Digital Strategy Formulation: An Investigation with Design Sprints and Deep Learning

This thesis is submitted for the Degree of Doctor of Philosophy

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This thesis is dedicated to my father and my uncle:
Ali Ghanim Al-Ali and Abdulrahman Ghanim A-Ali

DECLARATION

This thesis is the result of my own work and includes nothing which is the outcome of work done in collaboration except as declared in the preface and specified in the text. It is not substantially the same as any work that has already been submitted before for any degree or other qualification except as declared in the preface and specified in the text. It does not exceed the prescribed word limit for the Engineering Degree Committee of 65,000 words, including appendices, footnotes, tables and equations, but excluding the bibliography, and 150 figures.

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ABSTRACT

Since the invention of transistors, digital technologies have continued to have a profound impact on the global economy. Relentless performance improvements combined with convergence of digital technologies such as artificial intelligence, internet of things, and cloud computing has led to a surge in scale and importance as a source for competitive advantage. However, in 2019, only around 16% of companies managed to realize a significant improvement in business performance from digital transformation (DT). The challenges that organizations face in succeeding at DT can be traced back to strategy formulation and execution. Therefore, the aim of this research is to develop insights and tools to enhance the understanding and practice of digital strategy formulation.

A comprehensive review of the literature demonstrated that DT, as an emerging body of knowledge, is lacking an in-depth and applied investigation of digital strategy formulation. The main knowledge gaps are: (1) a lack of guidance on digital strategy formulation process activities and outcomes; (2) limited consideration of the iterative nature of digital strategy formulation and validation; and (3) limited empirical investigation of digital strategy archetypes to guide the formulation process.

Addressing this research gap was accomplished over three stages. First, an in-depth exploratory case study was conducted by investigating digital strategy formulation process with active participation research over six months. This investigation identified key process activities and highlighted the role of roadmapping in integrating the outcomes. Second, the findings were supplemented with literature review to design a conceptual framework for agile roadmapping to facilitate the digital strategy formulation process. This framework was then tested and calibrated over three pilot studies with companies across Europe attempting to start their DT journey. Finally, deep learning and natural language processing techniques were employed to empirically investigate the digital strategy of Fortune 500 companies from earnings call transcripts. This empirical investigation identified four digital strategy archetypes that are being employed by companies across various sectors.

The findings from this research contribute to a better understanding of digital strategy formulation. It was identified that digital strategy formulation is an ongoing search process for an adequate strategic response to the DT of the economy. Specifically, incorporating agility

into the formulation process is an effective way of managing the associated uncertainty of DT. Moreover, the findings demonstrated that proactively iterating between strategy formulation and validation can accelerate the realization of the emergent digital strategy. The proposed framework and the digital strategy archetypes provide a baseline for DT professionals toward a more robust digital strategy formulation.

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1. INTRODUCTION

1.1 Research Background

This chapter provides an overview of Digital Transformation (DT)[1]; specifically, how digital technologies are reshaping parts of the economy and therefore creating opportunities and challenges for companies. The objective of this chapter is to present the research background, aim, and objectives.

Digital technologies have penetrated many aspects of the economy. Both industry and society depend on digital technologies for everyday life. The growth of data, computation, connectivity, and communication is unprecedented (Bharadwaj *et al.*, 2013). The convergence of digital technologies, along with their plummeting costs, have enabled the rise of new digital business models (World Economic Forum and Accenture, 2016). This shift is dominated by technology giants along with startups. Large companies that built their success in a pre-digital economy are left disadvantaged (Sebastian *et al.*, 2017). Therefore, the DT of large companies is seen as a growth opportunity as well as an existential threat. However, developing a robust approach to DT remains an open challenge.

The evolution of digital technologies can be traced back to the 1940s. This is when the first computer and the transistor were invented. Since then, digital technologies are maintaining an exponential growth in performance as characterized by Moore's law (Venkatraman, 2017). While this growth trajectory is arguably not sustainable (Rotman, 2020), digital technologies have made immense progress. Today, a smart watch has more computational power than Apollo 19. This abundant growth in digital technologies has serious implications on the global economy. The World Economic Forum estimates that the "value at stake" of DT, the cumulative value to both industry and society, could reach $100 trillion by 2025 (World Economic Forum and Accenture, 2016). More specifically, it is estimated that by 2022, 60% of the global gross domestic product (GDP) will be digitized (World Economic Forum, 2019). This phenomenon is referred to as the digital economy. Hence, the survival of large companies depends on the successful integration of digital capabilities across their value chains. However, recent surveys showed that around 34% - 16% of companies embarking on DT achieved a significant improvement in business performance (de la Boutetière *et al.*, 2018; Correani *et al.*, 2020). The remaining companies were reported to have varying degrees of success.

[1] Defined in section 2.2 as: *"The effort of leveraging digital technologies to realign the business scope, offerings, or operations of an organization to the digital economy and generate value that results in improved business performance."*

Organizational transformation is not a new phenomenon. Information technology (IT)-enabled transformation has been researched since the 1990s (Venkatraman, 1994). This led authors to argue that DT is an evolution of IT-transformation (Reis *et al.*, 2018). However, DT typically goes beyond organization boundaries in terms of scope and has a profound impact on value creation (Vial, 2019), making it of strategic importance to the competitiveness of an organization (Bharadwaj *et al.*, 2013). Moreover, the processes and practices that differentiate "digital native" companies are focused on innovation and agility more than the mere use of digital technologies (Ries, 2011).

Planning for DT is formalized through digital strategy formulation (Bharadwaj *et al.*, 2013). Digital strategy consists of content, the future state as a digital enterprise; and context, the process and activities required for formulating and executing the plan (Vial, 2019). A dynamic approach to DT is needed to match the dynamics of the digital economy (Westerman *et al.*, 2014). The literature presents dynamic concepts for managing DT such as agile practices (Fuchs and Hess, 2018), roadmapping (Parviainen *et al.*, 2017), dynamic capabilities (Yeow *et al.*, 2018), and emergent strategy (Chanias *et al.*, 2019). However, a practical approach to integrating such concepts and theories into the digital strategy formulation is lagging behind (Chanias *et al.*, 2019). Moreover, in terms of digital strategy content, while some authors recommended strategy options (Sebastian *et al.*, 2017), an empirical investigation of digital strategy types is needed (Tekic and Koroteev, 2019).

