Unpacking Digital Transformation: Identifying Key Enablers, Transition Stages and Digital Archetypes

Abstract

This study aims to identify recurring Digital Transformation (DT) archetypes within firms and explore the capabilities and values associated with each archetype. Underpinned by the Resource-Based View (RBV) and Socio-Technical Systems (STS) theory, the study provides a framework explicating the enabling factors, their characteristics, interdependencies, operational capabilities, and resultant value creation within the context of digitalizing firm operations. Employing a deductive-inductive approach, an exhaustive literature review combined with an in-depth, multiple case study analysis of sixteen firms provides rich insights into the digital transformation journey. Findings reveal technology, data, human capital, processes, and organization structure as key enablers alongside their critical, complementary roles for transformation. Cross-case analysis identified instances of the DT framework, uncovering three archetypes: process efficiency, responsiveness, and strategic agility. Each archetype exhibits distinct socio-technical enabler configurations and improvements to business processes, resulting in unique operational capabilities and value generation. This research provides actionable guidance for managers in leveraging socio-technical enablers to achieve successful digital transformation. It underscores the need for tailored strategies, recognizing that a one-size-fits-all approach is inadequate. Managers must strategically select desired values and develop the necessary socio-technical system components, processes, and operational capabilities to attain them.

Originality: This study develops digital archetypes of firm operations linking sociotechnical components, operational capabilities, and goals of firm operations. To the best of our knowledge, no prior research has developed such digital archetypes.

Keywords – Digital Transformation, Digital Archetypes, Socio-technical System, Resource Based View, Operational Capabilities, Digitalized Operations

1. Introduction

In the dynamic business landscape, Digital Transformation (DT) emerges as the key to unlocking sustained competitive advantage, propelling companies towards excellence in their respective industries (Papadopoulos et al., 2020; Rapaccini et al., 2020). While some firms thrive at digital transformation, most struggle to do so effectively. A recent global survey by PwC found that despite more than $1.1 trillion invested, 64% of companies still face challenges in digital transformation (PwC, 2022). This is primarily due to the ambiguity surrounding DT implementation pathways (Battistoni et al., 2023), specific organizational capabilities, and micro-level factors that facilitate DT (Sousa-Zomer et al., 2020). Significant barriers include a lack of understanding of the DT process (McKinsey, 2018), confusion surrounding the critical enabling factors (Nasiri et al., 2022; Zahoor et al., 2023), insufficient vision and capabilities (Sutcliffe et al., 2019), and resistance to organizational change (Deloitte, 2020). The conceptual complexity of DT and multiple antecedent attributes creates confusion about enabling factors and their contributions to DT outcomes (Tran et al., 2023; Verhoef et al., 2021; Zhu and Li, 2023).

The literature on DT can be broadly categorized into two streams: one focusing on enabling factors and the other delving into the DT process itself. Studies centered on enablers identify several antecedents of DT (Bokrantz et al., 2017; Dalenogare et al., 2018; Gillani et al., 2020), while those concentrating on the DT process outline overarching approaches of transformation (Correani et al., 2020; Frank et al., 2019, Li, 2020, Sjodin et al., 2018; Yang et al., 2021). Both streams significantly contribute to our understanding of DT, but a notable gap persists in elucidating the underlying intricacies of the DT process (Beaulieu and Bentahar, 2021). This gap constrains our comprehension of how the DT enablers impact organizational operations, shape operational capabilities, and contribute to the values ensued by firms through DT. An in-depth and holistic sense of these enablers and their corresponding actions is essential to inform and configure the formalized routines for DT (Annarelli et al., 2021).

Recent studies emphasize the exploration of organizational enablers for DT, their interrelation, and development, unearthing how the DT process unfolds in practice (Csiki et al., 2023; Meindl et al., 2021; Sousa-Zomer et al., 2020). Despite the abundance of enabling factors for DT in the literature (Bokrantz et al., 2020; El Sawy et al., 2016; Gürdür et al., 2019; Tangi et al., 2021; Verhoef et al., 2021), identifying the key factors essential for facilitating the DT process remains a challenge (Davison et al., 2023; Lorentz et al., 2021; Nasiri et al., 2022). Studies have been vocal in emphasizing the need to identify specific attributes and favourable conditions that enable value creation from digital technologies (Calandra et al., 2023; Sadeghi et al., 2021). The literature lacks a granular characterization of how specific configurations of enablers interact and co-evolve to facilitate DT. A significant gap exists in explaining how the technical and social dimensions must be structured to enable progression through varying states of increasing digital sophistication. The existing body of work does not provide managers with an actionable roadmap delineating how to practically develop digital capabilities in a staged manner attuned to organizational readiness (Zahoor et al., 2023). Asdecker and Felch (2018) also mention how the existing frameworks provide insufficient information and remain inadequate for practical use in organizations. Similarly, Battistoni et al. (2023) also highlight that there is a lack of studies on the DT implementation paths followed by small or medium firms, which might differ from large firms with financial resources.

To develop this understanding, this study proposes a DT framework grounded in Resource Based View (RBV) and Sociotechnical System (STS) theory, enriched and validated through the identification of digital archetypes evident in real-world firms. Through this approach, the study seeks to address the following research questions.

RQ1: What are the critical socio-technical enablers of Digital Transformation?

RQ2: How do these enablers interrelate to facilitate the digital transformation of firm operations and result in the creation of operational capabilities?

RQ3: What are the digital archetypes developed by firms' Digital Transformation activities, and what values do they generate for firms?

The study comprised three stages. First, grounded in Sociotechnical Systems theory, a thorough review of extant literature identified critical social and technological factors enabling the digital transformation of firm operations. Second, semi-structured interviews with experienced

practitioners provided input on the relevance of these factors and their linkages to digitalizing operations. Third, integrating insights from the literature and practitioner interviews through the lens of Resource Based View theory, the DT framework was developed, mapping relationships between enablers, processes, capabilities, and value creation. Finally, interview data was analyzed to identify Digital archetypes implemented across firms.

The remaining paper is organized as follows. Section 2 entails the literature review and theoretical development. Section 3 describes the methodology of the paper. Section 4 constitutes the findings and digital archetypes identified. Section 5 concludes the paper with a detailed discussion, followed by section 6 on Research limitations and future directions.

2. Literature Review

2.1 Digital Transformation of Firm Operations

The digital transformation process entails the progression of organizations as they integrate and deploy sophisticated digital technologies. This transformation is concomitant with concurrent alterations in organizational factors, underscoring its imperative as a strategic consideration (Papadopoulos et al., 2020; Rapaccini et al., 2020). To effectuate this transformation, a comprehensive understanding of the pertinent enablers is indispensable, as they underpin the DT of a firm. These enablers comprise micro-level factors that studies have unearthed as microfoundation for DT (Sousa-Zomer et al., 2020; Zahoor et al., 2023). The DT microfoundation represents the elemental constituents within organizations, encompassing components such as individuals, processes, and structures, which collectively form and shape organizational capabilities (Arcidiacono et al., 2023). The efficacy of DT initiatives hinges significantly on the modification and fortification of robust microfoundation, providing a supportive infrastructure and system for the implementation of technologies and creation of DT related capabilities (Sousa-Zomer et al., 2020; Zahoor et al., 2023). In pursuit of DT, organizations must not only concentrate on microfoundation across individual skills, revamped processes, and organizational structures but also factor in the changes in technology and associated data that are at the core of DT. The development of these enablers, cumulatively geared toward DT, fosters an environment conducive to adopting new technologies and realizing their benefits (Chatterjee et al., 2022). The synergy between robust microfoundation and digital technologies is pivotal for the success of the transformation.

The DT of organizational operations is a complex process influenced by various factors, succinctly captured in the definition put forth by Tangi et al. (2021) as the "organizational changes enabled by digital technologies transforming the way organizations are structured and organized, resulting in a new state, encompassing processes, culture, roles, relationships, and conceivably all aspects of the organization." This conceptualization of DT aligns with the core objective of this study, which seeks to unveil critical enablers, their interdependencies, and their simultaneous development to achieve DT through organizational change. This organizational change is initiated and adjusted in response to the acquisition, adoption, and utilization of digital technologies at different stages of the transformation (Chirumalla, 2021; El Sawy et al., 2016).

Many firms have been highly successful in DT, such as Amazon, General Electric, Lego, Siemens and Samsung, while others still struggle to achieve it (El Sawy et al., 2016). A general observation is that large-scale information and communication technologies (ICT) implementation projects are mostly unsuccessful (McKinsey, 2018). The extant literature repeatedly emphasizes the need for DT. Still, it lacks a comprehensive picture of the DT process and lags in educating on the development and interrelation of micro-level factors that facilitate transformation and create enhanced operational capabilities (Dalenogare et al., 2018; Deloitte, 2020; Frank et al., 2019; McKinsey, 2018; Nasiri et al., 2022; Sandberg et al., 2020). These factors can be broadly categorized into social and technical factors, as have been done by studies of this stream (Tangi et al., 2021; Marcon et al., 2021; Munch et al., 2022). These studies discuss (i) general approaches to DT by providing a bird eye view of essential enablers and (ii) the DT frameworks entailing step-wise transition in the form of maturity models. While these studies have explored digital transformation and relevant enablers, they have critical limitations that constrain our understanding of how organizations transform over time. A literature review of representative studies on DT is shown in Table 1. The table exhibits that most studies discuss enablers for DT or the DT process but provide only a glimpse of their state at a single point in time rather than elucidating the developmental stages and transitional states.

Furthermore, identifying the right facilitating enablers is imperative to understand and unearth the intricacies of DT. A thorough review of the literature on DT reveals several enablers related to organization structure (Bendul and Bluck, 2019; Ozturan et al., 2019), workforce (Bokrantz et al., 2017; Dalenogare et al., 2018; Gurdur et al., 2019), integration (Frank et al., 2019; Leyh et al., 2016, Ozturan et al., 2019), technology (Cenamor et al., 2017; Kagermann et al., 2014; Mergel et al., 2019), data (Ivanov et al., 2023), supply chain (Mola et al., 2017; Golzer and Fritzsche et al., 2017), information systems (Buer et al., 2018; Cenamor et al., 2017; Bokrantz et al., 2017) and operating processes (Asdecker and Felch, 2018; Ozturan et al., 2019). These dimensions represent the varying enablers and micro-level elements that the firms display at different DT stages. Each stage's characterization depends on the firm objectives and what value it intends to create from the technologies. A representative set of DT enablers and their characteristics identified from the literature are displayed in Table 2.

