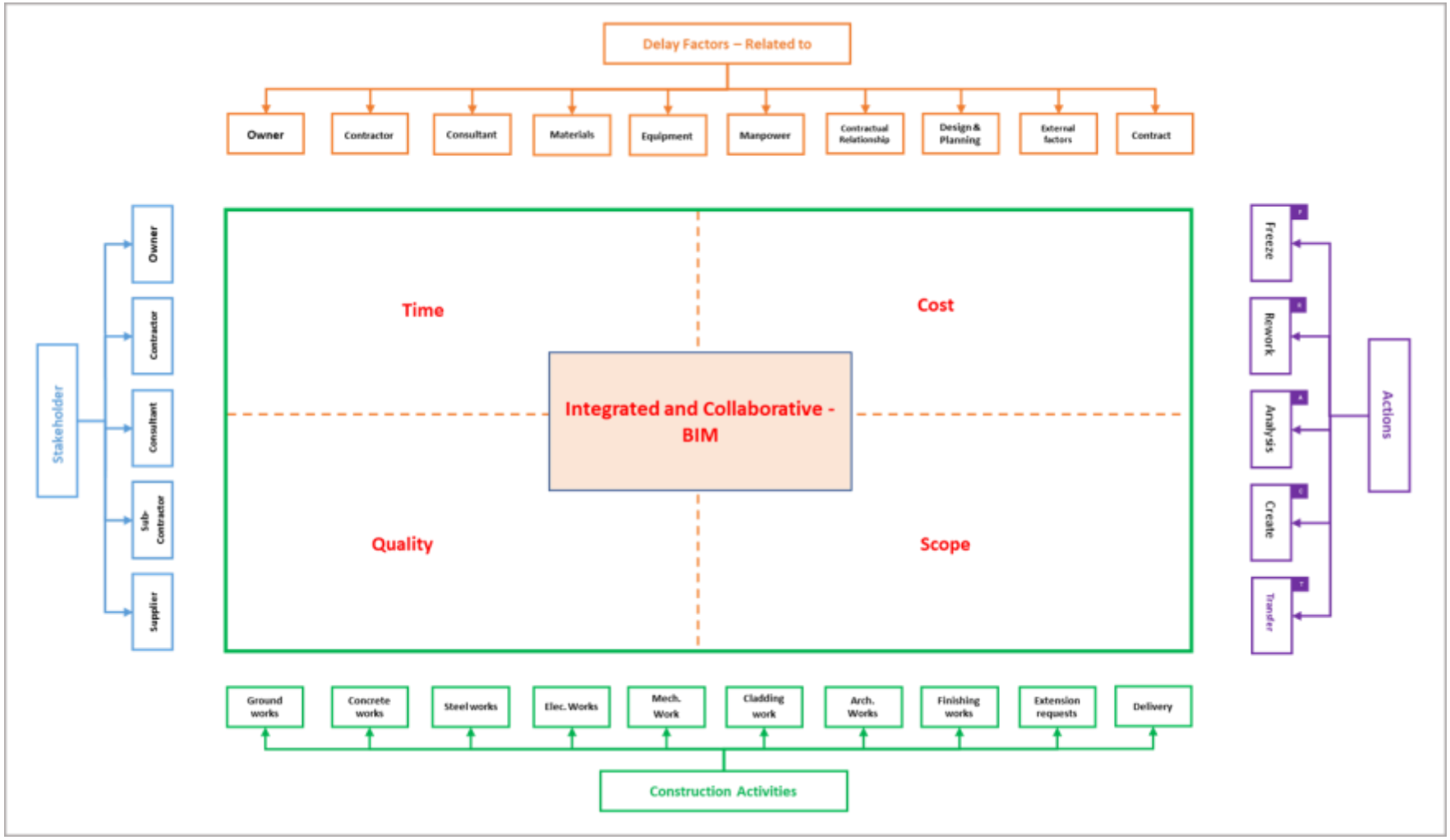

Figure 7.12: Schematic representation of how stakeholders, activities and collaborative integrated – BIM are correlated

7.4 Correlations

When the contract is signed, the project stakeholders enter a relationship with one another, and every party must become dedicated to the established activity plan. For instance, the client should provide support to every party aside from the contractor, who is responsible for the workforce and their competencies. Meanwhile, the consultant acts on behalf of the client has to keep track of the work by relying on an integrated counselling team. In the stage of construction, communication and input must be promoted to make the parties more productive and more satisfied. In addition, project delays can be minimised or avoided altogether by achieving the BIM of the project, which enhances reciprocity and collaboration (Figure 7.13).

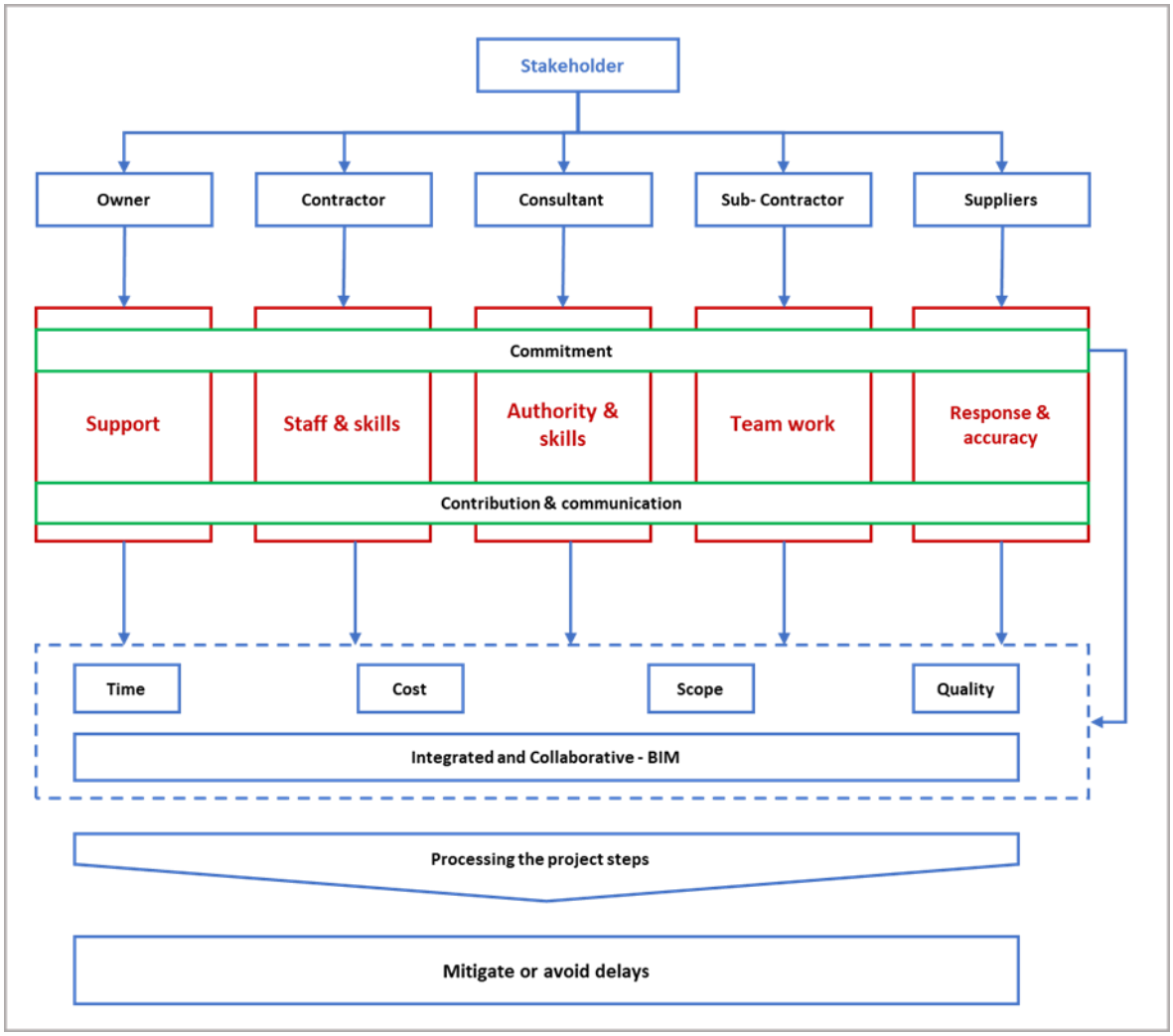

Figure 7.13: Required commitments of the stakeholders towards the project

After the selection of the delay factors structure (DFS), between three and five delay factors, representing questionnaire results, were quantified (Figure 7.14) and they constituted the factors with the highest delay in their groups. If they comply with the timeframe, budget and quality specifications imposed by the BIM to prevent delays, these factors will be addressed in the operations included in the stage of construction.

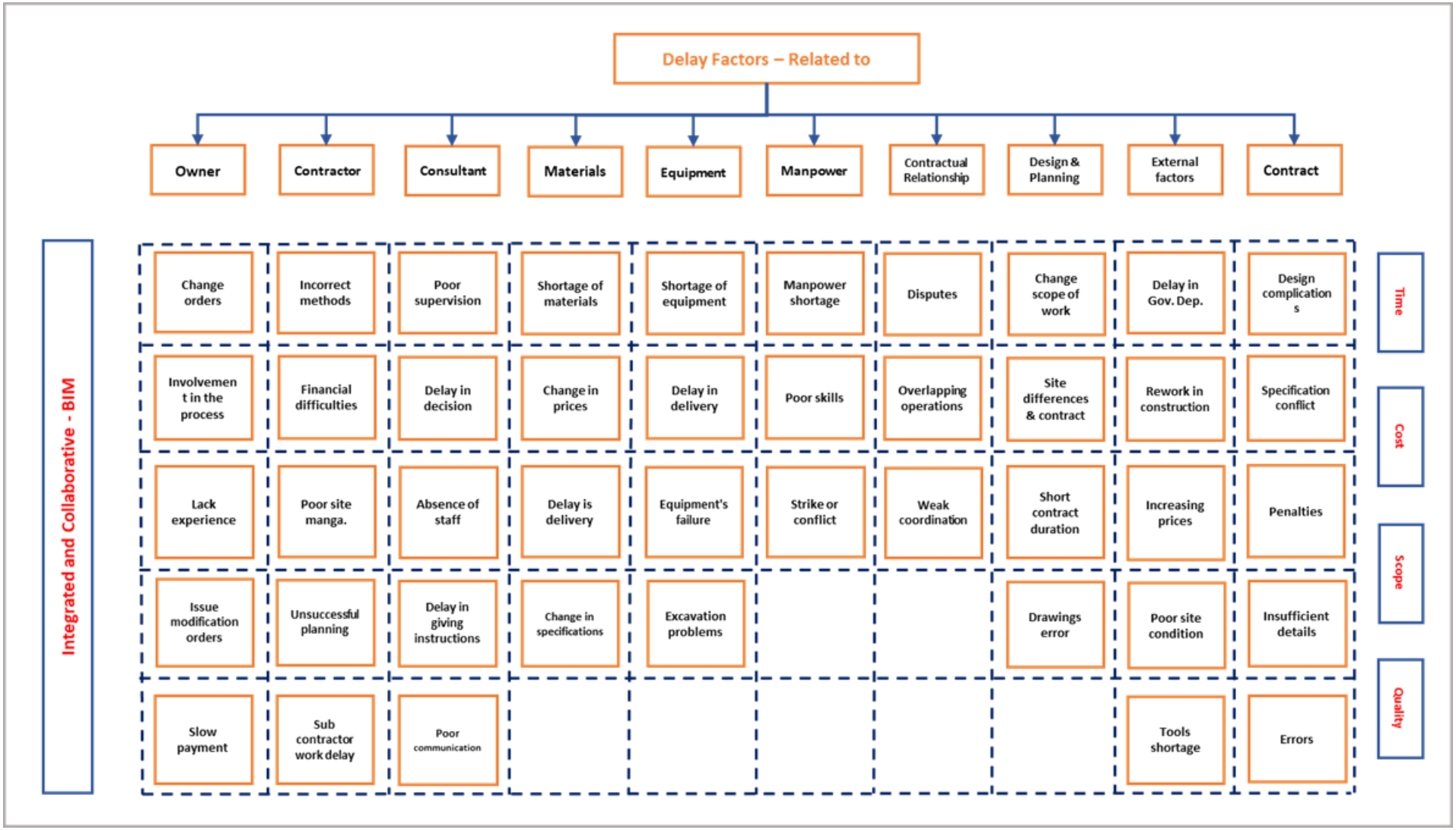

Figure 7.14: Delay factors alongside BIM, timeframe, budget, scope and quality

7.4.1 DFS and Stakeholders

During the phase of construction, it is the task of the analyst to identify the delayed activities, the timeframe of those activities, and the characteristics of the delays, such as delivery date or late commencement. Subsequently, the analyst determines who is accountable for every delay. Therefore, during this phase, the work must be followed up in order to prevent delays and, implicitly, the build-up of work and overlap of activities. The solutions generated must be suitable and consistent with the stakeholders' activities and aims; more specifically, the client aims to ensure that project completion is within the established timeframe, whilst the contractor, sub-contractor and suppliers are interested in obtaining their remuneration as soon as possible (Figure 7.15).