1.2 Research Aim and Objectives

As presented in section 1.1, the value at stake, the limited success of organizations, and the limitation of current research calls for an applied investigation of digital strategy formulation. Therefore, the aim of this research is:

To develop insights and tools that enhance the understanding and practice of digital strategy formulation within companies.

The research aim has been translated to actionable steps in the form of the following research objectives:

- **RO-1:** Identify key process activities and outcomes required for formulating a digital strategy

- **RO-2:** Develop an applied framework to aid the iterative formulation and validation of the digital strategy

- **RO-3:** Identify the main digital strategy archetypes that may guide the formulation process

1.3 Thesis Structure

The structure of this thesis is shown in Figure 1.1. Following this introductory chapter, Chapter 2 provides a comprehensive review of the literature. The main focus of the literature review was to investigate the body of knowledge on DT. Specifically, the current discourse around DT capabilities and strategy formulation was critically evaluated. Chapter 2 ends with the identification of the knowledge gaps this research aims to fill which are addressed in Chapters 4-7. Chapter 3 outlines the research approach followed to answer the research question. Mixed methods were used to balance the depth and breadth necessary to cover the research objectives.

Chapters 4 to 7 are self-contained; as such, their respective research design and discussion sections are integrated into each chapter. Chapter 4 presents an in-depth exploratory case study on the DT planning process of a Fortune Global 500 airline. The findings set a baseline for the remainder of the research chapters. In chapter 5, a conceptual framework for agile DT roadmapping is designed, based on findings from Chapter 4 as well as the literature around strategic roadmapping and agile concepts. Chapter 6 moves on to testing and calibrating the framework that was conceptualized in Chapter 5 through three pilot studies. The pilot studies followed an action research approach to integrate findings for further refinement of the framework. The findings from Chapter 6 demonstrated the need for an empirical investigation of digital strategy archetypes. Chapter 7 is quantitative in nature, presenting an analysis of the digital strategy patterns of the Fortune 500 companies. This was accomplished by applying text-mining techniques to earnings call transcripts of the sample companies. The 17 topics in of analysis were defined from the literature review findings in Chapter.

Chapter 8 is the final chapter of this thesis and outlines the answers to the research questions. Moreover, it presents the practical, theoretical and methodological contributions of this research to the current state of knowledge. The chapter ends with concluding remarks. A list of references follows, and the thesis concludes with the appendices.

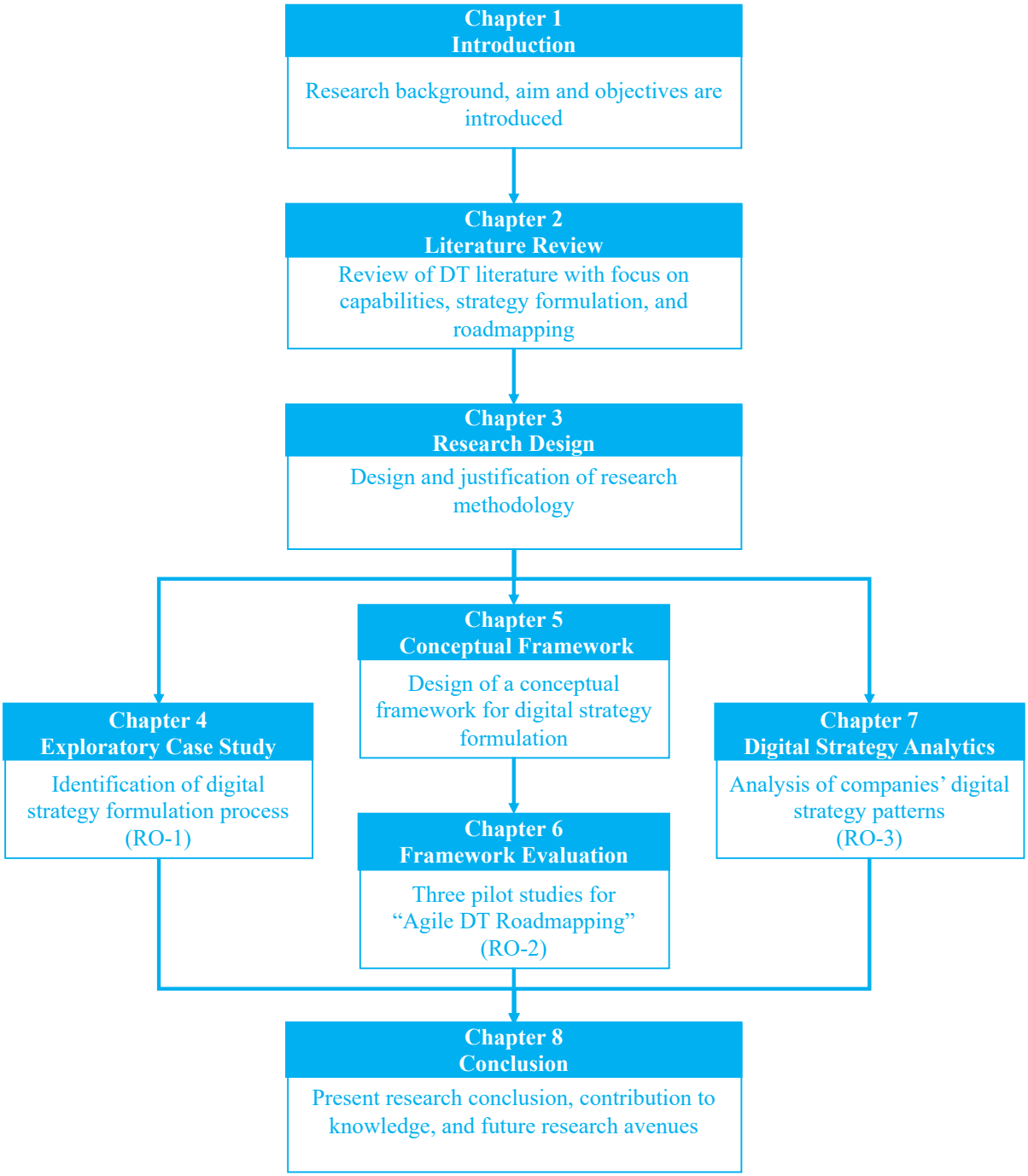

Figure 1.1: *Thesis structure*

2. LITERATURE REVIEW

2.1 Introduction

DT is an emergent body of knowledge. The investigation of the literature is focused on critically evaluating the state of the art in respect to DT strategy formulation and execution. DT is considered a multi-disciplinary field that is studied by management scholars, engineers, computer scientists, economists, physicists, and social scientists. Given the nature of this research, the literature review focuses on management practice and expands into other areas where relevant. The goal of this research is to enhance the understanding of how organizations can improve the success of their DT journey. Therefore, the definition of DT has guided the scope of this literature review.