Table 1 Literature review of representative studies that explore the DT process and relevant Enablers

Author & Year	**Focus of study**	**DT-related enabling dimensions**	**Limitations**
Sousa-Zomer et al., (2020)	Multiple industrial sectors	Digital savvy skills, digital intensity, risk taking culture, organization structure	▪ Misses out on the interplay of the enabling factors ▪ lack of details on the transition stages during digital transformation
Zahoor et al. (2023)	International New Ventures in Pakistan	Platform capability, web capability, top management diversity and strategic agility	▪ Lack of process aspect that sheds light on the transition
Nasiri et al., (2022)	Multiple industrial sectors	Digital orientation, digital intensity, digital maturity	▪ Interplay of these enablers to identify a transition is missing
Wohlleber et al., (2022)	Maritime Container Shipping	Cultural readiness, willingness, financial resources, digital skills, employee and top management engagement, cross-functional collaboration	▪ Characterization of dimensions missing ▪ Details on transition not provided
Senna et al. (2023)	Manufacturing companies	Infrastructure, digital technologies, strategy, human resource, culture, processes, inter-organizational aspects	▪ A prescriptive approach is missing that links the dimensions
Rocha et al. (2023)	Brazilian Manufacturers	R&D Collaborations, digital technologies, engaged workforce, mindset, operational processes, business models, data analpytics	▪ Details on the digital transformation and transition are lacking
Rafael et al. (2020)	Machine Tool Companies	Strategy and organization, employees, smart factory, data driven decisions, smart operations, smart products	▪ Lacks details on the interdependence of dimensions ▪ Does not mention how dimensions facilitate digital transformation

Caiado et al. (2021)	Single Multinational Manufacturing Organization	Customer, logistics, suppliers, production, integration, quality, maintenance	▪ The transition between maturity levels has not been entailed
Asdecker and Felch (2018)	Supply Chain Delivery Process	Covers three specific functions of the supply chain, order processing, warehousing and shipping, focuses on workforce development	▪ Does not incorporate organizational dimensions. ▪ Does not provide details on the process of change
Schumacher et al. (2016)	Manufacturing Firms	Technology, workforce, processes, organization	▪ Does not explain the stages or how the dimensions mature across stages
Özturan et al. (2019)	Travel Agencies	Technology, workforce, organization	▪ Transition stages not described ▪ Limited enablers identified
Akdil et al. (2018)	Retail Sector	Process, organization	▪ Does not describe “how” the transition will be done
Gökalp et al. (2017)	Manufacturing Firms	Technology, data, process, organization	▪ Does not describe transition ▪ Multiple dimensions clubbed in one dimension of ‘assets’ ▪ Characterization of assets not clear
Puchan et al. (2018)	Manufacturing SMEs	Process, organization	▪ No description of dimensions ▪ No details on transitions
Shahiduzzaman and Marek (2018)	Businesses in general	Workforce, process	▪ Does not explain the stages or how the dimensions mature across stages
Sjödin et al. (2018)	Smart Factory	Technology, workforce, process	▪ Does not explain how the dimensions mature across stages

Table 2: Critical enablers mentioned in the Digital Transformation Literature

Sr. no.	Dimensions	Constituent Factors	Source
1.	Processes	Digitization of processes, automation of processes, concurrent operations, lean production practices, interdependent processes, flexible and agile processes, digitized documentation, real-time monitoring of processes	Bokrantz et al., (2017), Buer et al., (2018), Frank et al., (2019), Liao et al., (2017), Tortorella et al., (2019)
2.	Integration	Internal integration, external integration, end-to-end digital integration, Integration of ICTs, horizontal and vertical integration of IT systems, uninterrupted information flow, enhanced collaboration, process interdependency	Dalenogare et al., (2018), Gürdür et al. (2019), Frank et al., (2019), Tortorella and Fettermann (2017), Müller et al., (2018), Leyh et al., (2016), Ozturan et al., (2019)
3.	Organization/ Organization Structure	Autonomy, organization structure, minimal hierarchical control, inter-organizational collaboration, non-hierarchical structures, decentralized decisions, conducive culture, cross department cooperation, top management commitment	Bendul and Blunck, (2019), Gölzer and Fritzsche (2017), Ozturan et al., (2019)
4.	Data / Information	Access to real-time information, timeliness of data to make business decisions, advanced data management systems, data processing, data standardization (bringing data to a common format), advanced tools and analytics techniques, big data analytics, data privacy tools and systems	Bokrantz et al., (2017), Cenamor et al., (2017), Gürdür et al. (2019); Ivanov et al. (2023),
5.	Human Capital	Project/digital champion, data scientists, IT personnel, IT competence, decision makers, problem solvers, multiskilled workers, analytical skills, reshuffle tasks, education and trainings, workforce flexibility	Bokrantz et al., (2017), Dalenogare et al., (2018), Gürdür et al. (2019), Gunasekaran et al., (2018), Schumacher et al., (2016)
6.	Technology	Flexible IT infrastructure, sensors, Internet of things devices/solutions, cloud computing, ICTs, augmented reality, virtual reality, Robotics (RPAs, Softbots), artificial intelligence, edge computing, machine learning, block chain	Cenamor et al., (2017), Dalenogare et al., (2018), Frank et al., (2019), Gürdür et al. (2019), Mergel et al., (2019), Strozzi et al., (2017), Kagermann et al., (2014)
7.	Information Systems	Flexible IT infrastructure, business – IT alignment, IT investments, up to date broadband infrastructure, cyber security, IT assimilation, interoperability, connectivity	Bokrantz et al., (2017), Buer et al., (2018), Cenamor et al., (2017), Frank et al., (2019), Müller et al., (2018)
8.	Supply chain	Virtual organization, collaborative supply networks, consultation with partnering firms, connectivity between partnering firms, resource sharing, information sharing, resource sharing, collaborative partners, supply chain integration	Mola et al., (2017), Ben-daya et al., (2017), Munch et al., (2022), Bokrantz et al., (2017), Meindl et al., (2021),

Note: ICTs – Information and communication technologies, IT – Information Technology, IoTs – Internet of Things, RFIDs – Radio Frequency Identification Devices

2.2 Resource Based View and Digital Transformation

The RBV posits that the firm's resources, which are rare, valuable, inimitable, and non-substitutable, can provide the firm with better performance and sustained competitive advantage (Barney, 1991). The resources and capabilities together form the tangible and intangible assets of the firm and include managerial skills, processes, routines and knowledge-based practices (Barney et al., 2001). The RBV places emphasis on the fit of these strategic resources and capabilities to achieve competitiveness. Establishing a value-adding alignment of resources and capabilities necessitates the identification, configuration, and composition of these resources (Rodríguez-Espíndola et al., 2022). This cumulation and strategic deployment of resources enhances, extends, or creates new capabilities, generating value and a lasting competitive advantage. In the context of DT, realizing value from digital technologies demands a comprehensive understanding of the essential resources, their composition, configuration, and the appropriate interrelation that informs capabilities and value creation. These elements serve as a foundation for firms to formulate and implement effective DT strategies (Li, 2020; Sousa-zomer et al., 2020; Verhoef et al., 2021). Given that DT can be leveraged to achieve diverse goals within a firm, the composition of resources, capabilities, and enabling mechanisms varies across different firms.

2.3 Socio Technical Systems Theory and Digital Transformation

The STS theory posits that an organization is analogous to a system comprising social and technical components. The mutual and unique interaction of these components in the organization design results in joint optimization and value creation for the firm to improve system performance (Appelbaum, 1997; Kolade and Owoseni, 2022; Marcon et al., 2021). We invoke STS theory to understand the DT process and segregate the enabling resources into social and technical ones. The social components relate to the work design, employees and organizational work practices, while the technical component constitutes the technologies and associated infrastructural elements. The STS comprises six dimensions: people, culture, infrastructure, technology, processes, and goals (Appelbaum, 1997; Kolade and Owoseni, 2022). To achieve an organization’s goals, the joint optimization and fit of social and technical factors is a compulsion. The STS serves as an appropriate explanatory mechanism for DT initiatives (Marcon et al., 2021; Munch et al., 2022) as the implementation and utilization of technologies is mainly dependent on workforce skills, IT infrastructure, the modification of processes and the organization structure that is changed due to technologies (Bokrantz et al., 2017; Munch et al., 2022; Kagermann et al., 2014). A brief description of the different critical elements of the proposed DT framework is as follows:

Digital Technology in DT

The acquisition, adoption and utilization of digital technologies are at the core of all digital transformations. For this paper, digital technologies refer to technologies such as the Internet of Things, additive manufacturing, augmented reality, virtual reality, cyber-physical systems, cloud computing, and big data analytics” (Dalenogare et al., 2018). These technologies evolve incrementally from base technologies to advanced ones (Frank et al., 2019), according to which

associated organizational elements are modified. Organizations incorporate necessary technology based on their specific business requirements. Implementing these technologies calls for the upgradation of infrastructure, data management capabilities and appropriately skilled employees that can support and advance a firm's technological sophistication and proficiency. Once these technologies are in place, they start generating data that needs to be stored, organized, and utilized appropriately for the firm's benefit.

Data Management in DT

The data generated by digital technologies need to be stored, processed, extracted, and analyzed (Ardolino et al., 2018). We adapt the definition of data proposed by Ardolino et al. (2018) to the DT context and refer to it as the "elementary descriptions of objects' properties (e.g. activities, events and/or transactions) generated by digital technologies and observation with different forms". The actual value of DT can only be realized when data is used at the right time for the right purpose. Lack of direction in using data appropriately adversely impacts the purpose of DT and results in failure (Chirumalla, 2021; Mukherjee et al., 2023; Ivanov, 2023). The effective utilization of data depends on the data management systems and the firm's human capital.

Human Capital in DT

The human element around digital technologies has gained much traction recently and has become a concerning and imperative prospect. Adapting the definition of human capital from Kim and Grant (2010) to the DT context, we refer to human capital in DT as "the knowledge and technical skills that employees develop during digital transformation". To explore the role and sustainable inclusion of the workforce in Industry 4.0, the European Commission has coined the term Industry 5.0 – which posits that humans are a vital element in the value creation mechanism supplemented by digital technologies (EC, 2022). Studies have been vocal on the lack of exploration of the human element in DT (Ivanov, 2023; Mukherjee et al., 2023), where the focus of literature largely has been on the performance and economic gains due to these technologies (Cenamor et al., 2019; Liao et al., 2017; Lorentz et al., 2021; Meindl et al., 2021). As technologies penetrate an organization, the workforce needs to be upskilled to leverage the full potential of technologies. The stance of technologies replacing humans holds less ground when the workforce is trained as per the need of different digital technologies. Employees working with digital technologies must be proficient at handling data and utilizing it at the right time for optimal decision making (Bokrantz et al., 2017; de Sousa Jabbour et al., 2018). The shift of employees from regular workers to knowledge workers and super operators becomes prominent, and the induction of technical people and data scientists fits well for the effective use of technologies (Cenamor et al., 2017; Li et al., 2020). Sadeghi et al. (2023) identify technical and analytical skills, digital literacy, ability to innovate, extracting data to identify business opportunities and project management skills as the core micro-foundations that employees require for DT. Therefore, as organizations navigate the complexities of DT, prioritizing the development of human capital alongside technological advancements emerges as pivotal for sustainable success.

Process modifications in DT

Due to the dynamic shifts in technology, data management, and workforce dynamics, firms experience consequential modifications in their operational processes, aiming for increased efficiency and effectiveness. The escalating utilization of enterprise-wide systems, soft bots, and robotic process automation (RPA) plays a pivotal role in this transformation, streamlining and automating processes, consequently reducing manual hours and standardizing optimal workflows. These process changes not only result in efficiency gains but also facilitate the cultivation of new capabilities, thereby advancing the realization of DT. For the context of DT, we adapt the process definition proposed by Stevenson (2012) and refer to it as the "part of the business that is modified and improved due to digital technology implementation to create new routines and operations". This refined perspective underscores the profound impact of process evolution on the intricate interdependencies among functional departments and the overarching organizational structure. The integration of processes, driven by digital technology, thus catalyzes organizational change, reshaping the dynamics within and between functional units.

Organization Structure in DT

As digital transformation unfolds, the organizational structure undergoes modifications in tandem with advancements in digital technology. The increasing integration of digital tools necessitates corresponding adaptations in organizational practices and structural frameworks. With the augmentation of information flow and the cultivation of a data-driven culture, a compelling need for employee autonomy arises. This imperative shift towards fostering greater autonomy among employees prompts a transformation in the hierarchical structure, evolving from a mechanistic to an organic form (Liao et al., 2017; Sandberg et al., 2020). The progression of digital technology not only influences the functional aspects of organizations but also triggers a cultural shift within, wherein the emphasis on data-driven decision-making fosters a more collaborative and flexible organizational structure. This departure from a rigid, hierarchical model to a more adaptive and fluid structure is essential for organizations to harness the benefits of digital transformation effectively. Furthermore, other organizational elements like top management commitment, responsibility, privacy and security have also been identified as the ethical narratives of DT (Rezaei et al., 2021) that are formed and ensured as the organization structure moves to an organic form.