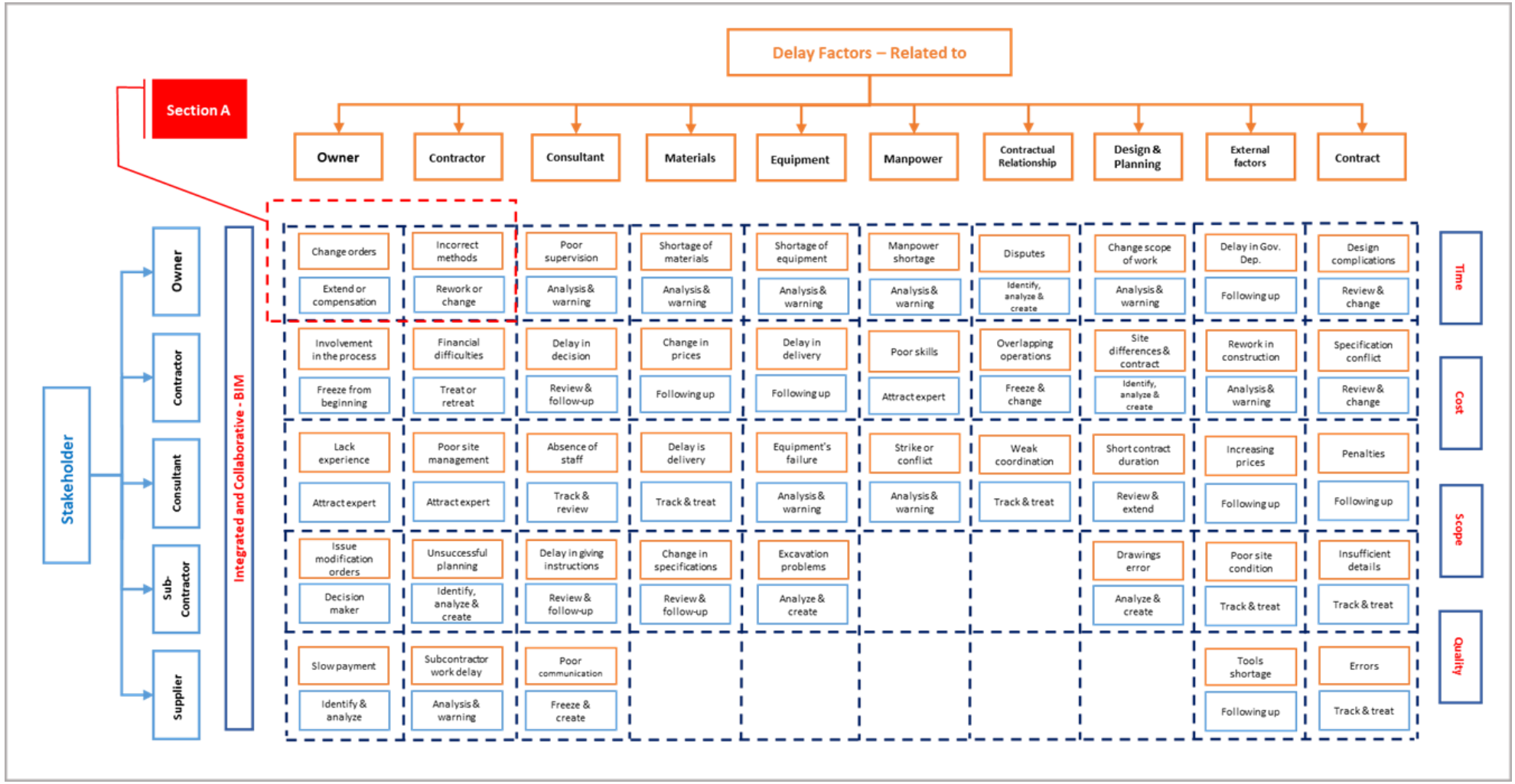

Figure 7.15: Delay factors and ways to solve them; DFs and solutions being indicated in brown and blue colour respectively

As shown in section A of Figure 7.16, the delays engendered by the client can be a type of directed or constructive change. Such delays may take the form of order modifications, defects or loss of information in the contract papers, discrepancies on site, securing approval too late, failure to address demands for information required for work progress in a timely manner or even order cancellation. Extra time can be gained as a result of certain events that have contract compatibility. The right to compensation due to delays is enforced if the alterations made by the client are the reason for a delay, which is therefore considered justifiable.

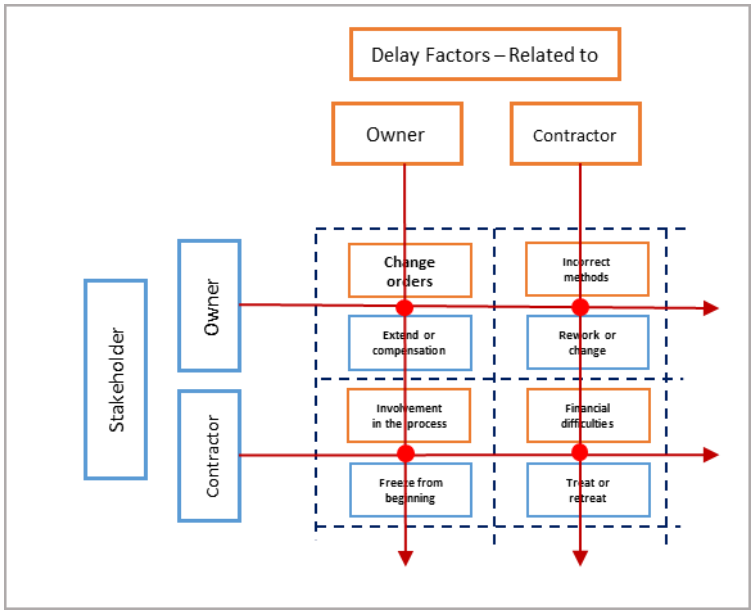

Figure 7.16: Exemplification of factor and practical solution

Despite the fact that the delay reason is not the appropriate approach, the client is entitled to request a qualify work or modify the actual sequence of the work.

7.4.2 CAs and Stakeholders

Complete operational drawings are required by the project manager at the start of the construction project. Detailed executive drawings are important for two reasons: firstly, the building site is often remote from the design offices so the design team cannot monitor operations directly; secondly, the availability of drawings helps to avoid future conflicts between the design engineer and project manager or the client and contractor. Hence, the quality management system

must be implemented access all project phases, taking into account project timeframe and budget (Figure 7.17).

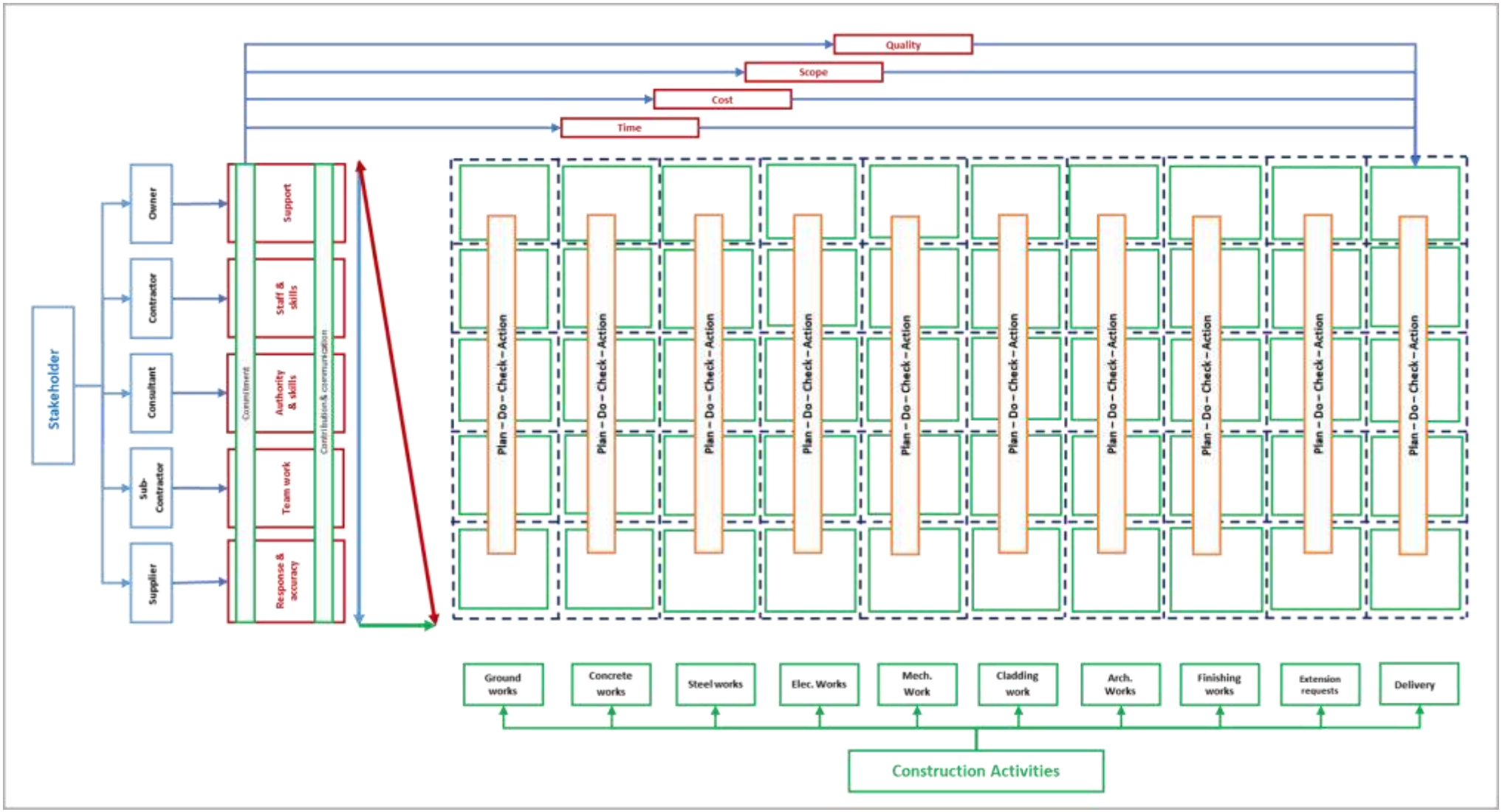

Figure 7.17: Correlation between CAs and stakeholders

7.4.3 Stakeholders and Actions

Full responsibility for the project rests with the project manager responsible for any decision made regardless of its nature. An inappropriate project manager may delay or even collapse the project. Their lack of experience increases the many differences during the project phases, contributing to their overlap, as well as the backlog of work. Therefore, efficient approach must be adopted to prevent delays and the justification underpinning the project manager's decisions and outcomes must be known via a protocol involving the steps of warning, identification and analysis. (Figure 7.18)

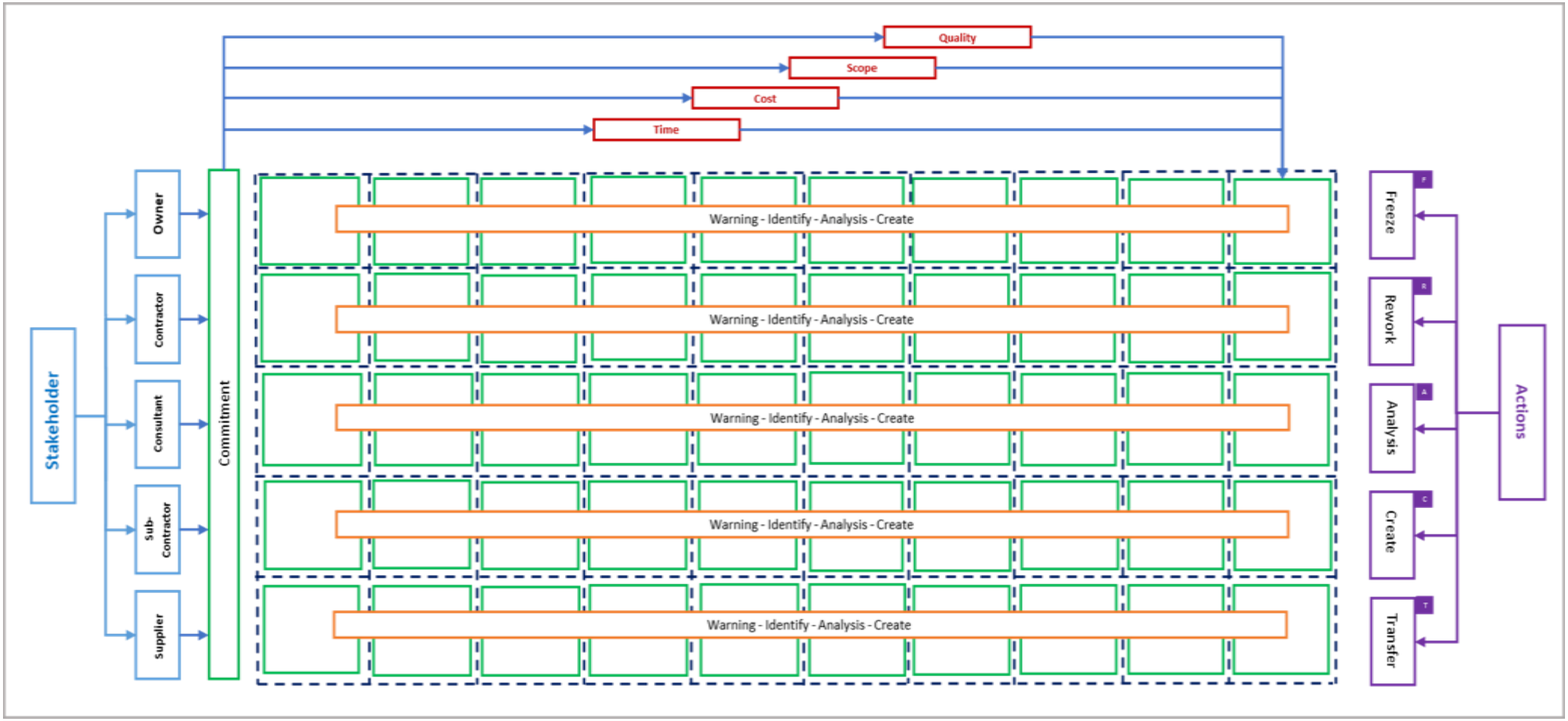

Figure 7.18: Correlation between stakeholders and actions

7.4.4 Correlation between CAs, Stakeholders and Actions

Since they are not the same as other projects, housing construction projects consist of many interrelated and consecutive phases and different parties are involved in them. The final budget and timeframe may be exceeded as the work and, implicitly, delivery can be delayed by the superimposed phases. Hence, construction projects require a range of technical inputs and fields of expertise and, additionally, the involved parties must be highly coordinated in every phase, including planning and future requirements. Furthermore, the specified quality can be achieved by employing novel technologies. The various activities needed by the quality function are associated primarily with the work undertaken by the project contractor, sub-contractor and consultant in the context of planning, decision-making, organisation, leadership, motivation and control. In turn, these are reliant on the management of the input of the team, provided that the overall purpose is shared. Consequently, by adequately dealing with project delay, it can be alleviated or prevented.