It was critical to start the literature review by reviewing DT definitions and adopting a working definition for this research. This is addressed in section 2.2 along with a review of systematic review papers on DT. Section 2.3 investigates digital strategy, current frameworks, and main limitations. Section 2.4 focuses on the theoretical underpinning of digital strategy and evaluates its suitability to explain such a phenomenon. DT capabilities are then critically evaluated in section 2.5 to be contrasted against the available approaches for digital strategy formulation. Section 2.6 explores the suitability and readiness of roadmapping to serve as a framework for DT strategic planning. Finally, section 2.7 provides a summary of the literature along with the identified knowledge gaps.

2.2 Digital Transformation

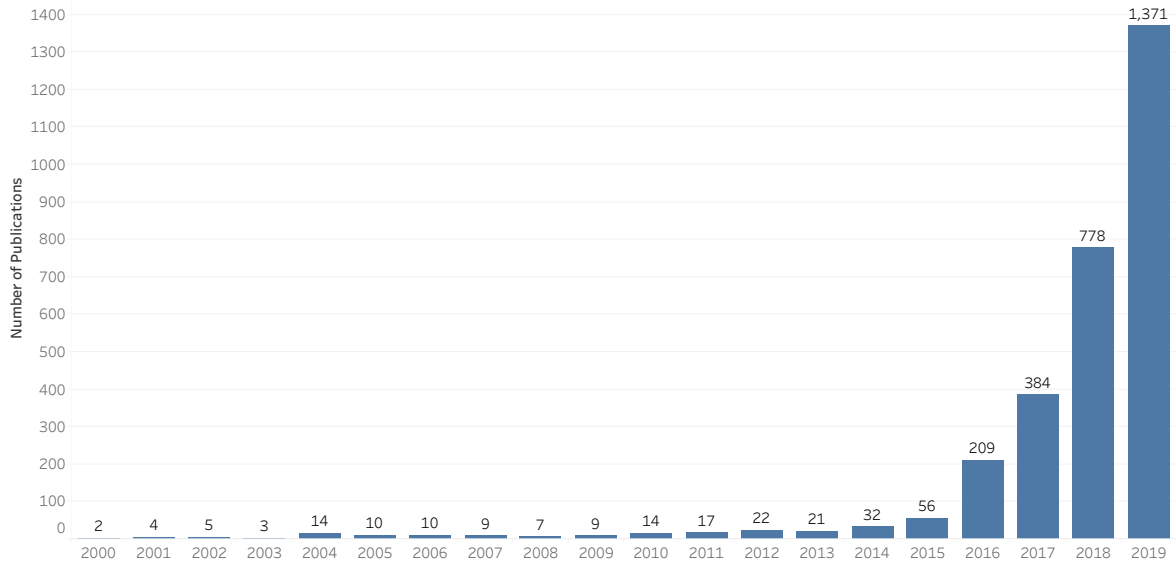

Figure 2.1: *Publications with DT in the title from Scopus database (2000–2019)*

DT research is at an early stage. The Scopus database indicates exponential growth in DT literature (Figure 2.1). Publications in this field grew almost 25-fold over the last 5 years (2015–2019). This reinforces the point that although digital technology inventions started in the 1940s, DT as an organizational phenomenon is relatively new. This section of the literature review provides a definition of DT and an overview of the DT research landscape.

2.2.1 Digital Transformation Definition

There is, as yet, no agreed definition of DT. Vial (2019) analyzed 23 definitions and synthesized a general definition that covers the context of organizations, society, and industry. For the purposes of the present research, only those definitions with organizational context were considered. Thirteen of the 23 definitions were found relevant and three more were added from other sources (Parviainen *et al.*, 2017; Bockshecker *et al.*, 2018; Reis *et al.*, 2018). These definitions covered four dimensions with varying degrees of focus: the *target* entity, the *scope* of DT, the *means* used for DT, and the desired *outcomes* (Vial, 2019). For this research, DT is defined as follows, based on the thematic analysis and synthesis of the 17 definitions as demonstrated in Appendix A1:

The ongoing effort to leverage digital technologies to realign the business scope, value proposition, and/or operations of an organization as a response to the digital economy and to generate value that results in improved business performance.

Hence, the following aspects are considered in this definition:

1. **Target:** Organizational level
2. **Form:** An ongoing effort
3. **Driver:** Respond to the opportunities and challenges of the digital economy
4. **Scope:** The business scope, value proposition, and/or operations
5. **Means:** Multiple digital technologies
6. **Outcomes:** Improved business performance.

Two observations were noted from analyzing the definitions:

1. The scope of DT covered a wide spectrum, from improving processes to reinventing a business value proposition.

2. The focus on the drivers for DT and the type of activities involved was insufficiently covered.

It can be argued that the scope of DT is dictated by its drivers. For example, the manufacturing industry is driven to leverage advanced automation for operational efficiency (Riasanow *et al.*, 2020), whereas the media industry is reinventing itself to predominantly operate through the digital medium (Hess *et al.*, 2016). Therefore, the degree to which a company is digitally transformed is driven by internal and external forces with the aim of benefiting from or avoiding the risks of the digital economy. Moreover, there is a lack of clarity as to whether DT is a process, an initiative or an ongoing effort.