However, a complete picture of what the socio-technical factors constitute, how they are modified and what type of value is created from their interlinkages and modifications is relatively underexplored (Correani et al., 2020; Sandberg et al., 2020). Understanding these aspects can facilitate the alignment of resource management with the necessary value, allowing for the thoughtful (re)devising of DT strategy and seamless transition, with which firms are still struggling (Annarelli et al., 2021; Deloitte, 2020; Nasiri et al., 2022; PwC, 2022). Though studies have provided sufficient details on the enablers and a bird's eye view of how these elements transition through DT, they lack details on the interdependency of enablers and the associated set of actions that create value and capabilities (Li et al., 2020, Nasiri et al., 2022). To address this gap, based on the RBV and STS theory, we propose a DT framework, as shown in Figure 1.

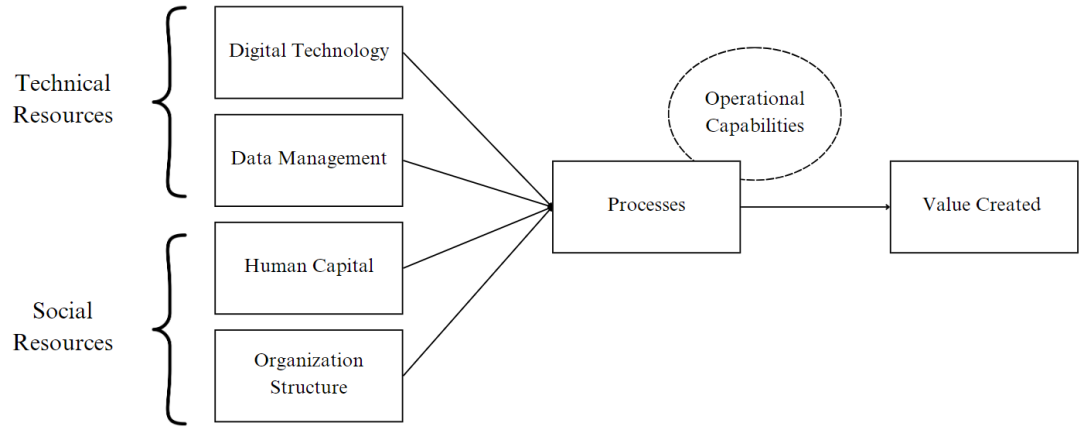

Figure 1: Framework for Digital Transformation archetypes based on RBV and STS Theory

3. Research Methodology

This study utilized a combination of deductive-inductive approaches to identify the transformation patterns and propose a DT framework to identify the archetypes (Comuzzi and Patel, 2016; Niazi et al., 2005), as shown in Figure 2. For the deductive phase, a detailed review of the extant literature on DT was conducted to identify the critical enablers and their constituent factors that facilitate the DT of firm operations (Table 2). The critical enablers were identified based on the frequency of their occurrence in the literature (Niazi et al., 2005). The enablers and their constituent factors were clubbed into five main dimensions with the help of two senior researchers in the field and three industry experts on DT (Hsieh et al., 2009). Based on these enablers, a guiding DT framework was developed. In the second step, we followed an inductive approach using the case study method and studied the DT of 16 firms in detail. Following similar studies in the domain, a within case and cross case analysis was conducted to gain insights into DT and develop an overarching understanding of the DT patterns observed by firms (Patrucco et al., 2022; Pereira et al., 2020). The case study approach was selected as an appropriate methodology for this research based on Eisenhardt's (1989) argument that this method is well-suited for understanding complex phenomena within real-world contexts. The case study methodology exposes the intricate and complex dynamics that characteristically unfold as organizations navigate enterprise-wide change (Baratt et al., 2011; Yin, 2018). Therefore, DT, an initiative that spans multiple years and involves numerous elements being modified and interacting in complex ways, can be better understood through this method.

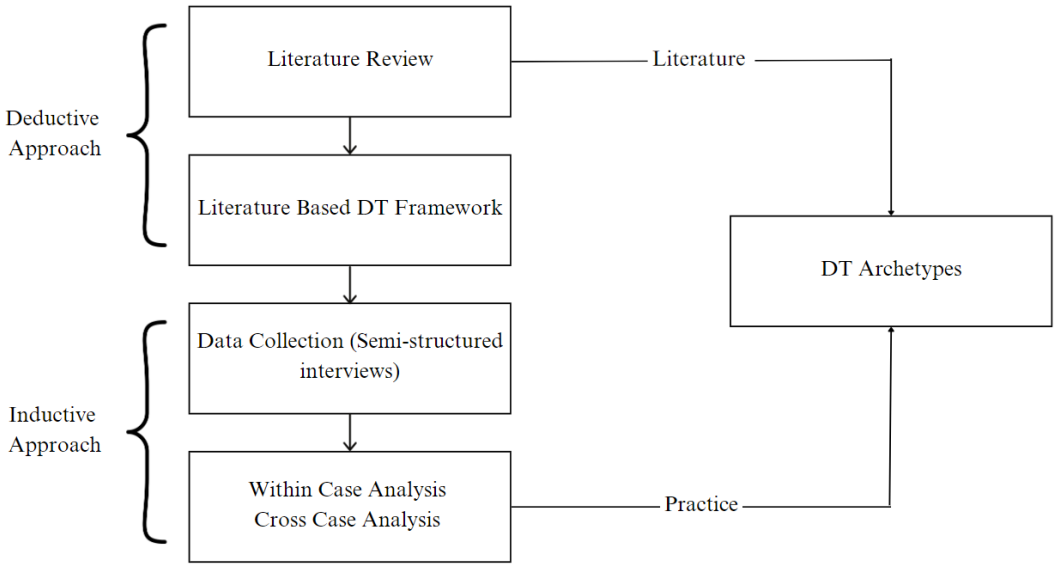

Figure 2: Flowchart of the research steps

3.1 Case Selection

To identify and understand the socio-technical enablers, their interdependence, and transition, theoretical sampling was used for the study. The theoretical sampling is well-suited for the study as it involves decisively selecting participants or cases based on theoretical concepts or ideas identified during the research process (Draucker et al., 2007; Patrucco et al., 2022). The respondents for this study were selected based on the extent of DT of their respective firms. Initially, companies were recruited via the authors' professional contacts, specifically targeting participants belonging to progressive firms and known to be advanced in their DT. These firms had been involved in digital technology-related executive training programs conducted by the authors previously. Later, snowball sampling helped expand the pool of relevant firms for the study. Firms that had undergone transformation to a certain extent were preferred over firms in the planning or initial phases. The authors confirmed the DT stage beforehand by conducting preliminary discussions with the digitalization leads/managers of respective organizations through telephonic calls or web conferencing tools. A total of 20 firms were approached, out of which 16 agreed to participate in the study. Among the 16 firms, 10 were relatively mature on the digital transformation spectrum, i.e., utilizing digital technologies for advanced analytics, while the remaining six were in the planning or implementation phase. The heterogeneity in the transformation state of firms also fulfilled the "polarity" criterion of Eisenhardt and Gaebner (2007), where the mix of firms depicts varying notions of the phenomenon under study to develop rich and contextual understanding.

The authors prepared a list of questions (Appendix A) related to the dimensions of DT. To ensure the comprehensiveness of the case study method, we ensured the construct validity, internal validity, external validity and reliability (Keller et al., 2021; Yin, 2018). To enhance the *construct validity*, the interview guide and skeleton DT framework were emailed to the respondents beforehand to inform the scope and focus of the discussion. Also, a telephonic conversation with the respondent was made beforehand to verbally brief them about the

research to enhance their understanding of the project. Furthermore, a cover letter was sent with the email that requested respondent consent and informed them about the anonymity and confidentiality of data so the respondents would be open to disclose information beneficial for the study. The interviews were recorded, transcribed, and verified by the interviewees to ensure no discrepancy was present (Yin, 2015). The research team made a DT table for each firm interviewed and later confirmed it by the interviewee for further amendments. Data from the interviews was also triangulated by studying the relevant documents provided by the respondent (if any). The *internal validity* of research concerns the identification of causalities in research, which was ensured by clearly explaining the causal links among dimensions in the proposed DT framework throughout the findings section of the paper. The *external validity* concerns the generalizability and applicability of research findings to other contexts and is strongly connected to the study sample. The external validity of this study was strengthened through purposeful sampling approaches and multiple rounds of interviews with digitalization leads. Specifically, criterion and snowball sampling ensured the inclusion of multinational corporations that had demonstrated excellence in digital transformation compared to global industry peers. Conducting in-depth interviews with multiple top management executives intimately involved in leading successful corporate transformations provided rich insights from those directly responsible for the design and implementation of digital strategies. Engaging with these experts from successful national and international firms enhanced the transferability of findings to other contexts. The rigorous qualitative sampling and data collection techniques enhanced the generalizability and trustworthiness of the results. *Reliability* relates to similar results produced in a different scenario (Yin, 2018). To ensure and enhance reliability, a semi-structured interview guide was prepared, the entire data collection process was documented, and interviews were recorded and transcribed by two researchers.

A brief profile of the interviewees and details of the interviews is shown in Table 3. The mode of interviews was primarily face-to-face, except for a few cases where web conferencing tools were used. The interviews were conducted by a research team consisting of a senior and junior researcher. Each interview lasted 1 – 2.5 hours and was conducted until saturation, i.e., no new information was added, no new enabling factors were identified, or no new pattern of DT emerged (Glaser and Strauss, 2017).

Table 3: Sample and profile of interviewees

Case	Firm Type	Respondent Designation	Experience in DT	Mode	Duration
Firm A	DT Consultants	Lead Consultant	>10 years	Face-to-face	2 hr 19 min
Firm B	Pharmaceuticals	Digitalization Manager	>10 years	Face-to-face	48 min
Firm C	Food manufacturers	CIO	>15 years	Face-to-face	1 hr 25 min
Firm D	Food manufacturers	CTO	>10 years	Online	56 min
Firm E	Electronics manufacturers	CDO	>7 years	Face-to-face	1 hr 10 min
Firm F	Transportation	Project Manager – Technology and Innovation	>5 years	Online	46 min
Firm G	DT Consultants	Principal Consultant – DT	>5 years	Face-to-face	1 hr 18 sec
Firm H	Food manufacturers	Technical Manager	>10 years	Face-to-face	45 min

Firm I	Pharmaceuticals	Head of IT	>2 years	Face-to-face	1 hr 35 min
Firm J	DT consultants	Digital Applications and Services Manager	>25 years	Face-to-face	1 hr 5 min
Firm K	IT & Services	Solution Engineer	>10 years	Face-to-face	1 hr 46 min
Firm L	Financial Institution	Head – Digital and Corporate Business	>15 years	Face-to-face	40 min
Firm M	Financial Institution	CDO	>10 years	Online	1 hr 35 min
Firm N	Telecommunication	Executive Vice President IT	>7 years	Online	55 min
Firm O	Financial Institution	Head of Innovation / DT	>5 years	Face-to-face	1 hr 30 min
Firm P	Telecommunication	Director Corporate Strategy and DT	>4 years	Online	40 min

Note: CIO – Chief Information Officer, CTO – Chief Technology Officer, CDO – Chief Digital Officer

4. Findings

4.1 Within Case Analysis

The within case analysis helped validate the critical enablers, unearthing details on the accompanying changes in each enabler and their interdependence to facilitate DT. After each interview, a DT table for each firm was made based on the recordings and transcriptions. This table was then sent back to the respondents and improved according to their feedback to make it more accurate. Each table entailed the constituent factors that represented the transition of each enabler alongside the capability developed and value generated at each stage due to the transition. A total of 16 transformation tables (one for each firm) were developed. They were then synthesized to devise a final version of the framework dimensions and their transition,[1] as shown in Appendix B. The analysis revealed that all firms transitioned through two phases: the DT readiness phase, where the firms worked on laying the groundwork and infrastructure for digital technologies, and the DT realization phase, where the technologies are implemented and used to create benefits for the firm.