In the current research, the execution stage is the stage of highest significance and sensitivity, and therefore the whole project can suffer delay if this stage fails as a result of delay or lack of completion (Figure 7.19).

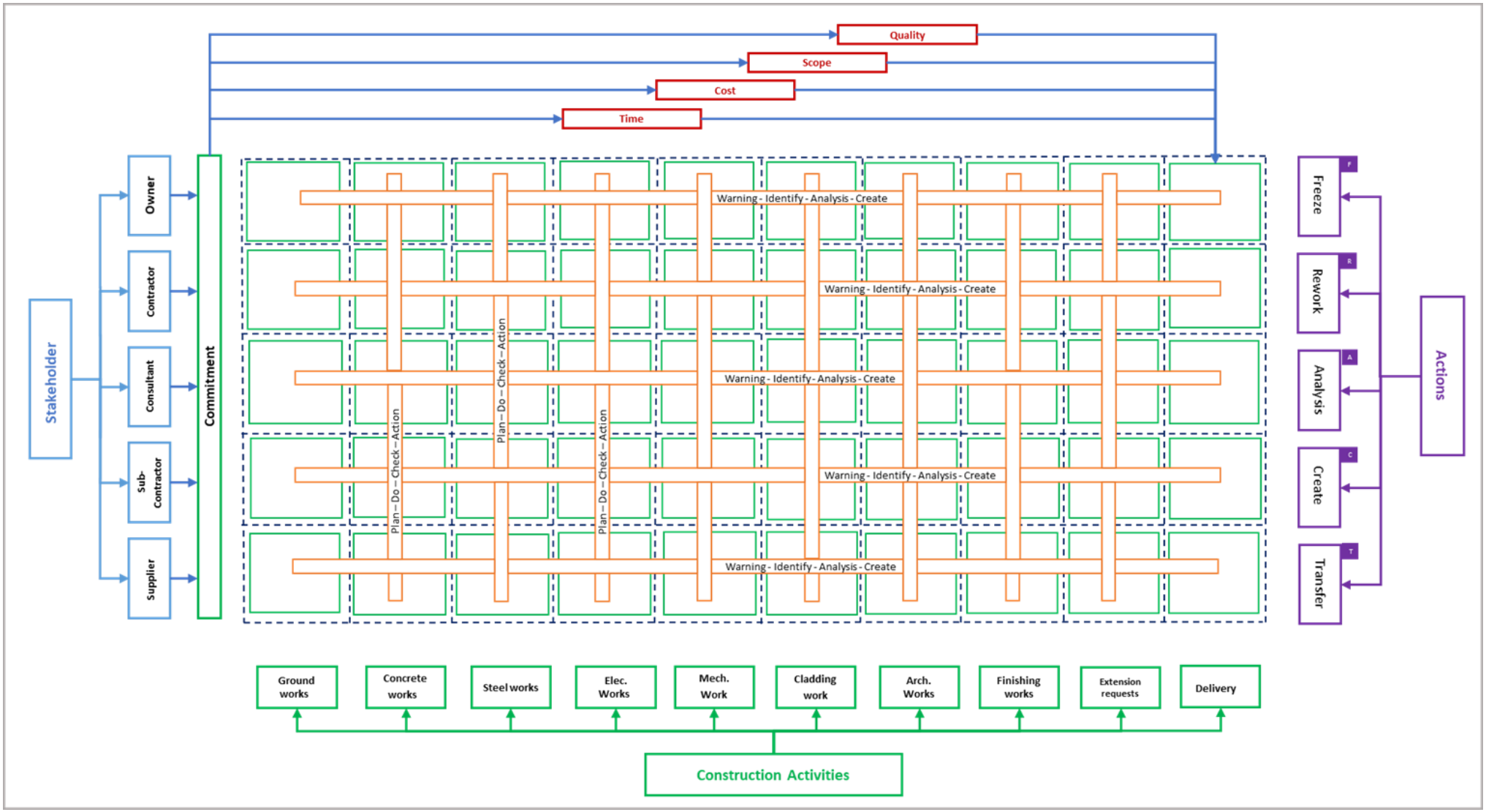

Figure 7.19: Correlation between CAs and stakeholders associated to actions

7.4.5 Correlation between DFs, CAs and Stakeholders

Adequate planning, efficient communication and commitment to the work aim to prevent delay and generate suitable solutions which are the foundation of the correlation between the parties. The process of project management begins with project planning, which must be carried out before the other administrative responsibilities associated with the project. Hence, in this phase, BIM is appropriate for generating a good project setting and management.

As an integrated model, BMI is compatible not only with the design process but also with the implementation process, and it can be altered constantly according to many aspects, including modifications brought to the implementation plan. The likelihood of simulation of precise element information implementation and extraction to the manufacturers; representation of every environmental, technical and architectural scheme as well as of additional information. Furthermore, the likelihood of employing the model to manage and maintain the establishment since it constitutes an integrated record of the activities undertaken during the implementation process. In this way, it is possible to achieve the targeted project quality without exceeding the planned timeframe or budget (Figure 7.20).

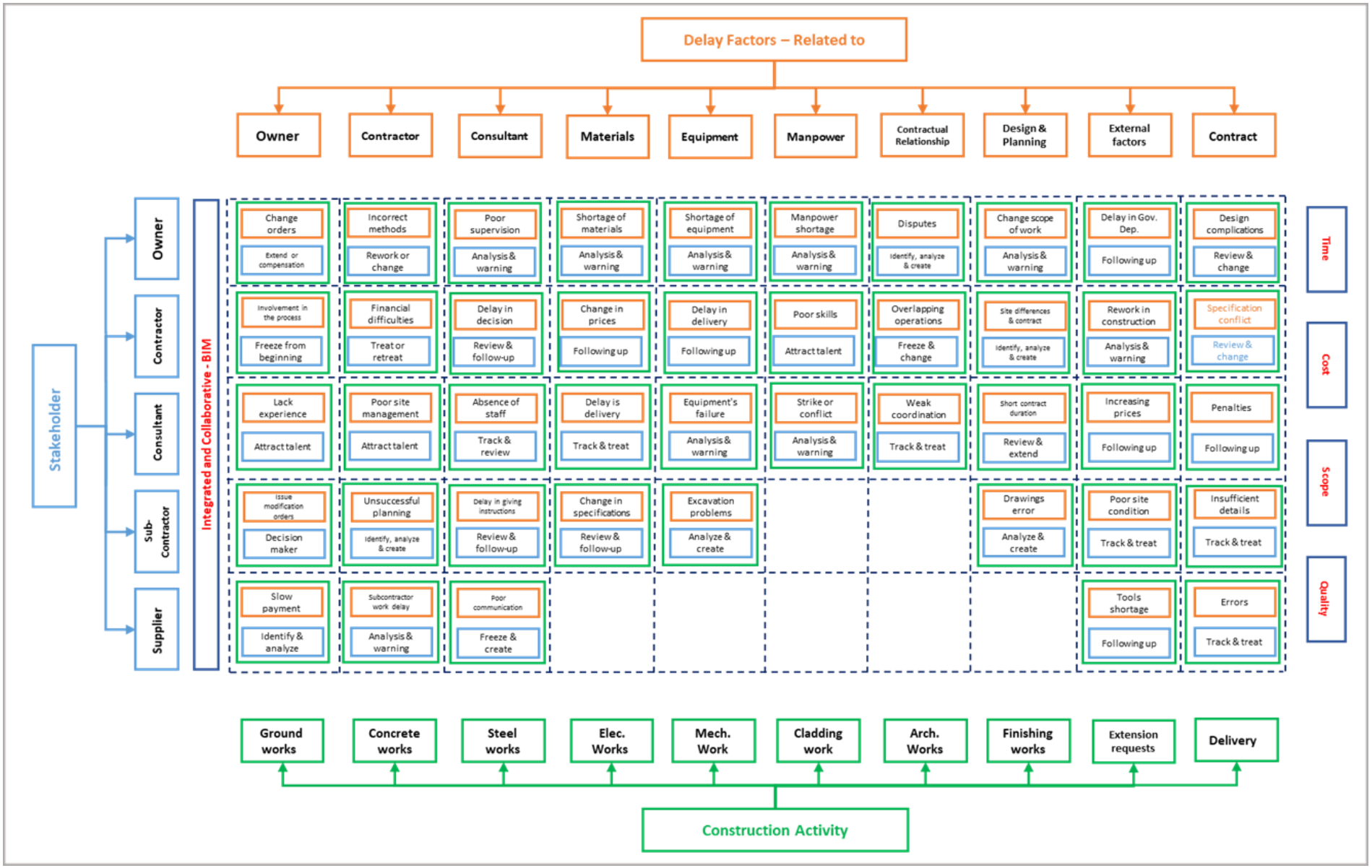

Figure 7.20: Correlation between DFs, CAs and stakeholders

7.4.6 Correlation among all Structures

Both extrinsic and intrinsic aspects are presented by all projects. Extrinsic aspects related to the manner of project development and the issues that are probable to occur when the project is commenced. On the other hand, intrinsic issues may emerge later in case reports or on software lacking compatibility and have an impact on external output in many instances. To avoid project management having to deal with difficulties, technical and monetary considerations must be considered when implementing particular activities and duties for every phase (figure 7.21). Thus, the primary aims can be attained by ensuring that the setting is ideal. Time, cost, scope and quality are the major aspects that underpin the aims of a project.

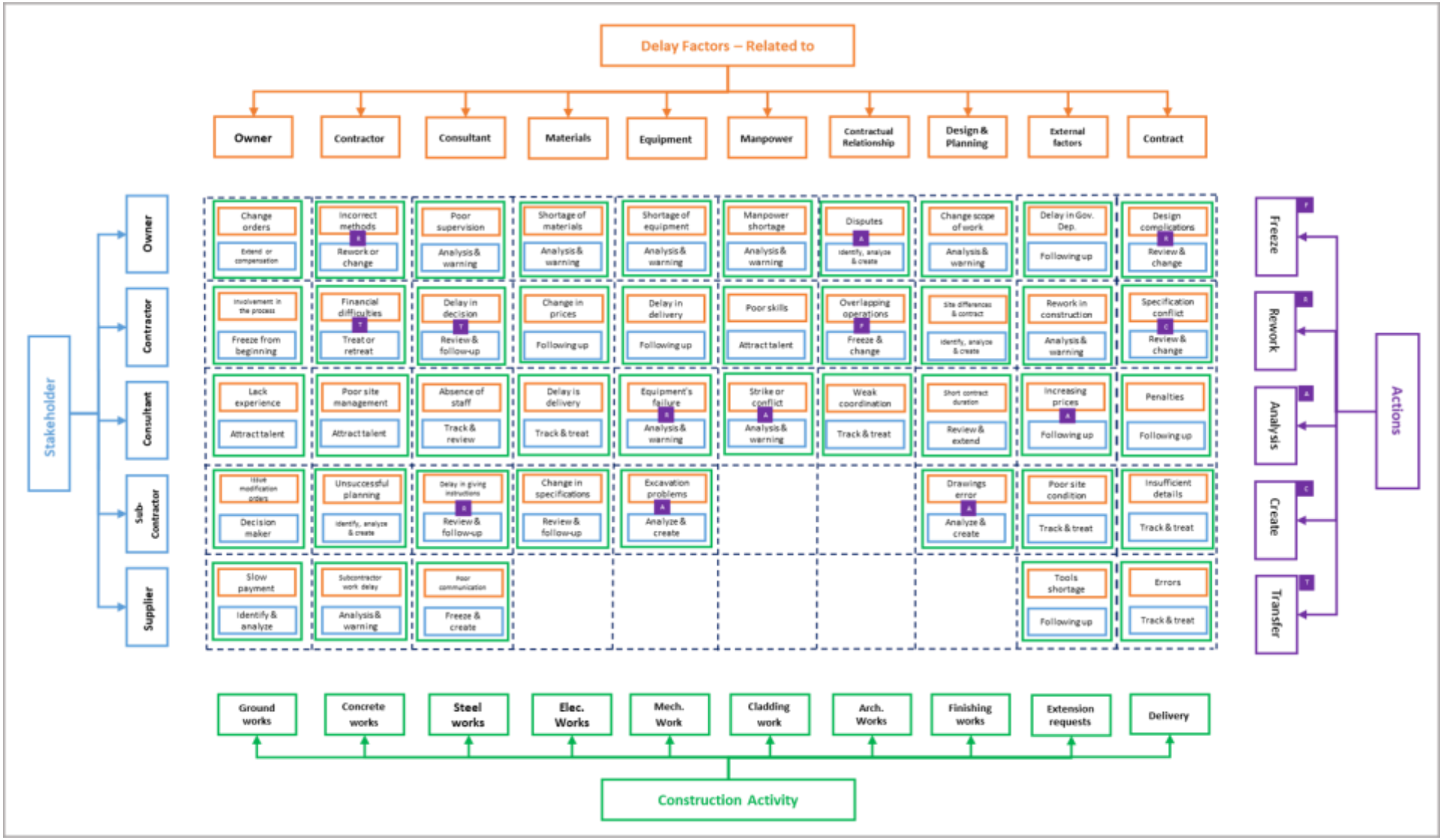

Figure 7.21: Correlation among all structures

7.5 Verification of the Framework

7.5.1 Introduction

The research aims to widen the scope of present knowledge through frameworks that help to avoid and minimise delays in the project. This section presents a detailed picture of the conceptual framework through independent external evaluation. The key aim is to understand and gauge opinions of the experienced housing professionals to critically assess the application of the proposed framework. This will establish prospects, suggest improvements and facilitate successful adoption.