The provided definition puts an emphasis on DT being a moving target. As discussed in section 1.1, by 2022, 60% of the global GDP is anticipated to be produced through digital technologies. This segment of the economy is referred to as the digital economy. The main objective of an organization's DT efforts is to realign organizations to this economic shift. This alignment aims to sustain or improve business performance. The outlined definition has been adopted by the present research when referring to DT.

Three keywords frequently arise in the context of DT: digitization, digitalization, and digital innovation. They are often confused as synonyms of DT. Bockshecker, Hackstein and Baumöl (2018) carried out a systematic literature review and analyzed 46 definitions of digitization, digitalization, and DT. Nambisan *et al.* (2017) provided a conceptual framework for theorizing digital innovation management research and offered a definition for digital innovation. The definitions are listed in Table 2.1 and illustrate a clear difference from DT. Digitization is the activity of transforming information from analog or physical to a digital medium (Bockshecker *et al.*, 2018). Digital innovation is the innovation process that includes the ideation, design, development, diffusion, and assimilation of digital solutions (Nambisan *et al.*, 2017). In this sense, digitization is an activity that can take place in the digital innovation of a business process, offerings, or business model. Digitalization, on the other hand, is the state or maturity of digital development in an organization (Bockshecker *et al.*, 2018).

Table 2.1: *Definition of DT-related terminologies*

Keyword	Definition	Sources
Digitization	*"The technological transformation of 'analog information into digital format' (Freitas Junior et al., 2016) including the development of digital infrastructure. Objects of digitization are technological processes and 'artefacts with their features, functionalities, and affordances' (Jackson, 2015)."*	Bockshecker, Hackstein and Baumöl (2018; p.8)
Digitalization	*"The state of an organization or a society referring to its current digital development and usage of ICT innovations."*	Bockshecker, Hackstein and Baumöl (2018; p.8)
Digital innovation	*"The creation of (and consequent change in) market offerings, business processes, or models that result from the use of digital technology."*	Nambisan *et al.*, (2017; p.224)

2.2.2 Literature Review Papers

This section provides an overview of the topics investigated in the DT literature review papers. Eight relevant papers were identified in the Scopus database. The number of sources analyzed in these papers demonstrates the exponential growth in the field: in 2014, 17 sources were analyzed (Cziesla, 2014); this number grew to 528 in 2019 (Pihir *et al.*, 2019). Another growth indicator is the increase in depth and breadth of covered topics. Four main topics were identified as core to the DT body of knowledge:

1. Drivers for DT
2. Use of digital technologies
3. Management of DT
4. Cases of DT in various industries.

Each topic is elaborated in the remainder of this section.

Drivers for DT

The following opposing views on the drivers of DT have been proposed:

1. The convergence of various digital technologies is enabling a new innovation paradigm for organizations in terms of interacting with customers, conducting business, and managing information (Henriette *et al.*, 2015; Kutzner *et al.*, 2018; Morakanyane *et al.*, 2018). Hence, DT is driven by business opportunities.

2. DT is a response to challenges caused by digital startups, changes in customers' expectations, and increasing operational complexity (Cziesla, 2014). Hence, DT is driven by competition and expectations.
3. The driving force goes through a reinforcing cycle and is both an opportunity and a response to the competitive landscape. This mainly depends on the digital maturity of both the organization and the industry in which it operates (Kutnjak *et al.*, 2019; Pihir *et al.*, 2019; Vial, 2019).

Vial (2019) analyzed the main research building blocks of DT as a process (Figure 2.2). Vial's investigation demonstrated that driving forces for DT go through a reinforcing cycle (Figure 2.3) which is in line with the innovation diffusion curve (Rogers, 2003). The cycle starts by an improvement in the maturity of digital technologies that enables innovators to build new capabilities. Those capabilities would then influence customers' expectations as well as challenge competitors. Followers would then digitally transform as a strategic response to those changes. Therefore, the present research is in favor of argument 3 above.

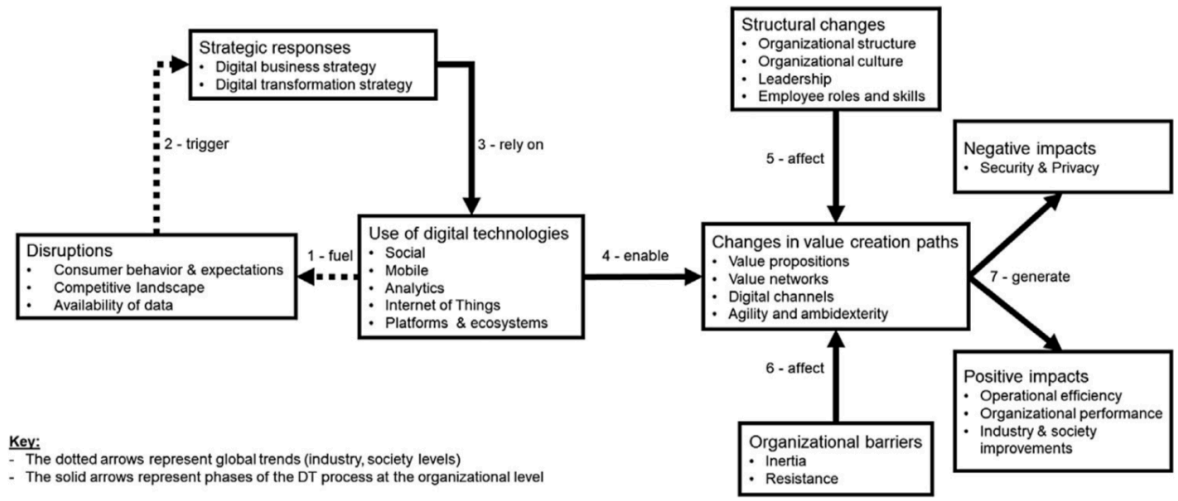

***Figure 2.2**: DT building blocks (Source: Vial, 2019)*

Use of digital technologies

Digital technologies are seen as the core component for DT. However, there has been limited research on how to identify, define, and use digital technologies. Authors mostly cite Westerman *et al.* (2011) and Sebastian *et al.* (2017) for social, mobile, analytics, cloud computing, and Internet of Things (SMACIT) as the main digital technologies (Cziesla, 2014; Henriette *et al.*, 2015; Morakanyane *et al.*, 2018; Vial, 2019). Other digital technologies, such as blockchain, digital platforms, 3D printing, and virtual and augmented reality (VR/AR), are

less considered in the mainstream DT literature. Moreover, authors follow Bharadwaj *et al.* (2013) in categorizing digital technologies as information, communication, computing, and connectivity (Kutzner *et al.*, 2018; Vial, 2019). The taxonomy of digital technologies is investigated in more depth in section 2.5.3.