Enablers for Digital Transformation

The within case analysis helped us identify and enrich the essential enablers critical for DT, unearthing their modifications and finalizing the DT framework. The final framework constituted digital technology, data management, human capital, organization structure, and processes as critical enablers. These enablers mapped well onto the dimensions of the STS theory. The 'people' dimension of STS was represented by the human capital in our framework, the 'technology' and 'infrastructure' dimensions were depicted by the digital technology and data management of our framework, the 'process' and 'culture' were represented by the processes and organization structure of the framework while the 'goals' dimension of STS was represented by the value generated in our DT framework (Marcon et al., 2021; Munch et al., 2022).

From Table 2, we see that supply chain and integration were also identified as critical enablers for DT from the literature. However, based on the case analysis and DT framework, the supply chain was not treated as a separate dimension, as the aspects of this dimension are covered in

[1] For detailed documentation and information of within case analysis please contact fatima.gillani@ntu.ac.uk

the organization structure dimension. Integration overlapped with the dimensions of technology and organization. So, the technological integration aspects were incorporated into the technology dimension and the organizational integration aspects in the organization structure dimension.

4.2 Cross Case Analysis

The cross-case analysis was conducted to identify the emergent DT patterns and the different transition stages. The purpose of this was not only to come up with an overarching framework but also to identify the state of firms at different stages of the transformation, also called archetypes in this study. Archetypes group or categorize cases based on common themes or characteristics that emerge from the data, revealing shared underlying patterns across cases (Sarkar and Mateus, 2023). For this study, similarities in enablers and their characteristics were clubbed at different stages of the transition to identify the Digital archetypes. Based on the cross-case analysis, the study identifies three Digital archetypes: process efficiency, responsiveness and strategic agility.

Following the RBV, the DT framework identified in this study informs that firms in their pursuit of DT tend to achieve specific operational goals. The synergistic impact of technology, data, workforce, and organization related resources result in more developed processes. As the processes develop, they modify existing operational capabilities and create new ones. The interrelation of modified resources, improved processes, and updated operational capabilities are leveraged to generate a set of values (or operational goals) for firms that provide a sustained competitive advantage. We find that firms follow some patterns (or what can be called digital archetypes) in their DT, which are a set of operational capabilities, processes, and related elements of the social and technical systems to achieve certain operational goals. The characteristics of the sociotechnical enablers vary from one digital archetype to the other in order to achieve their respective goals. We do not value judge these archetypes since the context and objectives of firms would drive certain digital transformation. However, we appreciate that these digital archetypes indicate relative digital sophistication in the operational systems of firms. Moreover, since the data for this research is collected from the manufacturing and service firms, the descriptions of the archetypes are kept generic at the operational level.

4.2.1 Archetype 1 – Process Efficiency via Basic Digitization

The Process Efficiency Archetype represents an early stage of DT that involves the utilization of basic digital technologies, data integration and management, descriptive analytics, organizational integration, and the automation of repetitive tasks. It emphasizes training initiatives, business process improvement, and the development of operational capabilities such as technical interconnectivity and cost reduction. The archetype represents an initial stage focused on achieving process efficiency, breaking down functional silos, and laying the foundation for further digital transformation in the firm.

In this archetype, firms update their IT infrastructure and use Robotic Process Automation (RPAs) for equipment level automation (Liao et al., 2017). They start using the Internet of Things (IoTs) encapsulating multiple devices that transmit and receive data. These devices, such as tags, sensors, and RFIDs, are used for localized automation of specific operations

(Ardolino et al., 2018; Liao et al., 2017). As data is being transmitted and generated, the use of visualization tools and dashboards is also initiated, supporting the partial integration of systems and devices. This initial integration is fundamental for data collection, management, and machine-to-machine communication. Since data management and accessibility are still at a nascent stage, the required data must be extracted from the designated systems. Nevertheless, firms start creating data lakes or central databases linked to individual data sources (Bibby and Dehe, 2018). Data is preprocessed and cleaned to discard meaningless data, and descriptive analytics is run to generate essential insights (Ardolino et al., 2018; Wang et al., 2018). The digitalization manager of Firm B states:

> *"Before there was no data standardization and functional silos existed. Some data was deleted, and some was stored in local servers. Standardization of data happened when integration started taking place. Different applications were made to make data compatible."*

Emphasizing the same point, the CIO of Firm C also expressed his views as:

> *"To initiate integration, we had to develop standardized data formats, standardized reporting, standardized procurement, and master data management. We had to work on the organization's readiness by creating standardization and centralized systems."*

On the people front, firms conduct technical trainings and workshops to enhance employee knowledge and skills (Eckhardt et al., 2014) so that they can provide technical support for the issues occurring during operational task execution. As technical integration is being developed, the functional silos of firms start eliminating. The process interdependency is complemented with the formation of cross-functional teams to enhance coordination among functional departments. This facilitates resolving technical issues collectively and informal face-to-face communication becomes more frequent.

Business processes improve and become interdependent due to the incorporation of IT. Firms develop connectivity throughout the functional departments, technologies are interconnected, and horizontal integration is established by sharing and exchanging data (Liao et al., 2017). Furthermore, this DT stage signifies the automation of repetitive tasks through RPAs. As automated processes replace manual ones, the chances of error reduce, and efficiency increases. The quality and speed of operations improve, resulting in cost reduction (Ross, 2003). The operational capabilities developed by the change in processes are technical interconnectivity, process improvement and cost reduction. Owing to these capabilities and the simultaneous development of the sociotechnical dimensions, the cumulative value addition represents efficient lean processes, reduced information asymmetry, and favourable cost performance. The Head of IT of Firm I posited:

> "*We started automating the processes using RPAs. The processes became simplified and automation enhanced efficiency. A byproduct we gained by simplifying and automating processes was resource efficiency".*

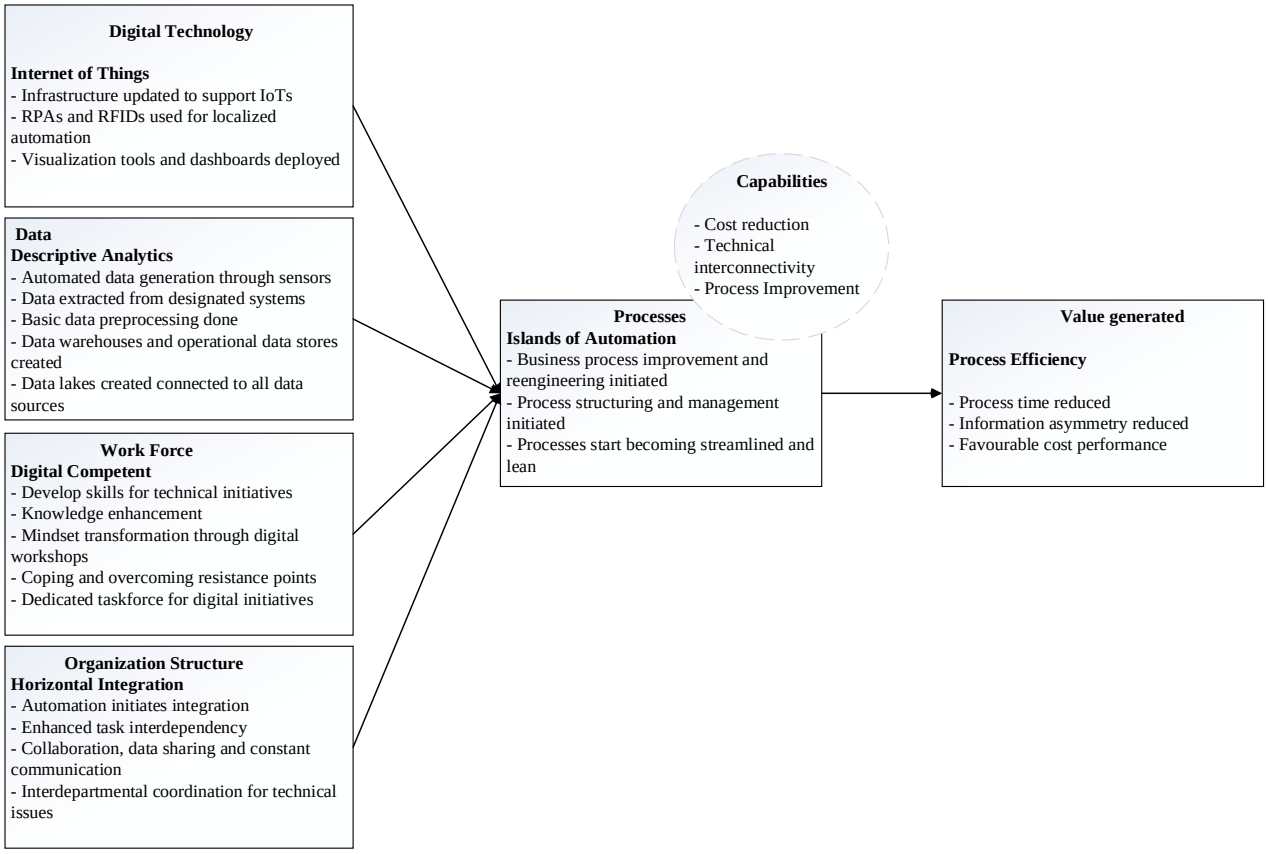

Figure 3 'Basic Digitization' – Process Efficiency Archetype of Firms

From an RBV perspective, the composition or characterization of the social and technical resources and their bundling with the process modifications creates or enhances operational capabilities. The improved capabilities generate value for the firm, translating into a sustained competitive advantage. For the process efficiency archetype, to effectively use IoTs, sensors and basic automation, the data management needs to be developed such that data is integrated and stored; the workforce needs to upskill themselves for technical initiatives and reduce cynicism to develop a digital mindset. The use of RPAs or softbots to automate processes is dependent on how well-designed the processes are. To automate, the processes need to be streamlined so that automation is not done for non-optimal processes. This results in technical interconnectivity, cost reduction and improved processes, which form the basis of lean. Overall, these capabilities are leveraged to develop the basic building block of process efficiency for DT in the firm (Wamba and Akter, 2019).

4.2.2 Archetype 2 – Responsiveness via Cross-Departmental Digitalization

The Responsiveness Archetype represents an intermediate stage of DT where deploying sophisticated technologies facilitates decentralization and integration within an organization. Centralized databases enable enhanced connectivity and data accessibility across functional departments. Firms comprising this archetype emphasize the strategic value of data, leading to standardization, systematic storage processes, and predictive analytics. Workforce proficiency is heightened through technical and analytical training. Internal collaboration intensifies, hierarchical gaps decrease, and cross-functional teams are formed. Data-focused strategies

create operational synergies, offering visibility, interoperability, and flexibility for enhanced responsiveness, problem-solving, risk mitigation, and informed decision-making.

Firms deploy sophisticated digital technologies to establish centralized databases accessible to all functional departments. A few firms prefer implementing cloud storage, which facilitates storing, managing, and processing the data virtually (Ardolino et al., 2018). In contrast, other firms work on local storage solutions. New servers and systems are installed to strengthen the infrastructure, and connectivity between systems and different technologies is established (Liao et al., 2017).