7.5.2 Verification Process and Selection of Experts

The need to create a framework that can be used as a tool to eliminate delays in completion of housing projects and comply with quality assurance requirements. To study the adequacy of the results as well as the processes that generated the results, along with maintaining a balance between the frameworks and the variables. Therefore, an independent group of senior practitioners in the field of housing was selected to address opinions and reduce bias.

In the initial sample six experts were individually contacted to confirm their participation in the research and a positive response was received from four of them. The selection was done based on their years of hand-on experience in the Saudi construction industry. Table (7.1) shows the final sample details for participants in the frame verification.

Table 7.1: Verification sample

Expert code	Title of expert	Experience	Size of organisation
Ex-V 01	Director	22	Large (Government)
Ex-V 02	Director	25	Consultancy services
Ex-V 03	Director	23	Large
Ex-V 04	Professor	22	Academic

The experts were then interviewed for the research to both add to the quality to the collected information and avoid the trappings of interviewer bias. The

interview was conducted with the aim to assess the major contributions to knowledge claimed to have been made in the thesis, particularly with regards to the indicators for construction delays, mapping of the state of the variables, and the framework. The interview framework consisted of pointers to help the interviewer cover the key topics and to ensure the collection of relevant data.

7.5.3 Aim of Verification

The main aim of the verification interview is to verify the results and how the conceptual framework works. In interviews, the researcher tried to ensure that the framework could be applied during the phases of housing construction projects while ensuring that delays were avoided or minimised (Yin, 2009). Moreover, to check the ability and flexibility of the framework in new phases additions or new verification steps for optimal quality.

7.5.4 Relevance of Indicators

Initially, the conceptual framework was presented to the experts for an evaluation. The experts were then discussed on the assessment of the effectiveness of the primary characteristics and many of the sub-nodes of delay described in the previous section. Experts stressed that the indicators give a comprehensive delay in any housing project, so it is very appropriate to apply the framework.

> *"It is an extensive list of indicators and it is evident that they cover all areas of the Saudi market and in my opinion, in much greater depth as compared to our delay indicators" (Ex-V 01)*

The second expert (Ex-V 02) reiterated the same views:

> *"The framework's delay features are comprehensive and include the entirety of what we want to assess with the ease to make additions." (Ex-V 02)*

Also, the third expert (Ex-V 03) said:

> *"It is very easy to see and read the indicators smoothly, and in fact any new indicator can be added." (Ex-V 03)*

The experts were then requested to assess the conceptual framework from the point of view of possible delays in the housing projects with a range of solutions aimed at determining the ways in which the framework can be used in practical applications. Upon a detailed review, the experts presented the opinion that it would certainly be advantageous in reducing and eliminating housing project delays in the future, with the potential to be extended to investment projects too.

> *"In all honesty, the final outcome of the framework has an ease of use that I like and new technologies can be added to projects, I am in particular fascinated by the BIM in the framework. This should be adopted by the government…" (Ex-V 02)*

> *"It is a good framework and exceptionally thorough in its approach. I am highly impressed and look forward to using it..." (Ex- V03)*

The third expert (Ex-V03) proposed the immediate implementation of the proposed framework because of its ability to avoid delays in housing construction projects. In addition, the method adopted by Expert IV (Ex-V04), which felt that there is a need to adopt BIM in government projects to ensure the integrity of the project.

> *"Despite its purpose it is very useful and very good. As an organisation we have always focused on the scientific aspects, and although we do so, we do not have this concrete framework, already implemented on assumptions and results but very useful. "(Ex-V04)*

Nevertheless, the second expert brought up the issues that as far as suitability is concerned, the framework might be too comprehensive for construction projects, whatever the function of the building. He also highlighted the fact that it would prove to be a valued tool for major regeneration projects. Further, the fourth expert highlighted other advantages of the framework and posited that:

> *"The first instinct as a professional is to evaluate the aspects subjectively, with regard to the environment, the feedback from local authority and the quality of relationship with them, reviews of other stakeholders and*

then the tendency is to offset that, and I am of the strong opinion that this is worth investing in." (Ex-V04)

In contrast, the third expert (Ex- V03) said that the commitment to the framework must be from all parties to the project and stressed that to achieve quality in the work, as well as the possibility of avoiding delays in the project from the beginning. (Table 7.2)

"In my opinion, the project team must adhere to this during the project stages otherwise the benefits of the entire framework will not be realized." (Ex- V03)

Table 7.2: Experts note

	Expert			
	V01	V02	V03	V04
Possibility of development	●	●	●	●
Saving time	●	●	●	●
Readable	●	●	●	●
Flexibility (adding a new factors)	●	●	●	●
Ability to review current operating capabilities		●	●	
Create a detailed work plan (initiation phase)	●	●	●	
Communication between project coordinators	●	●	●	●
Avoid work changes	●	●	●	●
Improved productivity	●	●	●	●
Employee & Client satisfaction reduces delays	●	●		●
Clarity	●	●	●	●
Good supervision	●	●	●	●
Improve the quality	●	●	●	●
Resource conservation	●			●
Cost-effectiveness		●		●

7.5.6 Summary

The verification process mentioned above is intended to verify the importance of the framework outside the organisation. A conceptual framework is built upon presuppositions in its entirety and every idea has an empirical and subjective role. Furthermore, the benefit in using the framework flexibly in both housing and other construction projects to understand all the project's aspects and avoid issues, such as delays, poor quality, and over cost, while also leaving the possibility of including another project was highlighted by the experts. It is to

be noted that the final implementation is the purview of the project manager and in this regard, there is need for her/him to designate a project manager adept at defining a clear vision and presenting it to the team to help achieve the end goals. Moreover, even though the conditions of the projects might vary, the project remains the same.

As is evident in the framework, the variables related to the projects have been determined and chosen thus rendering it effective for implementation. Furthermore, it helps gauge the scope of issues that can cause delay in the housing project. Also, the dependency amongst the variable was subject to the data collected from the Saudi market.

Proposed frameworks can be adapted as per the changes resulting from evolution of arising of new data or texts absent during the initial conceptualization. It is in accordance with the assumption that social phenomena are continuously evolving with time and conceptual frameworks help us understand and work with such phenomena rather than predict them.

7.6 Discussion

The framework outlines a clear, streamlined and viable activity flow, where practitioners can address the most severe delays currently affecting housing projects in the KSA. The conceptual framework is evidence-based, informed by both secondary and primary research data, and it is the product of close engagement with diverse stakeholders' goals. Since the viewpoints incorporated into the design include those of professional researchers, contractors, consultants, and clients. The scope of the conceptual framework is far-reaching, specifically, when combined with its details. The framework takes into consideration effective management practices and quality improvement methods to reduce and prevent delays such as BIM, CPM to site-based methods (Nafkha and Wilinski, 2016), FIDIC contracts, Lean principles and others. Additionally, given the importance of addressing the KSA’s current shortage of adequate, modern housing, it is worth mentioning that the consistent and widespread application of the framework, particularly the government-level initiatives, can be expected to benefit the government’s ability to deliver on its social strategy.

The proposed framework is based on the feedback of experienced professionals. The project manager may take full advantage of the use of the developed

framework through its flexibly for housing and other construction projects eventually. Also, the framework takes in to account all aspects of the project to avoid problems, such as poor quality, cost excess, delays, etc. Furthermore, the project manager should understand well how the ministry of housing handles the projects. Therefore, the framework is offering the possibility of changing positions in the project when necessary. Moreover, it is evident that the project-related variables have been identified and selected making them effective for implementation. This helps to measure the scope of issues that can cause delays in the housing projects. Therefore, the proposed framework can be subject to change resulting from the development of new data that are absent from the initial and actual scenarios. Therefore, the significances derived from the framework are to reduce or prevent delays in construction projects.

In addition, clients have a critical influence on how projects are managed, including health and safety risk management. Whatever the size of the project, they have contractual control, hiring designers, consultants and contractors, as well as setting the budget, scope of work and other resources for the project.

While consultants and contractors should have the skills, experience and organisational ability to work safely and without any delay. Consequently, to ensure control of any delay issues during the project phases, contractors have an important role in planning, managing and controlling works.

7.7 Conclusion

The framework assumes that the project is progressing according to sequential stages. It definitely will improve the performance of the project at each stage by learning from the results of the previous stages. Furthermore, setting goals and reviewing the scope of the project regularly contributes directly to the success of the project which surely will meet the client requirements. The procedures focus on avoiding project delays by identifying a series of actions during the project phases. Also, by defining the most important project tasks, the client can estimate the project milestones, deliverables and completion date. Resources are therefore allocated to tasks and schedules are built on the availability of these resources for the project.

Lastly, the framework identifies and justifies the use of a broad range of management practices and project quality improvement methods for the

mitigation and prevention of delays, ranging from BIM, prequalification, CPM to site-based methods, use of FIDIC contracts and Lean principles.

Moreover, the social phenomena evolve continuously over time and the framework is intended to deliver projects in an effective way ensuring clarity, consistency, collaboration, communication and capability.

CHAPTER 8: CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

The chapter contains the method that was used to investigate the research objectives, as well as to interpret the results.

Many reasons have been reached for the delay in housing construction projects in Saudi Arabia, the most important are changes during construction due to the client. Consequently, most of the projects were subject to delay, so the continuity of this phenomenon greatly affects the development of the construction industry, which may lead to the collapse of some related institutions.

Thus, the chapter provides conclusions for this research, limitations and recommendations. Furthermore, the recommendations will be presented to help improve the performance of the Saudi housing construction sector.

8.1 Conclusions

The purpose of this research project is to identify the factors contributing to delays in the housing construction projects in the Kingdom of Saudi Arabia, and to determine how these delay factors can be mitigated and avoid them using evidence-based solutions. The importance of conducting the study stems from three key considerations: firstly, the KSA's current housing shortage, and particularly a lack of sustainable schemes; secondly, the government's recent and substantial investments in the public-sector housing projects across the KSA; and finally, the importance of promoting the efficiency of investment while improving the availability of affordable housing in the KSA, which can be achieved through the minimisation of construction delays.

In order to explore this area, a mixed-methods research design was adopted, involving both questionnaires and interviews with experienced experts, as well as case studies. In each case, the data collection relied on interaction with KSA-based clients, consultants and contractors. In addition, a literature review was carried out and its main objective was to share with academic researchers and construction professionals' relevant findings related to delay factors in housing construction projects. Although relatively few studies were identified from the literature that had investigated the delay factors affecting the Saudi Arabian housing construction projects while many findings from around the world highlighted the existence of more than 70 delay factors. Furthermore, by

classifying the factors into 10 specific groups, the survey facilitated the identification of the most severe delay factors of each group. However, the collection of the qualitative data from the interviews and case studies permitted a deeper understanding of these delay factors, and a range of KSA-specific practical solutions were presented to avoid them.

Findings with regard to the research objectives

This research was carried out to identify the critical reasons for the delay in housing projects in the KSA. Therefore, primary and secondary data were collected in order to achieve the research objectives.

Critical delay factors were identified and classified through the literature review. Also, construction projects differed according to their type and function. Thus, studies from around the world helped identify many delay factors and which organisation is causing them (client, consultant or contractor). These factors contributed to the classification into ten groups that led to the smooth design of the questionnaire. The positive effect of the above helped the researcher understand the causes of many delays and bridge the research gap, as this contributed to the development of the conceptual framework.

The survey was analysed by Excel and SPSS, and the severity of each delay factor for each group was determined. Also, the highest value of delay factors was evaluated and was caused by the owner's group due to the large number of changes during the construction process and the severity was 3.34. The severity differs from one group to another due to the large number of works during the project stages. In addition, the groups were compared to a T-test to explore the differences between them, whether or not the hypotheses were correct.

Furthermore, experts were interviewed to find out the causes of delays, as well as the sustainability condition in KSA. Many of them agreed that the responsibility lies with the government because not all projects implemented sustainability requirements. In addition, a study and a comparison were performed between two residential projects, in terms of examining the delay factors and the sustainability requirements.

Secondary and primary data contributed to shaping the conceptual framework. The framework sought to provide practical solutions to mitigate or prevent

delays in construction projects. Also, the flexibility to add or change any step in the framework makes it easy to implement.

Therefore, the findings regarding delay factors and their causes generated by the literature review, the survey and the interviews were incorporated into the proposed framework, thereby ensuring the implication of diverse stakeholder viewpoints in order to bolster the framework's practical relevance.