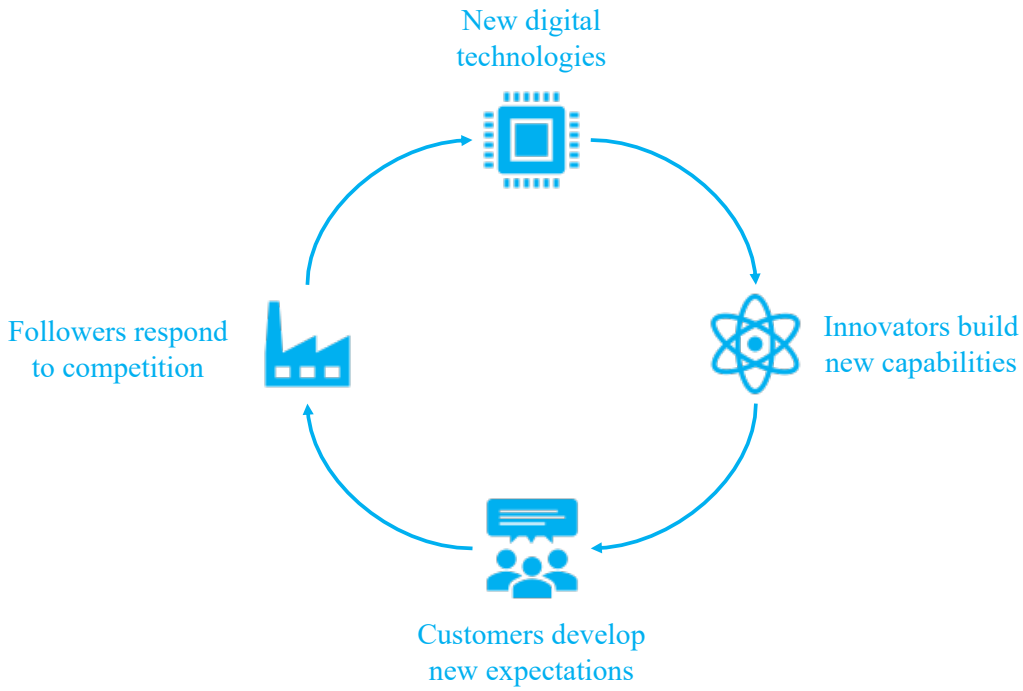

Figure 2.3: *DT reinforcing cycle*

Management of DT

The management of DT is a central topic in the systematic review papers. DT management aspects covered in the literature review by Vial (2019) include digital strategy formulation, digital innovation, change management, and value creation. Vail provided an illustrative summary of DT management research building blocks (Figure 2.2). Earlier research focused on leveraging digital technologies for innovating the customer experience, business model, and operational processes (Cziesla, 2014; Henriette *et al.*, 2015). Later research focused on the strategy and objectives for DT (Kutzner *et al.*, 2018; Morakanyane *et al.*, 2018; Reis *et al.*, 2018). The most recent research also incorporated change management and organizational impact (Vial, 2019). While not all industries have been covered, 88 case study papers have been published on DT (Kutnjak *et al.*, 2019) and include IT, manufacturing governments, retail, and finance. Sections 2.3–2.6 of the literature review provide a detailed analysis of DT management literature and its implications for digital transformation strategy (DTS) formulation.

2.3 The Digital Strategy

Digital strategy is developed as a strategic response to the internal and external driving forces of the digital economy (Vial, 2019). As a term, digital strategy is used to describe both the *future state* and the *journey*. The future state of an organization that aims to become digitally enabled is referred to in the literature as the digital business strategy (DBS) (Bharadwaj *et al.*, 2013). On the other hand, Managing the journey toward that future state is referred to as the digital transformation strategy (DTS) (Matt *et al.*, 2015). Definitions of both terms are presented in Table 2.2. This section provides a critical analysis of both terms, with a specific focus on formulation. When the term *digital strategy* is used in this thesis, it refers to both DBS and DTS, since both are critical components of the strategy formulation.

DBS is seen as an evolution of the IT strategy (Vial, 2019), which has always been aligned to—and a subordinate of—the business strategy (Bharadwaj *et al.*, 2013). However, given the impact of digital technologies on reshaping the value proposition of a business, it is argued that a DBS should be a fusion between IT and business strategy (Bharadwaj *et al.*, 2013). Moreover, DBS is framed to be business-centric and customer-facing, rather than technology-centric (Chanias *et al.*, 2019). Furthermore, having the DBS as an integral part of the business strategy reduces the potential tension arising from misalignment (Yeow *et al.*, 2018) and consolidates the focus on building digitally enabled and integrated business capabilities (Sebastian *et al.*, 2017).

Bharadwaj *et al.* (2013) developed a conceptual model that identified four key themes of DBS and their success metrics. Sebastian *et al.* (2017) investigated the DT journey of 25 large companies and found two common directions for DBS. Both authors share a similar perspective on DBS being an integral part of the business strategy and targeting the future state in terms of value created by DT. Researchers have also carried out in-depth case studies on DTS formulation in various sectors (Chanias and Hess, 2016; Chanias *et al.*, 2019). Researchers argue that DTS is focused on managing the development, deployment, and governance of the digital journey (Chanias *et al.*, 2019; Vial, 2019). In other words, DBS sets the future state of the organization, while DTS sets the journey to get there. Both concepts are discussed in sections 2.3.1 and 2.3.2.