The firm realizes data's importance and considers it a useful resource. The data is standardized and has a defined schema that increases the interoperability of systems in the organization. Systematic processes for data storage, retrieval, and processing are defined. Firms perform predictive analytics to gain insights from the existing data (Ardolino et al., 2018). The employees are trained in enhanced technical and analytical skills to leverage the data being stored. The director of DT at Firm P stated:

> *"We formed a dedicated unit of analytics. The unit started aggregating data that was needed to make decisions. We created data lakes and data warehouses. We enriched data from internal and external disconnected sources and started doing data analytics."*

As the firm is more integrated in this archetype, frequent coordination takes place among employees that facilitates collaborative learning and social connectivity. Furthermore, they are empowered for collective decision making and problem solving facilitated by enhanced interdependency among departments and data availability (Ply et al., 2012). The employees are proficient in IT skills and can adapt to the new requirements (Soule et al., 2016).

Vertical and horizontal integration takes place, functional silos diminish, and the activities and tasks of different departments are more interdependent (Bernus et al., 2003). This interdependence is largely enabled using central databases, data standardization, integrated systems and enhanced process interdependency due to digital technologies. On the workforce side, cross-functional teams are formed that work together to execute the assigned tasks and activities. This enhances internal collaboration in the firm and creates a decentralized culture. The organization starts getting flatter, and the communication gap among hierarchical levels starts reducing. This increases autonomy, coordination, and internal collaboration. The Head of IT of Firm I put it this way:

> *"We ensured the right placement of the right people with the right organization structure in place. The skillset of employees was constantly developed, and new incentive systems were in place. New hirings and firings were done for all business functions and skills developed in three areas – cloud development, big data, and project management. The software skills were enhanced, and data analytics skills started to develop. Work rotation was practiced and the collaboration between departments enhanced."*

The automation is scaled across significant processes of the firm, and maximum man-hours are automated. Due to wireless devices and increased data generation, processes are monitored, and relevant digital records of processes are maintained (Eckhardt et al., 2014; Venkatraman, 1994). The firm focuses on data storage, which comprises two main aspects: hardware (ICTs) and data management. The hardware constitutes the implementation of cloud or other local storage, whereas the data management constitutes the organization of data to facilitate processing and analyses (Ardolino et al., 2018). The information and data exchange within and between departments enhances firms' efficiency and visibility. Consequently, this leads to operational synergies where the systems, workforce and organization structure complement one another to achieve operational goals. The notion of synergies is aligned with the bundling aspect of RBV and with the STS theory proposition of the sociotechnical dimensions interacting to create value for the firm. Due to digital technologies, the enhancement of sociotechnical dimensions develop visibility, interoperability, and flexibility as operational capabilities (Fletcher and Griffiths, 2020; Huikkola et al., 2022). These capabilities help firms become more responsive, apt in problem solving, better in risk mitigation, and taking informed decisions.

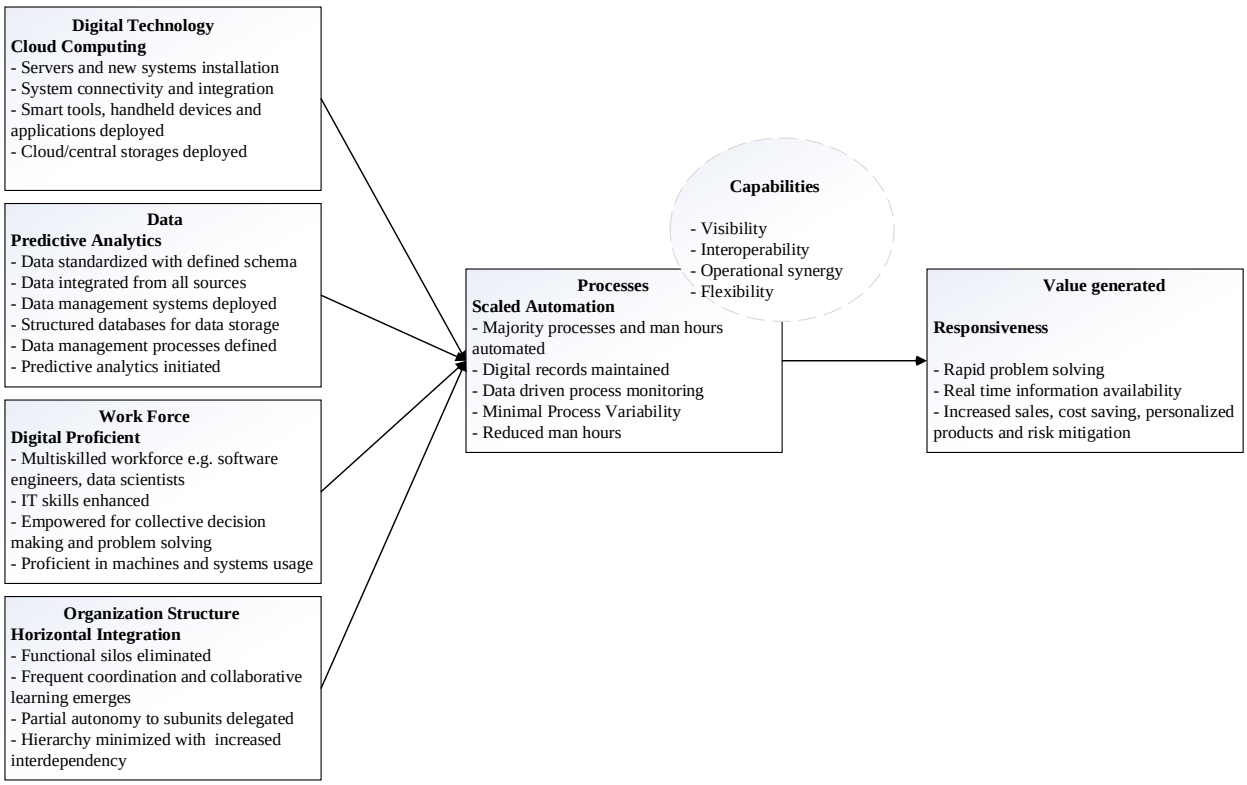

Figure 4 'Cross departmental digitalization' – Responsiveness Archetype of firms

4.2.3 Archetype 3 – Strategic Agility via Scaled Digital Transformation

The Strategic Agility Archetype epitomizes an advanced stage of DT with comprehensive digital integration across a firm's operations. It features streamlined, repeatable, and IT-dependent processes, incorporating advanced technologies like AI, machine learning, and customized applications. Knowledge workers with multitasking skills, including data scientists

and software engineers, play a pivotal role. Continuous improvement through technological initiatives is a hallmark, with a clear distinction between operations and digitalization workforces. Interrelated, interoperable applications facilitate end-to-end digital integration. The firm exhibits an organic structure with autonomy and a data-driven culture. The archetype achieves agility, responsiveness, and customer-centricity through end-to-end integration and real-time monitoring, resulting in strategic agility and digital dexterity, key outcomes that ensure sustained competitiveness.

This archetype is characterized by lean, defined, repeatable, and quantitatively monitored processes highly dependent on IT systems and digital technologies. Firms demonstrating this archetype use advanced digital technologies and experiment by using artificial intelligence (AI), machine learning, and Microsoft power applications to create customized applications. Edge computing and parallel computing approaches are leveraged using automated data. Data accessibility increases, and centralized databases are established. Big data management systems are deployed to utilize data, and prescriptive analytics provides insights for data-driven decision-making.

As advanced digital technologies and databases are a norm for these firms, knowledge workers who act as super operators and have multi-tasking skills are required. The employees are skilled and trained, and the workforce portfolio consists of data scientists, business intelligence (BI) architects and software engineers. The data is converted into actionable information when employees process, analyze, and interpret data for firms' benefit (Wang et al., 2018). They develop new systems and take technological initiatives to enhance the efficiency of business processes. These employees are highly proficient in leveraging modern technologies and can handle complex systems (Bokrantz et al., 2017). They come with a digital-first mindset and continuously develop digital skills and capabilities to ensure digital strategy implementation (de Sousa Jabbour et al., 2018). Firms in this state display a clear distinction between their operations workforce and digitalization workforce. The operations workforce is developed and upskilled to support technology related or technology induced processes of the firm. While the digitalization workforce is highly technical with data analytics skills and contributes to the intelligence and technological proficiency of the firm.

In this archetype, firms focus on continuous improvement through systems development and technological initiatives. Applications are interrelated and interoperable. The connectivity and integration between systems facilitate end-to-end digital integration (Bernus et al., 2003; Dalenogare et al., 2018). Different IT systems monitor the processes, making it easy to identify bottlenecks in real-time. This information provides decision support for business control and monitoring, enhancing the efficiency of the overall processes (Hasselbring, 2000). This facilitates visibility and avoids delays due to changes in demand.

Furthermore, achieving vertical and horizontal integration develops an organic structure where employee empowerment and autonomy are the norms. The firm has a minimal hierarchy, and power is decentralized. The real-time nature of information exchange requires employees to be vigilant to sense trends and make data-driven and timely decisions. The firm develops a data-driven culture with open communication and cross-functional collaboration, where decisions

are based on statistical figures and facts rather than on assumptions and incomplete information (Ramezan, 2011).

Firms characterized by this archetype develop distinct teams for information security and application development are also formed at this point. The security team is responsible for enhancing cyber security while the application development team develops in-house applications that automate and optimize business processes. The ease of data accessibility, enhanced interdependency of processes, elimination of functional silos, and continuously increasing vertical and horizontal integration and connectivity facilitate the firm's organic structure (Liao et al., 2017). In addition, the lean structure, paperless environment, enhanced transparency and decentralization of power and control are significant features of the organic structure enabled by DT.

Using real-time data clubbed with a technically skilled workforce allows firms to achieve digital dexterity, defined as "the ability to rapidly self-organize to deliver new value from digital technologies" (Soule et al., 2016). The firm benefits from the strategic agility and responsiveness created because of the complementary use of the technologies, human capital, data and integration. Strategic agility enables firms to keep an outlook towards market changes, respond promptly to those changes and become customer-centric. This helps sustain profitability and competitiveness facilitated by the IT capabilities developed along with the DT (Gunasekaran et al., 2018). The CDO of Firm M described this state in his organization as:

> *"Our firm now takes data-driven decisions and has developed digital platforms using Application Programming Interfaces (APIs). We have moved from a product-centric organization to a customer-centric one. Our objectives are driven by the need of customers. We plan to make processes completely paperless by 2025 and move to data lake analytics using Hadoop."*

The CTO of Firm D also made a similar comment, stating:

> *"Digitalizing our operations has enhanced the productivity of our factory. We have won back our major clients. Digitalization has enhanced our process flexibility and agility. We have started customizing our products and plan to move towards individualization. We have started using Microsoft Power Apps to develop applications for our routine tasks. This will help in the real-time monitoring of processes. We have also launched machine learning projects for sales forecast and predictive maintenance and train our employees accordingly."*