8.2 Limitations

The study aimed to gather opinions from professionals representing various contributors throughout the construction sector, such as consultants and contractors. Therefore, the factors identified in this study derived from research methods, such as quantitative survey and qualitative interviews, so the author was keen to choose the appropriate professionals to collect the targeted data. Furthermore, the survey identified views of a limited number of experts (consultants and engineers), but not all experts of the construction industry in Saudi Arabia, as well as not from all construction projects.

Moreover, there were some limitations in this research. Firstly, the author faced a number of difficulties during this research, especially during data collection. For example, the Ministry of Housing is still conservative in publishing in-depth data about the faltering projects, as well as faltering contractors. Moreover, there is no clear number of cases pending before the courts in this regard between the ministry and contractors, in the belief that they maintain the confidentiality of the work. Therefore, it was extremely difficult to validate the conceptual framework in the Ministry's housing projects.

Also, the development of the conceptual framework is limited to knowledge obtained from the literature and data collected for this purpose, as well as, to professional practices observed by experts.

The last limitation is that since the research specifically targets respondents from a specific country (from Saudi Arabia), this sample can be considered exclusive.

8.3 Recommendations

The first recommendation for mitigating and avoiding the identified delay factors in the KSA's construction industry is for project stakeholders (clients, contractors, consultants, etc.) to apply this study's developed conceptual

framework in the form of a process map. However, the utilisation of suitable conceptual frameworks to guide a flow of work has been associated with improved outcomes in many areas of practice, including the construction sector, and the field of management.

While some frameworks are unsuitable for use as process maps due to their non-linear nature, this study's conceptual framework, clearly illustrates the activity flow for each phase of the construction project lifecycle. Since each component of it represents an actionable measure that stakeholders can undertake to mitigate or avoid a specific delay factor, adherence to the conceptual framework would address many of the root causes of delay. Lastly, its application will definitely help the validation process of this framework for a potential wider implementation in the future housing projects in the KSA.

The second recommendation is concerned with the following interconnected issues. Firstly, the creation of a strategy by which the adoption of this study's conceptual framework in real-world housing construction projects in the KSA can be promoted. Secondly, the use of training and awareness interventions to improve relevant stakeholders' ability to apply the conceptual framework. However, regarding the first issue, organisations, government agencies and interest groups in the KSA could be engaged to promote the conceptual framework's implementation, comparable to the way that organisations such as the National Institute promotes new technology and guidance adoption in their sector. For example, since the financing of all public-sector projects must receive authorisation from the Saudi Ministry of Finance, the government agency could promote adoption of the key aspects of this study's framework when interacting with the project stakeholders.

Regarding the second issue, training and awareness interventions could be organised and provided as a component of the Building Technology Stimulus Programme (BTSP) of the Saudi Ministry of Housing's. Given the technology-oriented focus of many of the framework's elements (e.g., BIM and site-based methods), training in these areas would be constant with the overall theme of the BTSP. Additionally, University-level courses, including those offered at King Fahd University of Petroleum & Minerals (KFUPM, 2019), could train students in novel technologies such as BIM, as well as the advanced planning and management methods needed for delay prevention.

The third recommendation is related to this study's finding that government involvement in various areas of the KSA's construction industry is essential. In

particular, two especially crucial issues were identified by both the primary and secondary data assessed in this research: namely, the promotion of FIDIC contracts and the creation of an independent planning council. With these two issues in mind, the researcher recommends that, in line with the conceptual framework, the KSA's government should involve itself in the mitigation of contract-related delays in the country's public-sector housing projects, specifically through the promotion of FIDIC contracts. Alongside this, the government should establish a dispute adjudication board to facilitate the rapid resolution of contract disputes which can arise at any point within the project lifecycle.

Another area in which the government should be involved relates to the creation of an independent planning council to regulate and manage the country's construction projects. For example, the independent planning council could be modelled on the UK's Construction Leadership Council, the purpose of it is to close the gap between government and industry. In this way, the Saudi independent planning council would be effectively positioned to address diverse delay factors, including manpower shortage and poor communication with project stakeholders.

As a final recommendation, further research initiatives focusing on the promotion of evidence-based policy and effective project management within public-sector housing construction projects should be undertaken across the KSA. This can be facilitated at two distinct levels. Firstly, at the level of the government and secondly, at the level of individual researchers. Regarding the governmental level, it is worth noting that the Saudi Ministry for Labour and Social Development (MSLD) is already working with the Evidence for Policy Design (EPD) team at Harvard Kennedy School (Domash, 2016). As a result, the government is beginning to invest in evidence-based policy research in multiple areas by commissioning studies, but this approach should also be pursued by all the country's ministries, including the Ministry of Housing to benefit the construction industry as one of the most important sectors. This would facilitate the emergence of useful evidence for policymaking regarding the most effective ways to design, implement, test and refine policies intended to mitigate delay factors in housing projects. Regarding the second level, individual researchers should themselves consider undertaking further research in this area.

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APPENDIX-A

NTU ETHICAL APPROVAL FORMS

NOTTINGHAM TRENT UNIVERSITY

JOINT INTER COLLEGE ETHICS COMMITTEE

ETHICAL CLEARANCE CHECKLIST

College of Art, Architecture, Design and Humanities; College of Science and Technology; and the Centre for Academic Development and Quality (CADQ)

(TO BE COMPLETED FOR *ALL* INVESTIGATIONS INVOLVING PARTICIPANTS)

All staff and PGR students wishing to conduct an investigation involving participants in order to collect new data in either their research projects or teaching activities are required to complete this checklist before commencement. It may be necessary after completion of this form to submit a full application to the Joint Inter College Ethics Committee (JICEC). Collecting primary data in the absence of ethical approval, or in the face of an adverse ethical opinion, may constitute a disciplinary offence.

If, after receiving ethical approval, factors beyond your control change your project such that the information provided in this form no longer holds, the approval will automatically become void, and you should re-apply for ethical approval. The approval process should take no longer than one month.

IF YOUR RESEARCH IS BEING CONDUCTED OFF CAMPUS AND ETHICAL APPROVAL FOR YOUR STUDY HAS BEEN GRANTED BY AN EXTERNAL ETHICS COMMITTEE, PLEASE SEND DETAILS TO THE PROFESSIONAL SUPPORT RESEARCH TEAM FOR CONSIDERATION BY THE CHAIR. YOU WILL BE EXPECTED TO PROVIDE EVIDENCE OF APPROVAL FROM THE EXTERNAL ETHICS COMMITTEE AND THE TERMS ON WHICH THIS APPROVAL HAS BEEN GRANTED.

IF YOUR RESEARCH IS TRANSFERRING INTO NOTTINGHAM TRENT UNIVERSITY AND APPROVAL WAS OBTAINED FROM YOUR ORIGINATING INSTITUTION, THERE IS A REQUIREMENT ON THE UNIVERSITY TO ENSURE THAT APPROPRIATE APPROVALS ARE IN PLACE.

If you believe either of these statements applies to your research, please contact the Professional Support Research Team AHDResearchteam@ntu.ac.ukwith evidence of former approval and the terms on which this approval has been granted.

IT IS THE RESPONSIBILITY OF INDIVIDUAL INVESTIGATORS AND/OR SUPERVISORS TO ENSURE THAT THERE IS APPROPRIATE INSURANCE COVER FOR THEIR INVESTIGATION.

If you are at all unsure about whether or not your study is covered, please contact the Finance & Planning Manager in your Finance team to check.

Name of Applicant:	FALAH ALHARBI		
School:	Architecture, Design and Built Environment		
Title of Investigation:	Critical Delay Factors in Public Sector Housing Projects in KSA: Assessment and Solutions		
STAFF	☐	STUDENT	✓(*if student, please complete)
RESEARCH	☐	CONSULTANCY	☐
Degree Title and Level*:	PhD/ 1ST YEAR		
Supervisor (List Lead supervisor first)	1. Dr. HYNDA AOUN KLALIB 2. Prof. BENACHIR MEDJDOUB		
Names of co-investigators (CIs) (If any of the CIs are not employed at NTU, please give the name of their organisation)			
Project start date	5TH JANUARY 2017		
Estimated end date of the project	4TH JANUARY 2020		
Who is funding the project? Has funding been confirmed?	SELF-FUNDED YES		
Briefly outline the objectives of the research. [75 words]			

Research objectives:

- Identification of the delay factors and their reasons in the public sector housing projects.
- Classification of the delay factors in the public sector housing projects.
- Analysis and evaluation of delay causes in the public sector housing projects.
- Solutions proposal to eradicate the identified delay factors.

Specific objective:

The researcher seeks to find solutions that lead to the elimination of delay factors in construction projects through the development of a framework to reach quality in work and create a structured management method.

Briefly describe the principal methods, the sources of data or evidence to be used, and the number and type of research participants who will be recruited to the project. [150 words]

Methodology:

The study involves a blend of quantitative & qualitative data analysis to relate the questionnaire information and comes into contact with the research goals. This study endorses a mixed method approach to achieve reliable data..

Questionnaires:

These prove to be useful and a consistent method when researchers need information from a large population. Good statistical analysis is significant when the amount of data presented is substantial to precisely show patterns. They also function as an applied strategy towards the objectives mentioned above. Researchers can gather information on specific components and general mechanisms by using properly made questionnaires.

In order to collect large volumes of data in an organised process, this method is indispensable. As a result the quantitative data will be tested using SPSS software or MS Excel which will prove to be helpful.

Interviews:

Interview method has many benefits, one of which is that it seeks professionals' opinions and motives.. When researchers need more conclusive results of a circumstance otherwise not able to produce information on the subject, interviews take over as the best fit.

Do you intend to use questionnaires, scales, psychometrics, vignettes, etc that someone else has published?

- No

If YES, complete the next 3 questions
If NO, proceed 4 questions

Have you included with this application a full electronic copy or link to the above?

A. **Familiarisation with policy** - Please answer *as appropriate*			
Please confirm if you are fully acquainted with the policies for guiding ethical research named below:			
NTU research ethics policy, and the procedures for ethical approval	**Yes✓**	No☐	N/A☐
The guidelines for ethical research promulgated by a professional association, as appropriate	**Yes✓**	No☐	N/A☐
NTU Data Management Policy	**Yes✓**	No☐	N/A☐
The Regulations for the Use of Computers (*see* NTU website)	**Yes✓**	No☐	N/A☐
Guidelines for Risk Assessment in Research	**Yes✓**	No☐	N/A☐
If you answered **NO** to any of these questions, please note that you must study these guidelines and regulations before proceeding to complete the remainder of this form.			

B. **External Ethical Review** – *Please answer as appropriate*			
Has a favourable ethical opinion already been given for this project by any other external research ethics committee[1]? An external research ethics committee means any research committee *other* than those at Nottingham Trent University. Submission of this form is *not* a submission to an external research ethics committee.	Yes☐	**No✓**	N/A☐
Will this project be submitted for ethical approval to any other external research ethics committee[2]? An external research ethics committee means any research committee *other* than those at Nottingham Trent University. Submission of this form is *not* a submission to an external research ethics committee.	Yes☐	**No✓**	N/A☐
If you answered **YES** then sign the declaration and submit with the letter of confirmation to the Research Office to keep on file.			

C. **Investigators**			
Do investigators have previous experience of, and/or adequate training in, the methods employed?		**Yes✓**	No**☐
If involved will junior researchers/students be under the direct supervision of an experienced member of staff?	**Yes✓**	No**☐	N/A☐
If involved will junior researchers/students be expected to undertake physically invasive procedures (not covered by a generic protocol) during the course of the research?	Yes**☐	**No✓**	N/A☐
Are researchers in a position of direct authority with regard to participants (e.g. academic staff using student participants, sports coaches using his/her athletes in training)?	Yes**☐	**No✓**	N/A☐
** If you select ANY answers marked **, please submit your completed Ethical Clearance Checklist accompanied by a statement covering how you intend to manage the issues (indicated by selecting a ** answer) to the JICEC.			

D. **Participants**		
Clarify whether or not your research involves any do the following vulnerable groups.		
Children under 18 years of age (please refer to published guidelines)	Yes*☐	**No✓**
People over 65 years of age	Yes*☐	**No✓**
Disabled people	Yes*☐	**No✓**
People with mental illness	Yes*☐	**No✓**
Prisoners/Detained persons	Yes*☐	**No✓**
Is a DBS/Overseas Police Check required?	Yes☐	**No✓**
If required, do you have a DBS/Overseas Police Check?	Yes☐	**No✓**

[1] This includes the research ethics committee of another academic institution.
[2] This includes the research ethics committee of another academic institution.