Table 2.2: *Digital strategy definitions*

Term	Definition	Author
DBS	*Organizational strategy formulated and executed by leveraging digital resources to create differential value*	(Bharadwaj *et al.*, 2013; p.472)
DBS	*A business strategy, inspired by the capabilities of powerful, readily accessible technologies (like SMACIT), intent on delivering unique, integrated business capabilities in ways that are responsive to constantly changing market conditions*	(Sebastian *et al.,* 2017; p.198)
DTS	*A blueprint that supports companies in governing the transformations that arise owing to the integration of digital technologies, as well as in their operations after a transformation*	(Matt, Hess and Benlian, 2015; p.340)

2.3.1 Digital Business Strategy

There are multiple views in the literature on the content of a DBS. A common view is that it constitutes building both digital capabilities and transformation capabilities (Westerman *et al.*, 2011). Digital capabilities are described as leveraging digital technologies to transform the customer experience, business model, and operational processes. Westerman *et al*. also refer to leadership capabilities as managing DT in terms of creating a digital vision, engaging employees, governing the transformation, and establishing technology leadership. As leadership capabilities are meant to manage transformation efforts, they are referred to hereafter as transformation capabilities. Westerman *et al.* (2014) investigated the DT of 391 companies across multiple sectors in terms of digital and transformation capabilities against financial performance. Companies that have high maturity at both capabilities, known as *digital masters*, have on average 26% higher profitability and 9% higher revenue from their industry peers (Westerman *et al.*, 2014). However, the authors did not provide evidence of causality or whether these companies were already outperforming their industry peers. Nonetheless, the findings can be taken as capabilities that financially successful companies have in common. Murawski *et al.* (2018) statistically investigated the impact of DBS on financial profitability using a sample of 123 large companies and showed that digital innovation correlates significantly with profitability but is mediated by organizational agility.

Another perspective of DBS is that it should focus on the scope, speed, scale and source of value creation in the digital economy (Bharadwaj *et al.*, 2013). In terms of digital capabilities, Bharadwaj *et al.* considered adapting the scope of products, services, and operations. Digital platforms enable new value creation sources such as digital business models. Moreover,

transformation capabilities should target organizational agility by enabling accelerated product launches, fast iterations on product and service improvements, and having more robust decision-making processes. While the Bharadwaj *et al.* paper is conceptual, it is in line with the findings of Westerman *et al.* (2014) in terms of the importance of both digital and transformation capabilities. Nonetheless, Bharadwaj *et al.* (2013) put significant emphasis on digital platforms as the main enabler that shapes the potential of DT. It is not clear whether a digital platform approach to DBS is the most effective choice for all organizations.

Sia *et al.* (2016) built on the work of Bharadwaj *et al*. and carried out a case study on the DBS of a large bank. The authors found that leadership vision and envolvement, along with continuous exploration of emerging digital technologies, are critical transformation capabilities. Moreover, creating new value for the customer along with scalable technology infrastructure to support digital operations have been identified as critical digital capabilities. Although Sia *et al*. reported this DT as successful, other digital and transformation capabilities were not considered. Nonetheless, the deployed DBS was tailored to respond to the digital threats and opportunities faced (Sia *et al.*, 2016).

Researchers have also identified that DBS should focus on one of two digital capabilities—customer engagement or digitized solutions—to drive the focus of the digital investment (Sebastian *et al.*, 2017). The customer engagement approach is meant to create a seamless customer experience across digital channels, while digitized solutions would improve the value proposition of products and services by integrating digital features. The authors also found that in both options it is critical to build an operations backbone and integrate different solutions through a digital platform (Sebastian *et al.*, 2017). However, it is not clear on what basis organizations should select one strategy over another.

Another lens through which DBS can be viewed is that of external forces. Porter and Heppelmann (2015) carried out multiple case studies on the DT of product-based companies. The authors found that the impact of digital technologies starts from adding value to products or services and transcends across the whole value chain of an industry. They also presented findings on the importance of both digital and transformation capabilities. The main conclusion was that digital technologies are continuously creating more opportunities and challenges due to their convergence and maturity. Therefore, a DBS should adopt an agile approach to DT to allow for continuous adjustment to the shifts in industry boundaries. Tekic and Koroteev (2019)

proposed a conceptual model for analyzing the scope of DT based on existing literature. The authors argue that there are two dimensions for scoping DT, technology readiness and business readiness. The first dimension relates to the mastery of digital technologies, while the second relates to the readiness of the business model for digital operations. Contrasting those two dimensions on a high-to-low scale shows four different DT types. Tekic and Koroteev's summary to those typologies is shown in Table 2.3.

Table 2.3: *DT typologies (Source: Tekic and Koroteev, 2019)*

		Mastery of digital technologies	
		High	Low
Business model readiness for digital operations	High	Disruptive DT The goal is to transform an industry as a new entrant with limited constraints; typically startups with an advanced level of digital technologies mastery	Business model-led DT The goal is to respond to the new digital reality of an industry; typically Business to Customer (B2C) companies with a limited mastery of digital technologies
	Low	Technology-led DT The goal is to improve business performance and operational efficiency; typically large B2B companies driven by advanced mastery of digital technologies but limited readiness for business model transformation	Proudly analog DT is seen as having limited scope; typically small and medium enterprises and luxury brands, as the value of business originates from craftmanship where technology can harm value proposition

While the digital strategy matrix in Table 2.3 provides a logical typology, it is unclear whether this can be generalized. There are scenarios that do not fit this categorization. For instance, a Business to Business (B2B) company can have a digital spin-off that takes a disruptive approach to DT (Christensen *et al.*, 2015). Moreover, luxury brands are leveraging digital technologies to offer an immersive and engaging customer experience (Westerman *et al.*, 2014). Tekic and Koroteev have acknowledged the need for an empirical investigation of DBS archetypes, which is identified in section 2.7 as a gap to be addressed by this research.

As indicated by the six identified papers, a DBS is a strategic response to the digital opportunities and challenges faced by an organization. This response targets a future state of more effective digital and transformation capabilities. Collectively, digital capabilities are described as enhancing the value created by the main business functions through leveraging

digital technologies. The identified digital capabilities are: building a digital customer experience, business model, operational processes, and a digital services platform. However, the relationships or dependencies between these capabilities have not been addressed in previous research. Nonetheless, the DBS aims to express a future state of an organization's digital and transformation capabilities in a way that strengthens its core business and captures new economic opportunities.