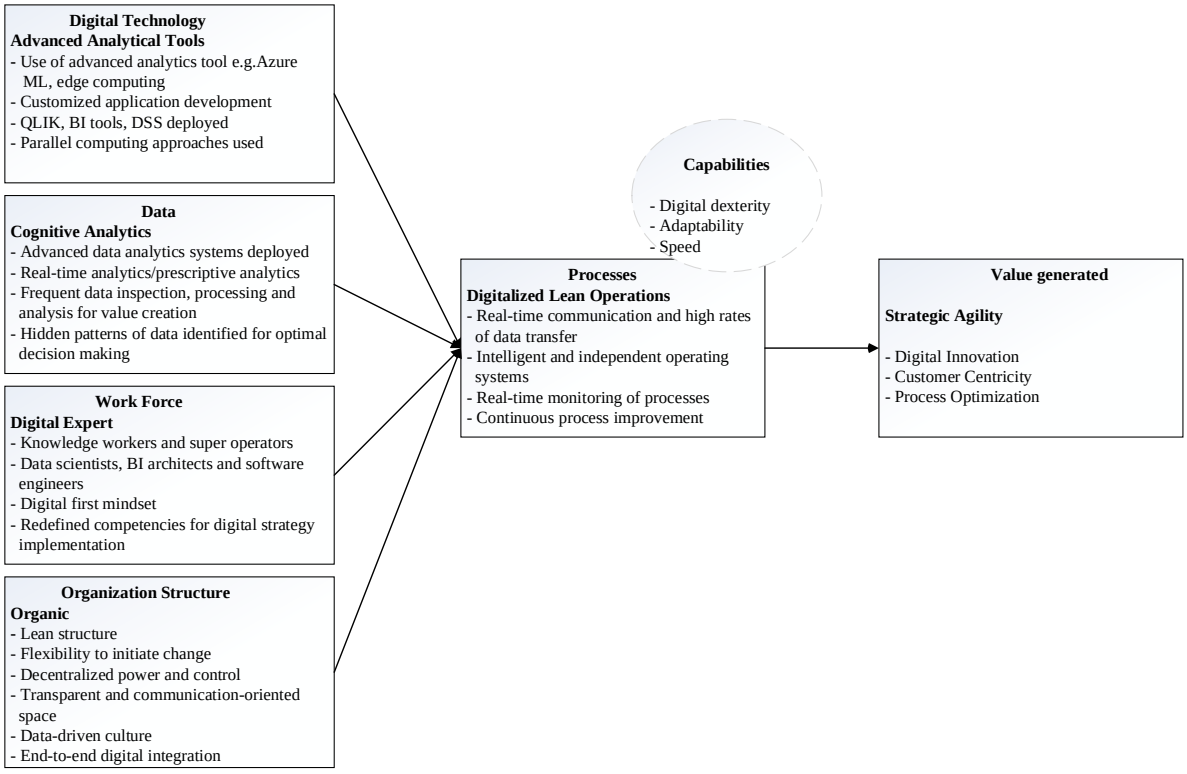

Figure 5 'Scaled Digital Transformation' – Strategic Agility Archetype of Firms

A holistic picture of the DT process and the transition of enabling dimensions through different archetypes is depicted in Table 4. The comparative table highlights the key distinct features of the enablers that facilitate a seamless DT. The activities and interventions undertaken within one archetype serve as the foundation for the enabler modifications in the subsequent stages. Archetype 1 lays the groundwork for automating data generation and instigating process re-engineering aimed at enhancing efficiency. It fosters the cultivation of a digital mindset among employees, mitigating cynicism and fostering collaboration and data sharing to establish connectivity within the organization. Building upon these foundational changes, archetype 2 endeavours to establish responsiveness within the organization through data-driven processes, a multiskilled workforce, predictive analytics, autonomy, and minimal hierarchy. Following the first two archetypes that provide digital transformation and analytics readiness for the firms, archetype 3 achieves strategic agility and digital dexterity. It does so through real-time communication, data sharing, prescriptive analytics, process optimization and developing competencies for digital strategy implementation in the workforce. It is worth mentioning that the quality of the readiness for DT plays a defining role in the subsequent stages of DT and what values can be created from it. The DT process, in general, constitutes three main components: technology readiness, digital technology exploration, and digital technology exploitation (Sadeghi et al., 2021). Technology readiness comprises the acquisition and use of technologies and the workforce's comfort and proficiency in using them. Digital exploration comprises the development of formalized routines for the use of technologies, while exploitation is the utilization of digital technologies. Our archetypes provide a deep dive into the micro-foundations of these components and highlight the strategic enhancement of

organizational capabilities, culminating in heightened agility and proficiency in digital endeavours.

Table 4 Comparative table for the three digital archetypes highlighting modifications in the enabling dimensions

Enabling Dimensions	Archetype 1 (Basic Digital Transformation)	Archetype 2 (Cross-Departmental Digital Transformation)	Archetype 3 (Scaled Digital Transformation)
Digital technology	**Internet of Things** ▪ Foundation for data collection developed ▪ Infrastructure updated ▪ Visualization tools and dashboards deployed	**Cloud Storage** ▪ Servers and new systems installed ▪ Smart tools, handheld devices and applications used ▪ Systems connectivity and integration established	**Advanced Analytical Tools** ▪ Advanced analytical tools e.g. Azure, ML, edge computing used ▪ Customized application, BI tools and DSS[2] deployed ▪ Parallel computing approaches used
Data	**Descriptive Analytics** ▪ Data generation automated ▪ Data warehouses and operational data stores created ▪ Basic preprocessing of data done	**Predictive Analytics** ▪ Data standardization and integration ▪ Data management systems deployed ▪ Predictive analytics initiated	**Prescriptive Analytics** ▪ Real-time analytics ▪ Frequent data inspection and analysis for value creation ▪ Hidden patterns in data identified for optimal decision making
Processes	**Islands of Automation** ▪ Business process improvement and reengineering initiated ▪ Process restructuring and management initiated ▪ Processes streamlined to become lean	**Scaled Automation** ▪ Majority processes and manhours automated ▪ Digital records maintained ▪ Data-driven process monitoring ▪ Minimal process variability	**Digital Lean Operations** ▪ Real-time communication and high rates of data transfer ▪ Intelligent and independent operating systems ▪ Real-time monitoring of processes ▪ Continuous process improvements
Human Capital	**Digital Competent** ▪ Develop technical skills ▪ Mindset transformation through digital workshops ▪ Coping and overcoming resistance	**Digital Proficient** ▪ Multiskilled workforce e.g. software engineers, data scientists ▪ IT skills enhanced	**Digital Expert** ▪ Knowledge workers and super operators ▪ Data scientists, BI architects, and software engineers ▪ Digital first mindset

[2] Business Intelligence tools and Decision Support Systems

	▪ Dedicated task force for digital initiatives formed	▪ Empowered for collective decision-making ▪ Proficient in machine and system usage	▪ Competencies for digital strategy implementation
Organization Structure	**Vertical Integration** ▪ Automation initiates integration ▪ Tasks become more interdependent ▪ Collaboration, data sharing and constant communication established	**Horizontal Integration** ▪ Functional silos eliminated ▪ Frequent coordination and collaborative learning ▪ Partial autonomy to subunits ▪ Hierarchy minimized with increased interdependency	**Organic** ▪ Lean structure ▪ Decentralized power and control ▪ Transparent communications ▪ Data-driven culture ▪ End-to-end integration
Value	**Process Efficiency** ▪ Reduction in process time and information asymmetry ▪ Favourable cost performance	**Responsiveness** ▪ Rapid problem-solving ▪ Real-time information availability ▪ Increase in sales, cost saving, personalized products ▪ Risk mitigation	**Strategic agility** ▪ Digital Innovation ▪ centricity ▪ Process optimization
Capability	**Connectivity** ▪ Technical interconnectivity ▪ Process improvement	**Visibility** ▪ Interoperability ▪ Operational synergy ▪ Flexibility	**Digital Dexterity** ▪ Adaptability ▪ Speed

5. Discussion

The need to adopt digital technologies to gain competitive advantage has exponentially increased over the past few years (Ardolino et al., 2018; Gürdür et al., 2019). However, confusion prevails regarding the successful DT of firm operations, especially in understanding the interrelation, interdependence and co-development of organizational enablers at the micro-level. Recent studies have placed a particular emphasis on identifying how the workforce impact, or is impacted by, the deployment of advanced digital technologies (Kolade and Owoseni, 2022), the implementation paths of DT (Battistoni et al., 2023), and the micro-level factors that enable DT calling for an in depth understanding of what strategic and operational modifications are required (Sadeghi et al., 2021; Sousa-Zomer et al., 2020). Using a deductive-inductive approach, this study attempts to address this gap by proposing a DT framework underpinned by RBV and STS theories. The RBV provides a theoretical lens to analyze how socio-technical resources are strategically leveraged to reconfigure organizational capabilities. Meanwhile, STS theory explicates the reciprocal interplay between the technical and social

subsystems needed for DT. Furthermore, this study proposes a process model of Digital archetypes representing transitional states distinguished by their digital sophistication. The archetypes reveal how the enablers comprising technology, data, human capital, organization and processes coevolve incrementally to transform capabilities.

The workforce and organization structure belong to the social dimension, while digital technology, data management and processes belong to the technical dimension (Munch et al., 2022; Marcon et al., 2021). The identified digital archetypes illustrate that the enabling dimensions progressively develop across basic DT that fosters process efficiency, cross departmental DT that enables responsiveness, to scaled DT that fosters strategic agility. The enablers and their constituent factors are reconstituted to attain a certain value or output from DT. The process efficiency archetype provides connectivity through a reliable support system for DT by developing the firm's social and technical subsystems. On the technical side, this is done by utilizing IoTs, wireless devices, and RFIDs to generate new data, and digitize and organize existing data for better accessibility and analytics. On the social side, efforts are made to develop digital awareness in the workforce and develop a conducive mindset for DT. Similarly, initiatives to improve the organization structure, reduce hierarchical levels and increase autonomy support data-driven decision making. The significance of pinpointing these enablers and tailoring them to specific needs is reinforced by Mahdiraji et al. (2023). Their study delves into the boundary conditions that impede endeavours related to digital technologies, particularly those concerning digital platforms. They stress that neglecting infrastructural, behavioural, operational, and managerial aspects during the implementation and utilization of digital technology could pose significant obstacles. This underscores the importance of integrating both social and technical dimensions to aptly navigate the intricacies of DT, thereby unlocking its complete potential for value creation.

It is interesting to note that among all enablers, interviews reveal “data” and “workforce” as the two core enablers without which the purpose and essence of DT is not achieved. The participants underscored the crucial interplay between data and human capital, highlighting that the core of achieving DT resides in leveraging high-quality data. The achievement of this goal heavily relies on the expertise of individuals who play a pivotal role in making sense of relevant data and use it for decision making (Gürdür et al., 2019). The analytics tools and techniques can sort and analyze data yet developing insights from the data lies with the workforce. Therefore, firms need to train the workforce to equip them with the necessary data management and analytics skills (Ardolino et al., 2018). The development of the workforce across the three archetypes, digital competent to digital expert, encapsulates the characteristics identified by Sadeghi et al. (2023) as micro-foundation for employees involved in DT. They identify technological management capabilities, knowledge management capabilities and leadership and management capabilities as three broad capability clusters. The digital competent characteristics of the workforce in Archetype 1 display technological and knowledge management capabilities. These capabilities are developed as employees familiarize themselves with the use of technology, understand the data generated and practice knowledge exchange through open communication. The Archetype 2 characteristics of employees are more focused on knowledge management, where they are sufficiently equipped to extract meaningful inferences from data for the business. The archetype 3 characteristics of

digital expert display leadership and management capabilities where the employees, based on a smart outlook, thrive for innovation and identify opportunities through an informed market outlook. The journey from digital competent to expert not only aligns with the micro-foundations outlined by Sadeghi et al. (2023) but also highlights the essential role of mindset transformation in overcoming challenges to digital transformation, thus emphasizing the critical need for adaptable approaches within organizations.

Another interesting discovery from the process modification for DT is the tight intertwining of lean philosophy with DT. From the three archetypes, we see that as processes are improved to support DT, they display characteristics that are identified as lean. DT drive streamlining of business processes to remove non-value adding activities and man hours. DT provide real-time monitoring and decision making that reduce process variability. The use of digital technologies enhances the cross-departmental communications, collaborative working, and social cohesion. These aspects are strongly aligned with the lean philosophy (Arcidiacono et al., 2023; Buer et al., 2021; Merino et al., 2020; Tortorella et al., 2019; Rossini et al., 2021), thereby making DT-induced processes optimal and lean.