Please contact NTU Disclosures, details can be found on the address book.		
What actions will you take to ensure the safety of yourself and the participants? **1. All research participants will be provided with a research code, known only to the researcher to ensure that their identity remains anonymous and confidential.** **2. The details of participants must be stored on a protected computer (Accessed by the researcher only).** **3. All data collected, such as questionnaires, must be coded and unnamed, hard paper copies of data should be stored securely.** **4. All publications of data should be written in a way so as to disguise the identity of the research participants involved. Data should not be used which can identify an individual unless prior consent has been obtained from the individual involved.** **5. They have their right to withdraw at any time.**		
How will you recruit your participants? **The questionnaires will be distributed to several individuals such as client representatives, consultants and contractors in the KSA. The research population will include contractors registered under the Central Tenders Committee, consultants registered under the Ministry of Municipality in the KSA and client representatives from the Ministry of Housing and Saudi council of engineering. The questionnaires will be prepared in English and distributed through the internet using Survey-Monkey.** **Also, the interviews will be chosen from the same sample above.**		
Have you completed a risk assessment form? Please attach to the application.	Yes*☐	**No✓**

Risk		
To the best of your knowledge, please indicate whether the proposed study:		
Involves procedures likely to cause psychological, social or emotional distress to participants	Yes*☐	**No✓**
Is designed to be challenging psychologically in any way	Yes*☐	**No✓**
Exposes participants to risks or distress greater than those encountered in their normal daily life	Yes*☐	**No✓**

E. Special Risks		
Does the project involve access to websites normally prohibited on university servers, for example pornography or sites of organisations proscribed by the UK Government.	Yes*☐	**No ✓**
Does the project involve access to investigation into extremism or radicalisation.	Yes*☐	**No ✓**
Does the project involve accessing and using data of a potentially damaging nature which has been obtained from a source which may not have the requisite authority to provide it. Here, potentially damaging can mean anything from information on cases of domestic abuse to data on international spy networks. In case of uncertainty please consult the Research Support Office or your School Associate Dean for Research.	Yes*☐	**No ✓**
Does the project involve the acquisition of security clearances, including the Official Secrets Act.	Yes*☐	**No ✓**
If you responded yes to any of these questions then this is classified as 'Special Risk Research' please refer to the guidance in Appendix B and ensure that these items are covered in the Risk Assessment (Appendix A). Please note that your application must be approved by your School Associate Dean for Research. This applies to both members of staff and Postgraduate Research Students.		
Is there any foreseeable risk that your project may lead to:		
Physical harm to participants or researchers?	Yes*☐	**No ✓**
Significant psychological or emotional distress to participants • i.e. Is designed to be challenging psychologically in any way • Exposes participants to risks or distress greater than those encountered in their	Yes*☐	**No ✓**

normal daily life			
Harm to the reputation of participants, or their employers, or of any other persons or organisations?		Yes*☐	No ✓
Chaperoning Participants **If appropriate,** e.g. studies which involve vulnerable participants, taking physical measures or intrusion of participants' privacy:			
Will participants be chaperoned by more than one investigator at all times?	Yes☐	No*☐	N/A✓
Will at least one investigator of the same sex as the participant(s) be present throughout the investigation?	Yes☐	No*☐	N/A✓
Will participants be visited at home?	Yes*☐	No ☐	N/A✓

If you have selected N/A please provide a statement in the space below explaining why the chaperoning arrangements are not applicable to your research proposal:

Interviews will be conducted in the work environment and government organisations (their site). All of them are adults in the work environment. The research proposal does not require the chaperone arrangements because the research work will be with a decision makers and consumers to collect data by interviews and questionnaire for critical delays factors in housing projects in the KSA. Furthermore, no special arrangements are needed for define gender and no need for a home visit.

If you have selected any of the * answers for any question in section E please explain/confirm:

- Explain why it is necessary to conduct the research in such a way as to qualify it as Special Risk research
- If applicable, confirm that access to websites which may be proscribed by the UK Government or may be subject to surveillance by security services will be undertaken using the University network
- Explain what, if any, steps will be taken, in addition to those listed in Section 6, to ensure that data obtained during the research project will be stored securely
- If applicable, confirm that the transmission of data obtained during the research project to any co-investigators outside of the University network will be in encrypted format and using Zend, which encrypts files during transmission.
- If applicable, explain why the transportation of research data or materials is required and that an encrypted memory stick will be used where such transportation is necessary or unavoidable

If the answer to <u>any</u> of the remaining questions is YES, please explain:

- the nature of the risks involved, and why it is academically necessary for the project to incur them
- how you propose to mitigate them
- the arrangements by which you will ensure that participants understand and consent to these risks
- any arrangements you will make to refer participants to sources of help, if they are seriously distressed or harmed as a result of taking part in the project
- your arrangements for recording and reporting any adverse consequences of the research

Advice to Participants following the investigation Investigators have a duty of care to participants. When planning research, investigators should consider what, if any, arrangements are needed to inform participants (or those legally responsible for the participants) of any health related (or other) problems previously unrecognised in the participant. This is particularly important if it is believed that by not doing so the participants well-being is endangered. Investigators should consider whether or not it is appropriate to recommend that participants (or those legally responsible for the participants) seek qualified professional advice, but should not offer this advice personally. Investigators should familiarise themselves with the guidelines of professional bodies associated with their research.

F. **Observation/Recording** - *Please answer: yes or no*		
Does the study involve data collection, or the observation or recording of participants? Note that data collection includes the re-use of material originally collected for a non-research purpose (e.g. client or student data already in your possession) and includes anonymous data	Yes✓	No☐
Will those contributing to the data collected (or being observed or being recorded), or the appropriate authority, be informed that the data collection, observation or recording will take place?	Yes✓	No☐
If you have answered **NO** to question to the first question in section E, because you are not undertaking empirical work, proceed to the declaration at the end of this form. If you have answered **NO** to question the second question, an application for ethical approval needs to be made to the JICEC.		

G. **Consent and Deception** - *Please answer: yes or no*		
Informed Consent & Data Withdrawal Will participants, or the appropriate authority, be fully informed of the objectives, and of all other particulars of the investigation (preferably at the start of the study, but where this would interfere with the study, at the end)?	Yes✓	No☐
Will participants, or the appropriate authority, be fully informed of the use of the data collected (including, where applicable, ownership of any intellectual property arising from the research)?	Yes✓	No☐
For detained persons, members of the armed forces, employees, students and other persons who may not be in a position to give fully independent consent, will care be taken over the gaining of freely informed consent? **NOT APPLICABLE**	Yes☐	No☐
If your research involves children under the age of 18 or participants who have impairment of understanding or communication:		
- will consent be obtained (either in writing or by some other means)? **N / A**	Yes☐	No*☐
- will consent be obtained from parents or other suitable person? **N / A**	Yes☐	No*☐
- will they be informed that they have the right to withdraw regardless of parental/ guardian consent? **N / A**	Yes☐	No*☐
For investigations conducted in schools, will approval be gained in advance from the Head-teacher and/or the Director of Education of the appropriate Local Education	Yes☐	No*☐

Authority? **N / A**		
For detained persons, members of the armed forces, employees, students and other persons judged to be under duress, will care be taken over gaining freely informed consent? **N / A**	Yes☐	No*☐
Will participants, or the appropriate authority, be informed of their right to withdraw from the investigation at any time (or before a specific deadline) and to require their own data to be destroyed?	Yes✓	No*☐
Deception		
Is deception part of the study? **NOT APPLICABLE** If the answer is no, proceed to section G	Yes☐	No*☐
If yes, please explain the rationale and nature of deception (50-75 words): **NOT APPLICABLE**		
Will participants be de-briefed and the true object of the research revealed at the earliest stage upon completion of the study? **N / A**	Yes☐	No*☐
Has consideration been given on the way that participants will react to the withholding of information or deliberate deception? **N / A**	Yes☐	No*☐

G. Storage of Data and Confidentiality		
Please see University guidance on https://www.ntu.ac.uk/intranet/policies/legal_services/data_protection/16231gp.html. If you are a member of NTU staff you can obtain direct access to this with your staff username and password. If you are not a member of NTU staff, please request of copy from your supervisor or course leader.		
Does the funder of your research require you to comply with policy around data management planning and access to publically funded research (RCUK funders, Horizon 2020, Welcome Trust, etc). If yes, please attach your data management plan (please use https://dmponline.dcc.ac.uk/ to design your plan based around your funder's requirements. If you have any queries or require support please email: LIBResearchTeam@ntu.ac.uk).	Yes☐	No✓
Will all information on participants be treated as confidential and not identifiable unless agreed otherwise in advance, and subject to the requirements of the law of the relevant jurisdiction?	Yes✓	No☐
Will storage of data comply with the Data Protection Act 1998 and the law of any non-UK jurisdiction in which research is carried out? **All data will be saved anonymously**	Yes✓	No☐
Will any video/audio recording of participants be kept in a secure place and not released for use by third parties? **N / A**	Yes☐	No☐
Will video/audio recordings be destroyed within six years of the completion of the investigation? **N / A**	Yes☐	No☐
If your study involves video/photography please ensure that participants have completed a release form.		

Have you taken steps to ensure full security and confidentiality of any personal or confidential data collected for the project. **All data collected will be saved in protected place.**	Yes✓	No☐
I confirm that any data will be stored in line with the University Data Management Policy. Files will be stored in a password protected computer with data coded and anonymised appropriately.	Yes✓	No☐

H. Incentives		
Have incentives (other than those contractually agreed, salaries or basic expenses) been offered to the investigator to conduct the investigation?	Yes**☐	No✓
Will incentives (other than basic expenses) be offered to potential participants as an	Yes**☐	No✓

** If you select ANY answers marked **, please submit your completed Ethical Clearance Checklist accompanied by a statement covering how you intend to manage the issues (indicated by selecting a ** answer) to the JICEC.
The design of the participant information sheet/consent form and of any research instrument (including questionnaires, sampling and interview schedules) that will be used, have been discussed with my supervisor(s).
Compliance with Ethical Principles If you have completed the checklist to the best of your knowledge and selected an answer marked with * or ** your investigation you will need to seek full formal approval from the JICEC. Please return to completed Ethical Approval Checklist with the following documents as necessary to the Research Team, Arkwright 204, City Campus, or via email AHDresearchteam@ntu.ac.uk: • A copy of the research tool you are using • Consent Form (if necessary) • Data Management Policy (if necessary) • Risk Assessment (if necessary) Please note that the ethics form does not abrogate your need to complete a risk assessment

Declaration ✓I have read the Ethics & Governance Statement https://www.ntu.ac.uk/research/research-at-ntu/research-integrity . I confirm that the above named investigation complies with published codes of conduct, ethical principles and guidelines of professional bodies associated with my research discipline. ✓I have read this form and confirm that appropriate steps have been taken to mitigate the special risks associated with the proposed project. ✓I agree to notify the Research Office of any changes or modification that may have an influence on ethical approval.	
Signature of Applicant *(Research Student or Principal Investigator)* Date	FALAH ALHARBI N0667232 
Signature of Supervisor/Line Manager *(Director of Studies/ATL)* Date	Dr. HYNDA AOUN KLALIB 
Signature of JICEC Chair Date	

APPENDIX-B

EXPERTS SURVEY

The Survey

Dear Participant:

Please answer these questions by ticking the appropriate answer below. The response should belong to your experience in construction field.

Note: The data will be treated with confidence and confidentiality.

Section I – Personal information

1. Type of work?
   - ☐ Consultant
   - ☐ Contractor
   - ☐ Client / Representative of the client
2. Education?
   - ☐ Diploma
   - ☐ Bachelor
   - ☐ Master
   - ☐ PhD/Doctorate
3. Years of experiences?
   - ☐ < 5
   - ☐ 6 - 10
   - ☐ 11 – 15
   - ☐ > 15
4. Your position?
   - ☐ Engineer
   - ☐ Site manager
   - ☐ Project manager
   - ☐ General manager
5. What are the organisations involved?
   - ☐ Public
   - ☐ Private
   - ☐ Both
6. What is your speciality?
   - ☐ Governmental
   - ☐ Commercial
   - ☐ Residential
   - ☐ Industrial

Section II – The project performance

1. How many construction projects did you participate in?
   - ☐ < 15
   - ☐ 16 - 30
   - ☐ 31 – 45
   - ☐ > 45
2. Were there any delays?
   - ☐ Yes
   - ☐ No
   - If NO, please go to ***Section III***
3. Percentage of projects delayed?
   - ☐ 20%
   - ☐ 40%
   - ☐ 60%
   - ☐ 80%
4. Percentage of delays during the project?
   - ☐ < 20 %
   - ☐ 21% - 40 %
   - ☐ 41% - 60%
   - ☐ 61 % - 80%
   - ☐ 81% - 100 %
5. Who was responsible for the delay?
   - ☐ Client
   - ☐ Consultant
   - ☐ Contractor
   - ☐ Sub-contractor

Section III – The Delay Factors

- Ranking of delay factors:

	Impact			
Scale	1	2	3	4
	No-effect	Fairly-severe	Severe	Very severe

Delays factor	***Severity***			
	1	**2**	**3**	**4**
1- Related to contractor				
1. Absence of motivation for staff	1	2	3	4
2. Deficiency of contractor 'managerial staff	1	2	3	4
3. Deficiency in specialised experts in the contractor's team	1	2	3	4
4. Poor contractor communication with all parties in the project	1	2	3	4
5. Delays in order modifications by the contractor	1	2	3	4
6. Insufficient contractor's head office implication in the task	1	2	3	4
7. Slowness of mobilisation	1	2	3	4
8. Poor contractor's control of the subcontractor	1	2	3	4
9. Poor safety rules and regulations in contractor's team	1	2	3	4
10. Inadequate contractor's qualifications for the allocated project	1	2	3	4
11. Unsuccessful planning during the project by the contractor	1	2	3	4
12. Delays by the contractor in surveys	1	2	3	4
13. Ineffectual control by the contractor of project progress	1	2	3	4
14. Inefficient control by the contractor of project quality	1	2	3	4
15. Delays in document submissions (contractor)	1	2	3	4
16. Incorrect methods performed by the contractor	1	2	3	4
17. Contractor's financial difficulties	1	2	3	4
18. Poor communication among the contractor and other parties	1	2	3	4
19. Sub-contractors work delays	1	2	3	4
20. Payments difficulties (with subcontractor)	1	2	3	4
21. Incompetence of the technical staff	1	2	3	4
22. Mismanagement of the site by the contractor	1	2	3	4
23. Corrective activities following construction phase	1	2	3	4