2.3.2 Digital Transformation Strategy

DTS puts a greater focus on the DT journey (Vial, 2019). Matt *et al.* (2015) developed a conceptual framework for DTS. The proposed DTS model has four dimensions: (1) use of digital technologies; (2) changes in value creation; (3) structural changes; and (4) financial aspects of the digital investment. The authors argue that DTS should act as a blueprint that supports the governance of DT. Hess *et al*. (2016) carried out three case studies within the media industry to validate the DTS framework developed by Matt *et al*. (2015). The outcomes were 11 questions to be used as a guideline by transformation managers to formulate strategy. While this approach to DTS covers broad dimensions of the journey, it has not materialized as a process for understanding its dynamics over time.

Chanias and Hess (2016) investigated DTS formation through multiple case studies with three European car manufacturers. The authors found that the realized strategy is predominantly emergent and shaped by a series of strategizing activities. These activities are mostly driven by consolidating different functional DT efforts, while the deliberate strategy was formed at a later stage to provide more structure and governance to the process. However, details are lacking on the structure, frequency, or drivers of those emergent strategizing activities. Nonetheless, from a high-level perspective, it demonstrates iterative adaptation of the DTS.

Chanias *et al.* (2019) carried out an in-depth case study on the DTS formulation of a European financial institution. The authors had similar findings to Chanias and Hess (2016), concluding that DTS is formed through a series of strategizing episodes, and that DTS is continuously in the making—even throughout implementation—with no specific foreseeable end. Moreover, the findings showed that the continuous formulation of DTS aims to incorporate the learnings from the ongoing implementation. However, this continuous

formulation lacks a systematic structure to maximize the value generated from the learning feedback loop.

Yeow *et al.* (2018) carried out a longitudinal case study on the DT of a B2B supplier of sports fashion goods. The authors found that the DT journey goes through three phases of exploring the value of digital opportunities, building digital capabilities, and extending digital capabilities through continuous and incremental development. Moreover, it was identified that transformation activities give rise to tension between digital capabilities and other non-digital business capabilities, which required continuous alignment. Warner and Wäger (2019) carried out case studies on the DT of multiple companies across various sectors. The findings are in line with those of other researchers: DT is an ongoing process. The DTS continuously iterates over sensing, seizing, and transforming digital capabilities.

Reviewing the DTS literature shows that the DT journey goes through multiple phases of explore/sense, build/seize, and expand/transform (Yeow *et al.*, 2018; Warner and Wäger, 2019). While those are distinct phases, a company will iterate over them multiple times while building different digital capabilities (Chanias *et al.*, 2019). There is a consensus among researchers on the importance of a DT roadmap to guide DTS implementation (Westerman *et al.*, 2014; Sebastian *et al.*, 2017; Chanias *et al.*, 2019). The goal of the roadmap is to focus investment and manage multiple digital innovation projects. The use of roadmaps for DT is detailed in section 2.6 of this literature review.

There are multiple perspectives on prioritizing digital capabilities. Westerman *et al.* (2014) argue that an organization should manage finite resources by starting with one digital capability—customer experience, business model, or operational processes—based on organizational strengths, to demonstrate early success. In contrast, Sebastian *et al.* (2017) argue that building an operational backbone along with a digital services platform is a prerequisite for DT success. Prioritization would then focus on the customer experience, to choose between customer engagement or a digitized solution. However, both cases lack strong reasoning or logic to aid the decision-making process. Nonetheless, the case is clear for an operational backbone to support reliable, repeatable, and scalable digital operation. The same applies to having a digital services platform that acts as a foundation for digital innovation and enabling agility in new product and service development (Sebastian *et al.*, 2017). Another prioritization perspective is to focus on the drivers for DT (Chanias *et al.*, 2019; Vial, 2019). For instance,

AssetCo noticed a shift in consumer behavior where B2B sales were declining. This led to prioritizing customer experience and building a direct digital sales channel (Chanias *et al.*, 2019). Another perspective is focusing on the gains from digital opportunities. Warner and Wäger (2019) reported multiple case studies of business model-led DT based on the value creation opportunities. In other cases, prioritization was driven both by internal goals for efficiency gains and by external goals from competitive pressure (Chanias and Hess, 2016). Therefore, synthesizing the literature shows that prioritization of the DTS is guided by the drivers for DT. This should also consider the foundational elements needed for enabling digital innovation and executing digital operations.

Agile practices have also been an area of focus for DTS. Organizations are moving toward embracing uncertainty associated with new digital initiatives by starting with a minimum viable product (MVP) (Westerman *et al.*, 2014; Chanias *et al.*, 2019; Warner and Wäger, 2019). The goals of deploying an MVP are realizing early value, continuously improving the outcomes, and incrementally extending the solution scope. Learnings from MVP iterations have also been used in feedback loops to identify emergent opportunities that shaped the realized DTS (Chanias *et al.*, 2019). However, there is limited coverage on scoping MVPs. The scope can potentially focus on maximizing learning or maximizing financial returns. Learning is generated from higher uncertainty, while returns require higher certainty. Moreover, the process of capturing learnings from MVP to incorporate them into the DTS requires further investigation (Chanias *et al.*, 2019). Figure 2.4 provides an illustrative summary of the digital strategy formulation cycle.