Furthermore, appropriate data management systems are also critical (Schniederjans et al., 2020). The sorting, storage, and processing of data for analytics are the main value creation mechanisms in DT. Data analytics helps to develop foresight for the firm (Cenamor et al., 2019), enhance intelligence (Frank et al., 2019), direct the firm towards data-driven decision making (Chatterjee et al., 2022; Rasouli, 2019), and enhance its competitive advantage (Cenamor et al., 2017; Frank et al., 2019). Practitioners also acknowledged this valuable addition and stated that it is challenging to realize the essence of digitalization without understanding data management. The details on the "data" dimension of our DT table and archetypes were widely appreciated by the industry as they felt that the current maturity models and guidelines being used did not provide a granular understanding of it.

Divergences in Digital Archetypes

The heterogenous mix of firms with different states of DT process illuminated some important disparities and variations which impacted the DT of firms. These discrepencies can be broadly classified as (i) the challenges faced by different firms that obstructed the DT process, and (ii) the difference in approaches of firms in pursuing their DT.

Challenges to DT

Firms revealed mindset transformation, business-IT alignment, top management commitment and supply chain players as major reasons that made the DT process challenging.

Interviews revealed ***mindset transformation*** as a significant hindrance for DT. Companies (mostly representing Archetype 1 and Archetype 2) faced a tremendous challenge in reducing the cynicism of employees and making them more adaptable. Studies posit that employee trainings and education, empowerment, skill enhancement and digital awareness are essential and should be focused on throughout the transformation (Bokrantz et al., 2017; Gunasekaran et al., 2018; Kolade and Owoseni, 2022). The CDO of Firm L informed that conducting continuous training and digital workshops was not as impactful as they desired it to be. Any

initiative for DT would be considered a job threat by the workforce especially those that had been using legacy systems since years. Therefore, firms would then need to delve into the different approaches for DT where the respective employees can adapt to the DT change seamlessly.

Additionally, all firms also pointed to the importance of **business-IT alignment** and identified it as an essential enabler facilitating DT. Almost all firms explicitly or implicitly mentioned this aspect and how it played a key role in DT. It was evident from the interviews that firms with strong business-IT alignment had a relatively smooth DT and transitioned through the required initiatives more intently. Studies have also highlighted the critical enabling role of business-IT alignment for the digitalization of operations (de Sousa Jabbour et al., 2018; Sia et al., 2021). Firms at an advanced DT stage (Archetype 3) recalled their planning phase and identified making the IT department the business partner for all other functions as a critical step. Functional and strategic integration between IT and other functional departments greatly facilitated the subsequent DT stages. Firm H and Firm O faced difficulties in the implementation stages due to the lack of business-IT alignment. They mentioned it as a significant barrier where, despite the presence of human, technological and financial resources, the DT initiatives were not frutiful in creating value. This aspect was also evident from the fact that firms that constitute archetype 3 had the strongest business-IT alignment.

Another related factor that held utmost importance was the **top management commitment** and support to the DT agenda. Firms struggled with the development of specific enablers and therefore were less successful in effectively modifying their resources for DT due to the lack of support from the top management. Firm C, though being a multinational firm, faced this issue. The top management for Firm C proposed and pushed the DT agenda in executive meetings yet failed to provide the support required to do so later. This resulted in the DT agenda being constrained to the IT department with other functional departments continued to work in silos.

The **supply chain partners,** though less of a concern by others, were highlighted by Firm D for having a role in the focal firm's ability to leverage their DT. To fully benefit from DT, the partnering firms should also be digitalized to a certain extent and be digitally integrated with the focal firm (Yang et al., 2021), especially for certain processes and transactions that require partner integration. The partners' not being at the bare minimum poses a barrier to the focal firm benefitting from their own systems (Siachou et al., 2020). Insights from interviews also revealed how players with sophisticated levels of DT (Firm D) facilitated basic digital infrastructure for key partners, increasing partner adaptability over time. This underscores the critical role of collaboration and co-evolution of digital capabilities within business ecosystems to maximize value creation (Arciadiacino et al., 2022). The findings align with calls emphasizing digitalization’s reciprocal interplay across supply networks. Firms with greater digital maturity appear positioned to develop alliance capabilities to propel collective transformation.

Approaches to DT

The interviews analysis and findings revealed that the DT pattern and overall approach is similar for all type of firms in the manufacturing and services industry. A subtle difference in the data dimension existed between the two sectors. Owing to the nature of their businesses, financial institutions and telecommunication companies already had vast amounts of data in the systems, which were mainly used for reporting financial KPIs. However, data generation was the key initial step in the case of the manufacturing firms. The DT pattern for both industries remained the same despite this difference.

Similarly, the approach to DT varied slightly across firms belonging to different sectors and industries. Some firms started with proper and careful planning, while others began with digital technologies' experimentation and gradually formalized their use. Either way, the DT pattern did not change as each archetype developed unique capabilities and created a specific value for the firm. Li (2020) states three approaches to digitalization: first, innovating by experiments; second, a radical approach to digitalization; and third, a dynamic sustainable approach achieved through temporary advantages. The archetypes identified in our study propose that firms can achieve radical transformation in stepwise manner as they move from basic to cross-departmental to scaled digitalization. In this approach, the firm achieves its DT through smaller and more manageable strategic decisions and steps. Each step determines the course of action for the subsequent steps and transition state. An advantage of this approach is that at each archetype, the firm can assess whether the investments and initiatives for DT are working well for the firm and if the firm has the flexibility to redirect and revise its DT approach (Li, 2020).

5.1 Theoretical Implications

This study makes several theoretical contributions to the domain of digital transformation. First, the study identifies and validates the specific and essential socio-technical enablers that facilitate the DT of firms. The starting point of any initiative is based on the knowledge of the antecedents and how they need to be modified to achieve that initiative. In the realm of DT, the extant literature has identified the need for identifying these enablers and unearthing how these enablers facilitate DT. This study, using RBV and STS, unearths the interrelation between enablers that facilitate DT, which addresses the call for assessing the combinative effect of different factors (Sousa-zomer et al., 2020). Furthermore, the detailed case analysis also elucidates the modifications in these enablers that advance the DT of a firm. The detailed characterizaton of enablers for each stage of the transformation informs the DT by unearthing and explicating the composition of the enablers (RQ1 and RQ2). The nature and composition of enablers contribute to the DT literature in general and also informs the DT strategy domain which calls for a granular understanding of the startegic actions and factors that constitute a firm's digital strategy (Fernandez-Vidal et al., 2022).

The Digital archetypes identify the unique structuring and interrelation of an organisation's social and technical (digital technology related) resources to realize DT and its value. The archetypes provide holistic DT frameworks, while each enabler in the archetypes provides a theoretical construct specific to the context of DT (RQ3). These constructs and their interrelation contribute to the DT literature that displays a lack of constructs and variables specific to it. These constructs can be quantified and empirically validated to assess the capability and value creation of DT. This study also provides insights into the contingent

factors that can be tested as moderators or mediators in the DT framework. These contingent factors are the challenges of DT that can be used to extend the DT framework by including business-IT alignment, top management commitment or mindset transformation relevant attributes as contingent factors.

Our study also provides the potential to inform and extend the microfoundation literature by validating the socio-technical enablers, their interdependence and, Digital archetypes that can be useful in developing microfoundation concept in realms of DT. Furthermore, identifying "data management" and "technology management" as crucial elements of the DT, the concept of microfoundation can be extended beyond individuals, processes and organization structure.

Each DT archetype of the study identifies a set of capabilities developed. There is a cushion to understand whether the development of capability progresses cumulatively or some tradeoff pattern is involved in the capability development from one archetype to another. This shall broadly inform the DT capabilities literature and has the potential to use, combine or extend theoretical viewpoints such as tradeoff theory or cumulative capabilities theory.

Furthermore, the study also supports the DT business model literature by identifying the critical resources, their development for digital maturity and how they create value through DT (Zahoor et al., 2023). The business model literature can draw insights from the enablers and their granular characterization about the basic technical and organizational infrastructure that shall support the DT based business model.

The transition of each dimension from basic to scaled digitalization also confer with theories in the literature. For instance, the digital technology dimension depicts how each new technology is based on the previous one and cumulatively develops the firm's technological proficiency. This notion is similar to the combinatorial technology evolution theory (Arthur, 2009) or the technology development process (Teece, 1996) that indicates the cumulative nature of the technology development based on the earlier technologies. The transition of data generation and utilization from an ad hoc state to advanced analytics has also been informed in literature (Ardolino et al., 2018; Arcidiacono et al., 2023). These studies show how data is initially digitized through technologies, and along with the transformation, the data management tools advance for storage, computing and analytics. Similarly, the organizational and technological integration in the proposed framework is aligned with the business process integration levels proposed by Bernus et al. (2003). These levels depict how technological and organizational integration go hand in hand, from heterogeneous technologies and functional silos to end-to-end integration and interdependent processes.

In sum, these theoretical implications extend and enrich our understanding of DT, advancing the domain and paving the way for future research endeavours that contribute to the dynamic and evolving landscape of DT induced organizational change.

5.2 Practical Implications

The findings of this research provide valuable insights and practical strategies that managers can employ to steer their organizations' DT. This research outlines a structured pathway,

highlighting several critical dimensions that are instrumental in navigating the complex DT process effectively for business leaders:

First, Digital Technology Adoption Paths: The study introduces Digital archetypes that outline a clear passage for managers to follow a phased, methodical approach from foundational DT efforts to comprehensive cross-departmental integration, leading to extensive DT at scale. The archetypes entail the integration of socio-technical systems at each phase, providing managers with an itemized checklist of necessary hardware, software, and other organizational changes that need to be established alongside expected outcomes. Managers can map their firms according to the archetypes. They can assess the state of their DT to calibrate investments in technology at each stage, ensuring informed decision-making and expected outcomes.

Second, Human Capital Development: The pivotal role of workforce competencies and attitudes is underscored, advocating for significant investments in training, upskilling, and nurturing a digital mindset to facilitate and leverage DT. Managers can plan the development of their workforce as per the evolving training needs across different stages of DT for their firm. It provides evidence for more target recruitment, proposing a strategic shift. necessitates a strategies from stage 1 in having digital skills as a bolt-on, to stage 3 for strategy of digital-native workforce. The archetypes offer a framework to managers for assessing human capital readiness, ensuring the workforce is primed for the demands of each DT stage. Additionally, the findings can equip managers with insights to develop contingency plans in the event that trainings and workshops fail to reduce resistance or achieve the necessary mindset transformation sufficiently.

Third, Organizational Change Management: The research emphasizes the imperative for managers to navigate the organizational restructuring necessitated by DT aptly. It forecasts the transition from traditional departmental silos within a hierarchical framework to a streamlined, end-to-end operational model that champions cross-functional collaboration. The Digital archetypes explicate how departmental boundaries are expected to blur, task force orientations will shift, and data-sharing practices will change. This suggests a need for a dynamic, possibly more flattened organizational structure that aligns with the maturity level of DT. The suggested characteristics of organisational structural and behavioural changes for each DT stage are indicators for managers to determine the timing of DT stages and prepare for them accordingly.

Fourth, value creation across DT stages: This study highlights that DT has the potential to reduce costs and generate revenue. It provides managers with detailed insights into the economic benefits of DT at each stage, from cost-efficiency (Archetype 1) to revenue-centric models powered by digital innovations and customer centricity (Archetype 3) at later stages.