1- Related to Client

1.	Shortage in the construction experience	1	2	3	4
2.	Incorrect feasibility study	1	2	3	4
3.	Lack of knowledge of the field	1	2	3	4
4.	Delays in making decisions	1	2	3	4
5.	Slow coordination with the contractors	1	2	3	4
6.	Contract changes	1	2	3	4
7.	Financial difficulties (with contractor)	1	2	3	4
8.	Slow delivery of the site by the client	1	2	3	4
9.	Unreasonable contract duration	1	2	3	4
10.	Slow settlement claims	1	2	3	4
11.	Delays by the client in issuing modifications orders	1	2	3	4
12.	Slow decisions from the head office	1	2	3	4
13.	Client participation in the construction phases	1	2	3	4
14.	Slow payments to the contractor	1	2	3	4

2- Related to Consultant

39.	Low efficiency of consultant's staff in the project.	1	2	3	4
40.	Delays in drawings	1	2	3	4
41.	Delay in agreeing on contractor's reports	1	2	3	4
42.	Designing delays	1	2	3	4
43.	Poor supervision and bad response	1	2	3	4
44.	Absence of consultant's staff on the site	1	2	3	4
45.	Delays in making decisions	1	2	3	4
46.	Insufficient documentation	1	2	3	4
47.	Delays in giving instructions	1	2	3	4
48.	Lack of communication	1	2	3	4

3- Related to Materials

49.	Shortage of materials	1	2	3	4
50.	Delivery delay	1	2	3	4
51.	Changes in prices	1	2	3	4
52.	Changes of specifications	1	2	3	4

4- Related to Equipment

53.	Shortage of equipment	1	2	3	4
54.	Equipment's failure	1	2	3	4
55.	Excavation problems	1	2	3	4
56.	Delay in delivery	1	2	3	4

1- Related to Manpower

57. Manpower shortage	1	2	3	4
58. Poor manpower skills	1	2	3	4
59. Strikes or conflict	1	2	3	4

2- Related to Design & Planning

60. Changes to the scope of work	1	2	3	4
61. Errors and conflicting specifications	1	2	3	4
62. Differences in site status and contract documents	1	2	3	4
63. Short contract duration	1	2	3	4

3- Related to External Factors

60. Weather conditions	1	2	3	4
61. Increase of materials prices	1	2	3	4
62. Shortages in the market for tools & equipment	1	2	3	4
63. Poor site conditions (soil, etc.)	1	2	3	4
64. Changing economic situations (inflation, etc.)	1	2	3	4
65. Delays in the test of materials samples	1	2	3	4
66. Delay in the coordination with other government departments	1	2	3	4
67. Problems with neighbours	1	2	3	4
68. Delays in clearance	1	2	3	4
69. Unclear regulation	1	2	3	4
70. Rework of defects in construction	1	2	3	4

4- Related to Contractual Relationship

71. Weak coordination and communication between all parties	1	2	3	4
72. Overlap between different contractor's operations	1	2	3	4
73. Disputes	1	2	3	4

5- Related to the Contract

74. Complication of the design	1	2	3	4
75. Conflict in the specifications	1	2	3	4
76. Errors in the drawings	1	2	3	4
77. Insufficient detail in the construction contract	1	2	3	4
78. Penalties	1	2	3	4

Any comments:

.....

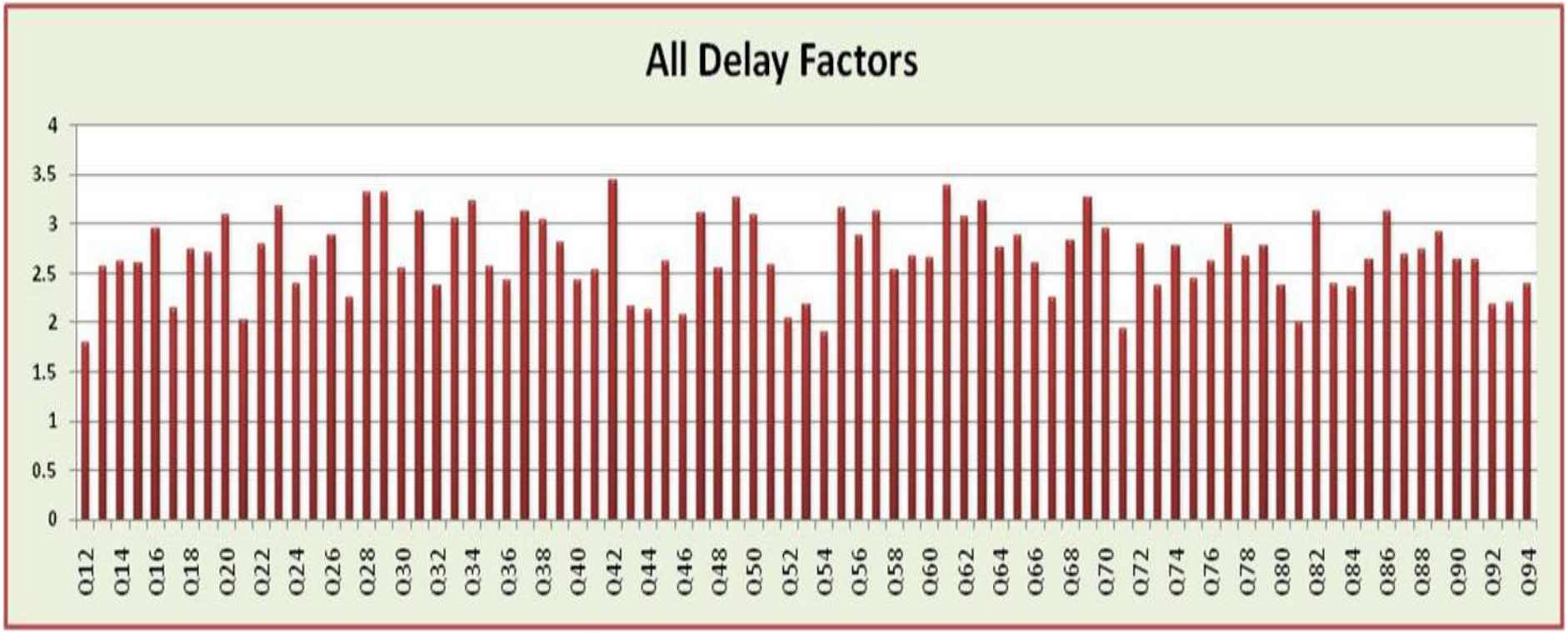
.....

.....

Thank you

APPENDIX-C

ALL DELAY FACOTRS



- **ALL DELAY FACTORS CHART**

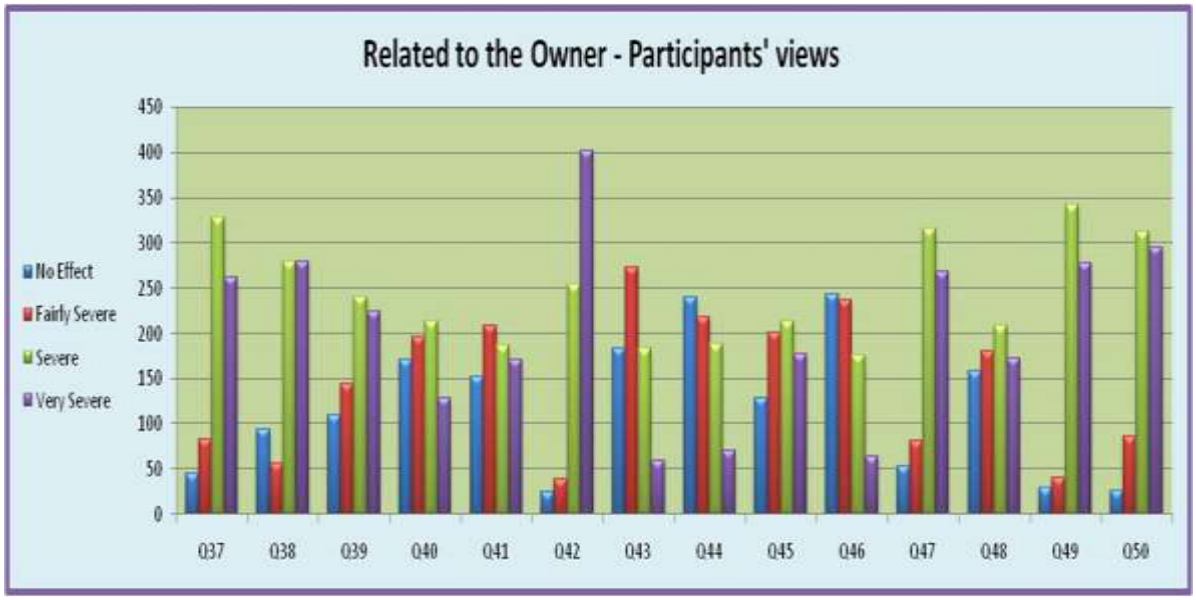
- **All delay factors and severity impact**

Ref.	*All Delay Factors*	*SI*
Q12	Absence of motivation of contractor's staff	1.8
Q13	Deficiency in contractor’s managerial staff	2.57
Q14	Deficiency in specialised experts in the contractor’s team	2.61
Q15	Poor contractor communication with all parties in the project	2.59
Q16	Poor contractor coordination with all parties in the project	2.94
Q17	Delays in order modifications	2.14
Q18	Insufficient contractorhead office implication in the task	2.73
Q19	Slowness of mobilisation	2.7
Q20	Poor contractor’s control of the subcontractor	3.08
Q21	Poor safety rules and regulations in contractor’s team	2.02
Q22	Inadequate contractor’s qualifications for the allocated project	2.79
Q23	Unsuccessful planning during the project by the contractor	3.17
Q24	Delays by the contractor in surveys	2.38
Q25	Ineffectual control by the contractor of project progress	2.66
Q26	Inefficient control by the contractor of project quality	2.87
Q27	Delays in document submissions (contractor)	2.25
Q28	Incorrect construction methods performed by the contractor	3.32
Q29	Contractor’s financial difficulties	3.31
Q30	Poor communication by the contractor	2.55
Q31	Sub-contractors work delays	3.12
Q32	Payments difficulties (with subcontractor)	2.37
Q33	Incompetence of the skilled staff	3.06
Q34	Poorsite managementby the contractor	3.23
Q35	Corrective activities following construction phase	2.57
Q37	Shortage in the construction experience	3.12
Q38	Incorrect feasibility study	3.03
Q39	Lack of knowledge of the field	2.8
Q40	Delays in making decisions	2.42
Q41	Slow coordination with the contractors	2.52
Q42	Contract changes	3.43
Q43	Financial difficulties (with contractor)	2.16
Q44	Slow delivery of the site by the owner	2.12
Q45	Unreasonable contract duration	2.61
Q46	Slow settlement claims	2.08
Q47	Delays by the owner in issuing modifications orders	3.11
Q48	Slow decision making by the head office	2.55
Q49	Owner participation in the construction phases	3.26
Q50	Slow payments to the contractor	3.08
Q51	Low efficiency of consultant’s staff in the project.	2.58
Q52	Designing delays	2.03
Q53	Delay in the agreement of contractor reports due to the consultant	2.17
Q54	Delays in drawings	1.89
Q55	Poor supervision and bad response	3.15
Q56	Absence of consultant’s staff on the site	2.88

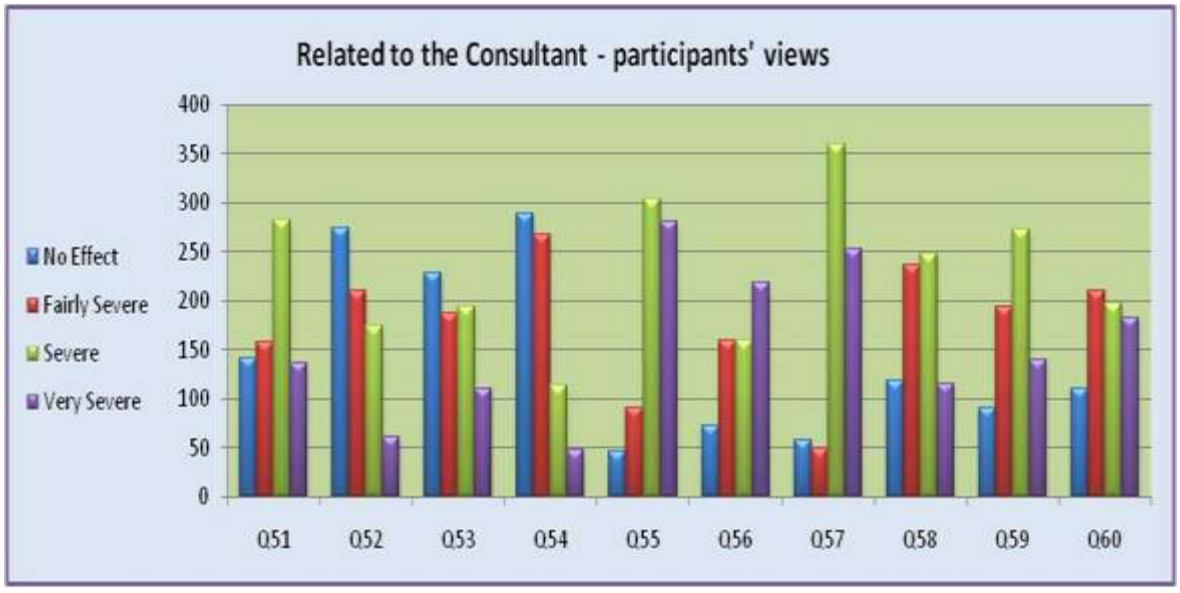
Q57	Delays in making decisions	3.12
Q58	Insufficient documentation	2.53
Q59	Delays in giving instructions	2.66
Q60	Lack communication by the consultant	2.65
Q61	Shortage of materials	3.39
Q62	Delivery delay	3.07
Q63	Changes in prices	3.22
Q64	Changes of specifications	2.76
Q65	Shortage of equipment	2.88
Q66	Delay in delivery	2.82
Q67	Equipment's failure	2.6
Q68	Excavation problems	2.24
Q69	Manpower shortage	3.27
Q70	Poor manpower skills	2.95
Q71	Strikes or conflict	1.94
Q72	Changes to the scope of work	2.79
Q73	Errors and conflicting specifications and drawings	2.37
Q74	Difference between the site conditions and the contract documents	2.77
Q75	Short contract duration	2.44
Q76	Weather conditions	2.61
Q77	Increase of materials prices	2.99
Q78	Shortages in the market for tools & equipment	2.66
Q79	Poor site conditions (Soil, etc.)	2.77
Q80	Poor economic conditions (inflation, etc.)	2.37
Q81	Delays in the test of materials samples	2
Q82	Delay in the coordination with other government departments	3.13
Q83	Problems with neighbours	2.39
Q84	Delays in clearance	2.36
Q85	Unclear regulation	2.64
Q86	Rework of defects in construction	3.13
Q87	Weak coordination and communication between all parties	2.69
Q88	Overlap between different contractor’s operations	2.74
Q89	Disputes	2.92
Q90	Complication of the design	2.64
Q91	Conflict in the specifications	2.63
Q92	Errors in the drawings	2.18
Q93	Insufficient detail in the construction contract	2.19
Q94	Penalties	2.39

Sample of charts

- **Related to Owner/Client**



- **Related to Consultant**



APPENDIX-D

T TEST REPORT

Project Report – T Test

Loading the required packages:

```
library(dplyr)
library(ggplot2)
library(readxl)

##install.packages("readxl")

setwd("C:\\Users\\1012233\\Downloads\\20200106 -  T Test in R")

   contractor_data <- read_excel("T-Test_Data.xlsx", sheet = 1)
        owner_data <- read_excel("T-Test_Data.xlsx", sheet = 2)
   consultant_data <- read_excel("T-Test_Data.xlsx", sheet = 3)
     external_data <- read_excel("T-Test_Data.xlsx", sheet = 4)
```

1: T-Test between factors related to Client and External factors

```
t.test(external_data$Severity,client_data$Severity)

##
##  Welch Two Sample t-test
##
## data:  external_data$Severity and client_data$Severity
## t = -0.58867, df = 22.994, p-value = 0.5618
## alternative hypothesis: true difference in means is not equal to
0
## 95 percent confidence interval:
##  -0.4247428  0.2365609
## sample estimates:
## mean of x mean of y
##  2.640909  2.735000
```

2: T-Test between factors related to Contractor and External factors

```
t.test(external_data$Severity,contractor_data$Severity)

##
##  Welch Two Sample t-test
##
## data:  external_data$Severity and contractor_data$Severity
## t = -0.44551, df = 22.516, p-value = 0.6602
## alternative hypothesis: true difference in means is not equal to
0
## 95 percent confidence interval:
##  -0.3408572  0.2201754
## sample estimates:
## mean of x mean of y
##  2.640909  2.701250
```

3: T-Test between factors related to Consultant and External factors

```
t.test(external_data$Severity,consultant_data$Severity)
##  Welch Two Sample t-test
##
## data:  external_data$Severity and consultant_data$Severity
## t = 0.43385, df = 17.487, p-value = 0.6697
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.2886051  0.4384233
## sample estimates:
## mean of x mean of y
##  2.640909  2.566000
```

4: T-Test between factors related to Contractor and Consultant

```
t.test(contractor_data$Severity,consultant_data$Severity)
##  Welch Two Sample t-test
##
## data:  contractor_data$Severity and consultant_data$Severity
## t = 0.84642, df = 16.226, p-value = 0.4096
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.2031095  0.4736095
## sample estimates:
## mean of x mean of y
##   2.70125   2.56600
```

5: T-Test between factors related to Client and Consultant

```
t.test(client_data$Severity,consultant_data$Severity)
##  Welch Two Sample t-test
##
## data:  client_data$Severity and consultant_data$Severity
## t = 0.93405, df = 19.987, p-value = 0.3614
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.2084338  0.5464338
## sample estimates:
## mean of x mean of y
##     2.735     2.566
```

6: T-Test between factors related to Contractor and Client

```
t.test(contractor_data$Severity,client_data$Severity)
##  Welch Two Sample t-test
##
## data:  contractor_data$Severity and client_data$Severity
## t = -0.23142, df = 25.499, p-value = 0.8188
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.3338109  0.2663109
## sample estimates:
## mean of x mean of y
##   2.70125   2.73500
```

Finally, the formula used to calculate the Welch t-statistic in each of the tests was the following:

$$t = \frac{\mu_1 - \mu_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}},$$

Where μ_1 and μ_2 denote the means of the two groups, S_1 and S_2 represent the standard deviations of the two groups, and n_1 and n_2 refer to the sizes of each groups. A worthwhile point to note is that, as indicated by the alternative name often used to refer to the Welch t-test (namely, the unequal variances t-tests), the t-statistic formula given above compares the variances of the two groups (i.e., S^2_1 and S^2_2).

APPENDIX-E

EXPERT INTERVIEW QUESTIONS – PHASE ONE AND PHASE TWO

Interview Questions - phase one

SECTION: This section provides questions for the interview – Phase 1.

1. Please:
    a. Provide a description of the qualifications, both technical and managerial, of the people in charge of the project.
2. Are there any variations, claims, and requests for the extension of time in this project? Please provide their history in brief and explain how they have affected the project.
3. In (2), in case delays arising, who takes responsibility?
4. What strategies do you think can be implemented in the construction and housing sector in the KSA to reduce or eliminate delays?
5. According to your experience, what is the environmental factor that you think affects the timely completion of projects in the KSA?
6. Do you think the existence of a housing and construction authority in the KSA would help in reducing the delays in project accomplishment-time?
7. (From Government Representative). Since you are a government employee, have you noticed that construction bids are always awarded to the lowest bidder? Do you think this mentality contributes to project delays?
8. (From the contractor) Do you think that the lack of proper evaluation of tenders and knowledge for doing so is what leads to project delays?
9. According to you, and based on the experience that you have gained over time, what do you think are the most common effects of the delays that arise in constructon projects? Please describe the impact of these delays.
10. What measures do you usually take to minimise the effect of delays whenever they arise?
11. What strategies do you recommend for addressing and harnessing the delays that occur in the construction project to facilitate the successful completion and delivery of the project?

Interview question – phase two

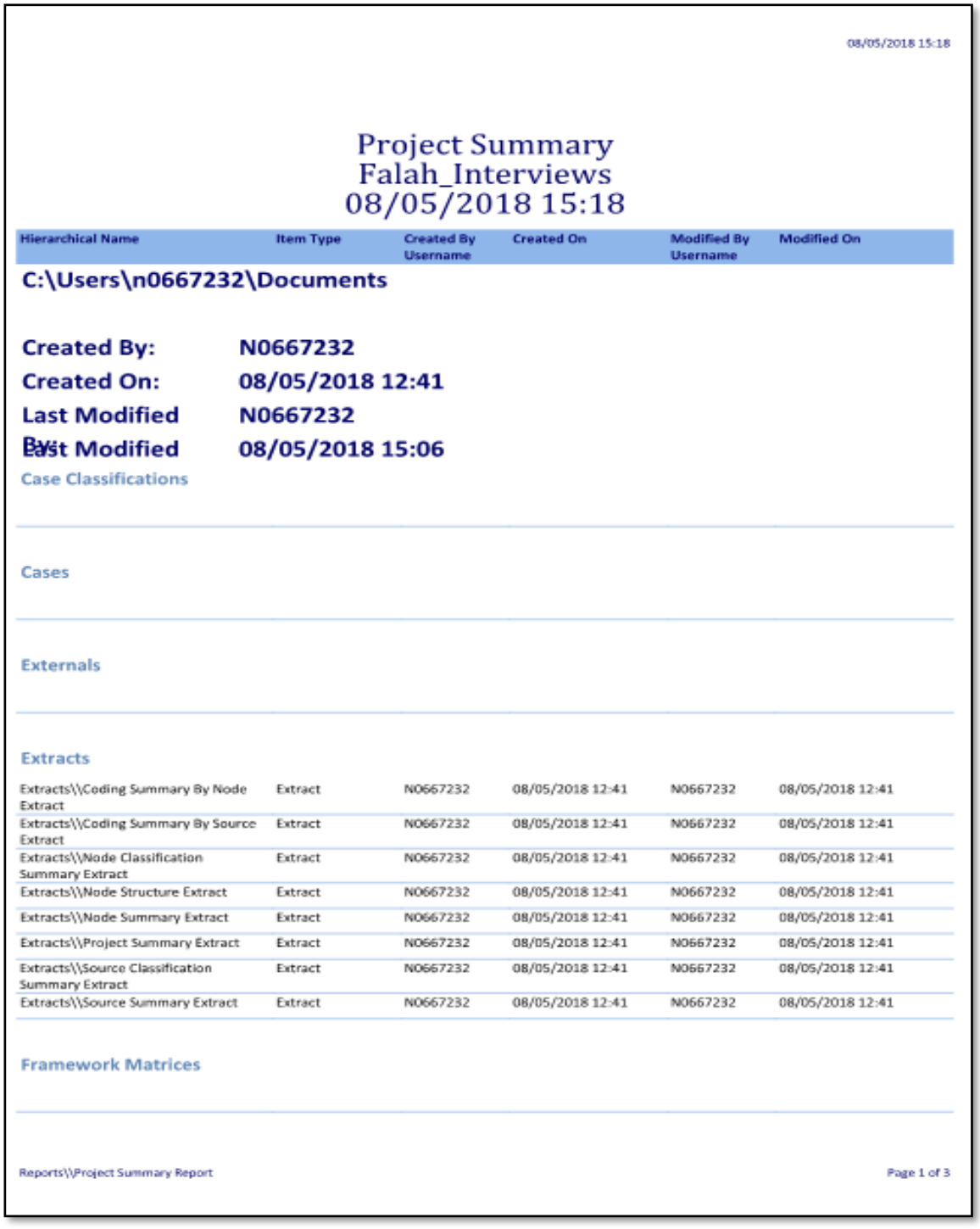
SECTION: This section provides questions for the interview – Phase 2.

1. How is the current status of Saudi households classified in terms of sustainability? And why?
2. What is the likelihood of the Saudi general public accepting sustainable buildings?
3. In your opinion, what are the obstacles that currently hinder a transition towards sustainable housing?
4. Can you suggest any additional measures to enhance household energy and water efficiency?
5. Who do you think has the key role in promoting sustainable design practices in the Saudi residential sector? And why?
6. Can government regulations help make homes more sustainable in Saudi Arabia? And why?
7. What strategies do you recommend for making residential buildings in Saudi Arabia more sustainable?

APPENDIX-F

SAMPLE OF NVivo ANALYSIS

- Project Summary



08/05/2018 15:18

Project Summary
Falah_Interviews
08/05/2018 15:18

Hierarchical Name	Item Type	Created By Username	Created On	Modified By Username	Modified On

C:\Users\n0667232\Documents

Created By: N0667232
Created On: 08/05/2018 12:41
Last Modified By: N0667232
Last Modified 08/05/2018 15:06

Case Classifications

Cases

Externals

Extracts

Extracts\\Coding Summary By Node Extract	Extract	N0667232	08/05/2018 12:41	N0667232	08/05/2018 12:41
Extracts\\Coding Summary By Source Extract	Extract	N0667232	08/05/2018 12:41	N0667232	08/05/2018 12:41
Extracts\\Node Classification Summary Extract	Extract	N0667232	08/05/2018 12:41	N0667232	08/05/2018 12:41
Extracts\\Node Structure Extract	Extract	N0667232	08/05/2018 12:41	N0667232	08/05/2018 12:41
Extracts\\Node Summary Extract	Extract	N0667232	08/05/2018 12:41	N0667232	08/05/2018 12:41
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Extracts\\Source Summary Extract	Extract	N0667232	08/05/2018 12:41	N0667232	08/05/2018 12:41

Framework Matrices

Reports\\Project Summary Report

Page 1 of 3

Hierarchical Name	Item Type	Created By Username	Created On	Modified By Username	Modified On
Internals					
Internals\\Falah_Interviews	Document	N0667232	08/05/2018 12:43	N0667232	08/05/2018 15:04
Maps					
Memos					
Node Matrices					
Nodes					
Nodes\\Consultan 1	Node	N0667232	08/05/2018 12:49	N0667232	08/05/2018 13:00
Nodes\\Consultan 1\Suggestions	Node	N0667232	08/05/2018 15:04	N0667232	08/05/2018 15:06
Nodes\\Contractor 1	Node	N0667232	08/05/2018 13:01	N0667232	08/05/2018 15:04
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Nodes\\Contractor 2\Suggestions	Node	N0667232	08/05/2018 14:47	N0667232	08/05/2018 15:04
Queries					
Relationship Types					
Relationship Types\\Associated	Relationship Type	N0667232	08/05/2018 12:41	N0667232	08/05/2018 12:41
Relationships					
Reports					
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Reports\\Node Classification Summary Report	Report	N0667232	08/05/2018 12:41	N0667232	08/05/2018 12:41
Reports\\Node Structure Report	Report	N0667232	08/05/2018 12:41	N0667232	08/05/2018 12:41
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08/05/2018 15:18

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Results

Search Folders

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Sentiment

Sets

- Interviews relationship