Fifth, Stakeholder Integration and Ecosystem Perspective: As DT progresses to advanced stages, managers can initiate integrations with customers and supply-side partners. They can adopt an ecosystem-wide approach, fostering proactive collaboration and knowledge sharing with all stakeholders in the value chain. This strategy not only enhances the potential for digital innovation but also creates avenues for new product development, ultimately strengthening the organization's competitive edge in the digital economy.

Finally, Holistic Overview of DT Components: the study presents a comprehensive framework that merges the social and technological facets of DT. This offers a panoramic view of the DT landscape, namely, as an assemblage of digital technology, data processing, human capital, organization structure and value creation. This holistic perspective equips managers with the tools and checklist of items to conduct a thorough assessment of their DT initiatives at each stage, against expected value extraction. It enables managers to identify potential gaps and prepare for subsequent phases with a well-rounded understanding of the requisite components.

In essence, the research provides a robust, actionable blueprint for managers to navigate the digital transformation of their organizations. By addressing the multifaceted challenges and opportunities presented by DT, managers are better positioned to leverage digital technologies, cultivate a future-ready workforce, and orchestrate organizational agility, thereby driving sustained value creation in the digital age.

6. Limitations and Future Research Directions

This study offers a comprehensive exploration of avenues for future research within the realm of DT. Firstly, there is a notable opportunity for a longitudinal study, providing a nuanced and insightful perspective on the transformation process over time. Such an approach could contribute to a deeper understanding of the evolving dynamics inherent in DT initiatives. Secondly, the proposed generic DT framework, tailored for the manufacturing and services sector, presents an opportunity for researchers to validate and refine the model to targeted industrial sectors, thereby enhancing its generalizability across diverse contexts. Thirdly, the dimensions of cyber security and financial aspects, recognized as significant factors in the DT discourse, remain unexplored in this study due to limited clarity on their development or progression. A study by Rezaei et al. (2021) has also identified responsibility, privacy and security as essential ethical considerations in the realms of DT. Therefore, owing to their necessity for DT and lack of understanding, future research endeavors can focus on investigating these dimensions and incorporating them into subsequent DT frameworks, thereby enriching the comprehensiveness of the models. Fourthly, while this study identifies Digital archetypes, empirical testing through statistical means has not been undertaken. This represents a promising area for future research, allowing researchers to rigorously test the identified archetypes and contingency factors, providing a more robust understanding of their applicability and impact.

Additionally, there is potential for more research by testing individual enablers within archetypes. This can provide a nuanced understanding of the complexities of transformation in specific dimensions, such as data and digital technology. This is particularly important given the continuous evolution of these technologies. Furthermore, the predominantly inward-looking focus of the enablers, rooted in the Resource-Based View (RBV), prompts an extension of this research to explore external factors influencing DT. Applying the Resource Dependence Theory, future research could explore how external dependencies, such as industry collaborations, partnerships, or regulatory frameworks, impact and contribute to the broader digital transformation landscape, offering a more holistic understanding of the influencing factors.

APPENDIX A – Semi-structured Interview Guide

General

a. On a scale of 1- 3; where would you rate yourself with respect to digital transformation of your organization? With 1 = planning phase, 2 = implementation phase, 3 = utilization phase
b. What are the main drivers for your organization's investments in digital technology?
c. Which department/function in your organization has the main responsibility for digitalization?
d. In your opinion what capabilities and values have developed as a result of digitalization?

Dimensions

1. Digital technologies
    a. Which technologies[3] did the firm adopt for digitalizing itself and what changes did these technologies bring in the data management of the company?
    b. Was there a sequence of adoption of these technologies?
2. Data
    a. Does your firm store and process the data generated by digital technologies?
    b. How does your firm manage and analyze the data?
        i. Are there any form of data management tools being used by the firm?
        ii. What are the different data storage devices being used, if any?
        iii. Is the firm using analytical tools for data analysis?
3. Integration
    a. How does adoption of digital technologies contribute to organizational integration?
    b. What are the different goals of integration that your firm achieved or intends to achieve from digital technologies?
    c. How did digitalization at your firm inform the different types of integration: *network integration, data sharing, application integration, business process level integration?*
4. Organization structure and HR
    a. What changes were made in the organization structure and processes during digitalization of the firm?
    b. What are the different stages of change your organization went/is going through during digitalization?
    c. How do HR skills and roles change during digitalization?
5. Capabilities
    a. What capabilities are developed in the organization through digitalization?
    b. What value generation is realized from digitalization or relevant initiatives?
    c. Is there a sequence to the development of capabilities from digitalization?

Stages

[3] By digital technologies the author means use of internet, Internet of things which includes wireless devices which exchange or transmit data, storages such as cloud or local ones, big data or any form of analytics which is performed on the generated data.

a. Were there any stages the firm went through during the digital transformation?
b. Can you name and explain the different stages and briefly describe the status of processes and technologies at each stage?

End

a. Is there anything you think we have missed about digitalization during the interview that you wish to bring up?

APPENDIX B - Synthesis of within case analysis of Sixteen firms

	Digital Transformation Readiness		**Digital Transformation Realization**	
Stages / **Dimensions**	Stage 1 (Business as usual)	Stage 2 (Basic Digitalization)	Stage 3 (Cross Departmental Digitalization)	Stage 4 (Scaled Digital Transformation)
Digital Technology	**Legacy Systems**	**Internet of Things**	**Cloud Computing**	**Advanced Analytics Tools**
	Use	**Use**	**Use**	**Use**
	- Legacy equipment/systems used - Systems used for specific business tasks - Usual technology upgrades	- RPAs used for equipment level automation - Devices such as tags, sensors, RFID start being used for a specific task - Simplify/update infrastructure	- Cloud or centralized central storages used - Smart tools, handheld devices and applications used - Power BI used - Installation of servers and new systems	- Use of Azure machine learning, Microsoft power applications - Edge computing, AR, VR start coming into practice - QLIK, BI tools, DSS deployed - Customized solutions for analytics are used
	Nature	**Nature**	**Nature**	**Nature**
	- Systems and infrastructure incapable of handling data - No systems integration, technology functioning in silos - Physical heterogeneity of machines and devices	- Visualization tools and dashboards deployed - Foundation for data collection and machine to machine communication established	- Connectivity between systems - Technologies/systems start integrating	- Initial working on AI, Machine learning, deep learning - Parallel computing approaches used - Customized application developed
Data	**Ad hoc Data Management**	**Descriptive Analytics**	**Predictive Analytics**	**Prescriptive Analytics/cognitive analytics**
	Data Characteristics	**Data Characteristics**	**Data Characteristics**	**Data Characteristics**

	- No data storage or retrieval systems - Mix of manual and automated data - Data scattered and in bad shape - Data management or interpretation not a concern - No data standardization	- Data not available readily rather extracted from designated systems - Basic data preprocessing done, descriptive analytics - Automate data generation through sensors	- Data generation increases - Data is standardized and has a defined schema - Data integrated from all sources	- Data accessibility increases - Data from internal and external sources utilized
	Data Management	**Data Management**	**Data Management**	**Data Management**
	- Excel used to record data - Data in silos - only used for reporting of financial KPIs - Information and technology both not considered crucial	- Create data lakes linked to all data sources - Data warehouse and operational data stores created	- Data management systems deployed - Data stored in structured databases - Processes for data storage and processing organized and defined at this stage - Predictive analytics done	- Centralized database created, stored in SQL servers - Big data management systems deployed (if required) - Real-time analytics/ prescriptive analytics - Data inspected, transformed and analyzed to extract values - Hidden patterns of data identified and used for decision making
	Digital Novice	**Digital Competent**	**Digital Proficient**	**Digital Expert**
	Role	**Role**	**Role**	**Role**
	- Executing assigned tasks - High cynicism - Classical IT shows resistance	- Gain knowledge of how and when to apply skills for technical initiatives	- Employees can manage machine and systems - Empowered for collective decision making and problem solving	- Employees become knowledge workers and super operators - Employees understand business and IT both
	Skills/Trainings	**Skills/Trainings**	**Skills/Trainings**	**Skills/Trainings**

Human Capital	- Basic internet skills - Adhoc IT efficacy - Trainings for awareness and adaptability conducted	- Work on resistance points - Conduct digital workshops for mindset transformation - Technical trainings to enhance employee skills	- Conduct trainings on new systems, digital tools and technologies and on analytics - Multiskilled workforce – software engineers, data scientists - IT skills enhanced	- Data scientists, BI architects and software engineers - Employees can analyze and interpret data - Digital first mindset and redefined competencies - Digital skills and digital capabilities developed for digital strategy implementation
	Teams Formed	**Teams Formed**	**Teams Formed**	**Teams Formed**
	- Digital Champion assigned - Dedicated task force/committee formed	- Basis of the information security team in place	- Teams based on capabilities such as analytics, application development start to form	- Information security team and Digital team formed separately - Application development team
Organization Structure	**Mechanistic**	**Vertical Integration**	**Horizontal Integration**	**Organic**
	Practices	**Practices**	**Practices**	**Practices**
	- Higher levels of hierarchy - Vertical decision making - No autonomy - Functional silos exist	- Automation initiates integration - Tasks become more interdependent - Cross-functional teams formed	- Silos eliminated, increased interdependency - Hierarchy minimized; reduced communication gap with top management - Increased autonomy - Ongoing mindset transformation	- Consolidation - Integrated functional departments, connectivity between departments leveraged - Minimal hierarchy - Lean structure - Paperless environment
	Impact	**Impact**	**Impact**	**Impact**
	- No integration - Communication gap with top management - Decision making based on intuition	- Collaboration, data sharing and constant communication	- Collaborative learning - Frequent coordination and internal collaboration - Decision making allocated to subunits to some extent	- Flexibility to initiate change - Decentralization of power and control - Transparent and communication-oriented space

		- Departmental Coordination increases for technical issues - Informal face to face communication increases		- Data-driven culture - End-to-end digital integration
Processes	**Mechanized**	**Islands of Automation**	**Scaled Automation**	**Digitalized Operations**
	Nature	**Nature**	**Nature**	**Nature**
	- Mostly manual operations with heavy reliance on workforce - Paper-based work - Business units use electromechanical system - Physical channels for customers	- Automation of repetitive tasks done through RPAs - IT incorporated in business processes to some extent - Technical connectivity is established	- Scaled automation – spans to majority processes - Man hours automated - Standard technological processes are established	- Automatic monitoring of processes - Intelligent and independent operating systems - Digitized operations - Lean processes
	Impact	**Impact**	**Impact**	**Impact**
	- Minimal process monitoring - Islands of automation, not leveraged fully	- Business process improvement and reengineering initiated - Process structuring and management initiated - Processes streamlined	- Digital records start being maintained - Data for process monitoring becomes available	- Real-time communication - High rates of data transfer - Real-time monitoring of processes
Value Created	**Local Optimization**	**Process Improvement**	**Interoperability**	**Strategic Agility**
	- Local optimization - Cost saving - Minimal learning - Product centricity	- Cost reduction - Improvement in KPIs - Reduction in process time Reduction in information asymmetry	- Rapid problem solving - Real time information availability - Interoperability - Increase in sales, cost saving, personalized	- Data driven decision making - Better control due to real-time data - Uninterrupted access of data - Process optimization - Making better strategy - Costumer centricity

			products and risk mitigation - Transparency - Speed	
Capability	**Uninterrupted Routine Tasks**	**Connectivity**	**Visibility**	**Digital Dexterity**
	- Traditional way of work - Critical tasks have systems assigned that aid seamless execution	- Technical interconnectivity - Favourable cost performance	- IT capabilities leveraged through entire business processes - Operational synergy achieved - Flexibility - Responsiveness	- Business intelligence and decision support systems developed - Agility - Innovation - Adaptability

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