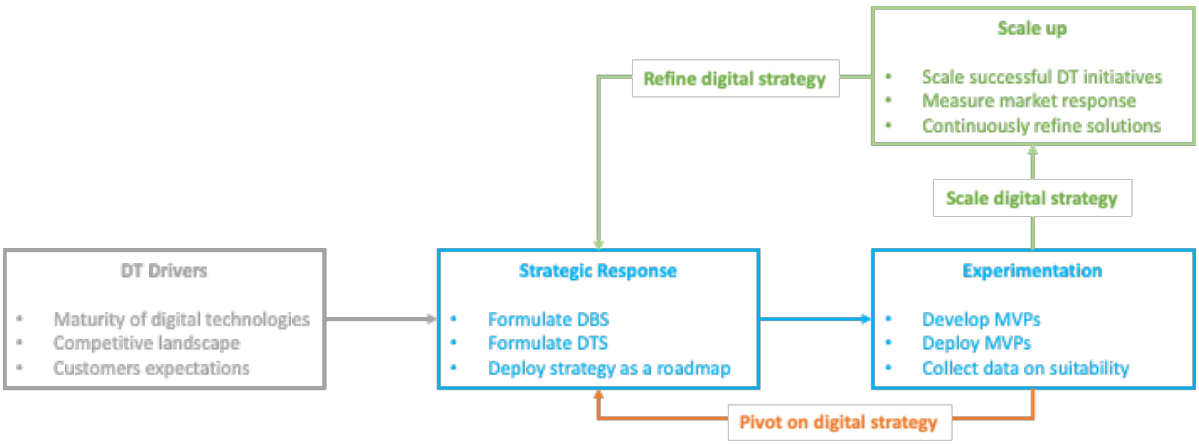

Figure 2.4: *Summary of digital strategy cycle*

Together, the reviewed papers indicate that DTS is a plan to prioritize, govern, execute, validate, and refine the DBS. Therefore, a DBS is considered a prerequisite for formulating a DTS. Moreover, there are various strategic approaches to formulating and executing the DTS. Section 2.4 investigates the theoretical underpinning of the digital strategy.

2.4 Digital Strategy Theories

Digital strategy literature builds on existing business strategy frameworks and theories. Among the most cited are *dynamic capabilities* (Warner and Wäger, 2019), *Mintzberg's strategy* (Chanias *et al.*, 2019), *strategy-as-practice* (Chanias *et al.*, 2019), *disruptive innovation* (Christensen *et al.*, 2015), and *industry five forces* (Porter and Heppelmann, 2015). Each theoretical framework is unpacked and critically evaluated here, in the context of DT.

Dynamic capabilities theory is among the most widely researched in business strategy. It is defined as "the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments" (Teece, Pisano and Shuen, 1997, p. 516). The theory argues that in an age of rapid technological changes, organizations need to develop capabilities for continuous adaptation (Schoemaker *et al.*, 2018). Therefore, business success requires the ability to sense changes in the market, seize opportunities, and transform resources accordingly (Schoemaker *et al.*, 2018). Researchers argue that dynamic capabilities should aim to sense changes and opportunities across different parts of the business model in terms of value creation, delivery, and value capture (Teece, 2018). This theory is strongly associated with organizational agility in dealing with uncertainty (Teece *et al.*, 2016). The authors argue that dynamic capabilities can steer organizational agility through uncertainty by sensing changes associated with technological opportunities and customer needs. Dynamic capabilities provide an adequate lens through which to view DT, given that DT is a strategic response to changes influenced by the digital economy (Vial, 2019). Yeow *et al.* (2018) used the dynamic capabilities approach to view digital strategy. They found that misalignment can occur between the emergent strategy and existing resources. Therefore, the authors propose that DT should explore digital opportunities, build digital capabilities, and continuously extend digital capabilities. This continuous approach would provide an opportunity for the continuous alignment of resources. Moreover, Warner and Wäger (2019) explored how organizations can leverage dynamic capabilities for DT, identifying nine critical elements for digital sensing, digital seizing, and digital transforming capabilities. In line with Teece *et al.* (2016), Warner

and Wäger found that DTS formulation is an ongoing process that uses organizational agility as a core mechanism for the strategic renewal of an organizations business model, ways of working, and culture (Warner and Wäger, 2019).

Another common view of strategy is Mintzberg's theory on *emergent* and *deliberate* strategy (Mintzberg, 1978). The theory argues that a common pattern in strategy formation starts with an intended strategy that is not always realized. An unrealized strategy can provide an opportunity for an *emergent* strategy in the absence of a *deliberate* one. Mintzberg found that the realized strategy sits on a continuum from purely *deliberate* to purely *emergent*. Nonetheless, most realized strategies would be a combination of both, with emergent and deliberate components, falling somewhere in the middle of the continuum (Mintzberg and Waters, 1985). In cases of high uncertainty, parts of the intended strategy are highly likely to be unrealized, giving rise to an emergent strategy (Mintzberg, 1978; Mintzberg and Waters, 1985). Chanias and Hess (2016) found that DTS is predominantly shaped by emergent strategizing activities where a top-down deliberate strategy would later follow to provide more structure to the process. Moreover, Chanias, Myers and Hess (2019) found that DTS can be deliberately emergent to allow different business functions to deal with associated uncertainty, and that continuous emergent strategizing episodes are required to navigate through uncertainty.

Strategy-as-practice is also a steadily growing area of research in the strategy domain. The main concept behind it is the evolution of strategy from planning-based in the 1960s, policy-based in the 1970s, process-based in the 1980s, and practice-based in the 1990s (Johnson *et al.*, 1996). *Strategy-as-practice* researchers believe that strategy practice is not the same for everyone, and view it as a social practice consisting of micro-level activities and interactions (Johnson *et al.*, 1996; Jarzabkowski, 2004). Understanding strategizing activities falls in the intersection between strategy practices, strategy praxis, and strategy practitioners (Jarzabkowski *et al.*, 2007). More recently, *strategy-as-practice* has also been used to research information systems (IS) strategizing activities (Marabelli and Galliers, 2017), placing emphasis on strategizing as an emergent process in IS transformation. This is also true in DT strategizing practice research (Yeow *et al.*, 2018; Chanias *et al.*, 2019; Warner and Wäger, 2019).

The most dominant views in DTS are dynamic capabilities and Mintzberg's theory on strategy (Vial, 2019). Both are seen as an extension of the resource-based view (Bharadwaj *et al.*, 2013; Vial, 2019). Both theories provide a lens through which to view different aspects of the DTS. Dynamic capabilities focus on reconfiguring assets and resources as a response to DT trends and drivers, whereas the Mintzberg view sheds light on the evolution of the realized strategy. In fact, both encourage experimentation with MVPs to deal with uncertainty (Teece *et al.*, 2016; Chanias *et al.*, 2019). Digital sensing and digital seizing would generate new learning that influences the emergent strategy (Warner and Wäger, 2019). The inflection point happens when the intended strategy is deployed and evidence on its realizability is generated.

Other theories are not sufficiently covered in the DT domain, but since DT is an emerging body of knowledge, a wider investigation is taken here. Disruptive innovation strategy is also among the leading strategy perspectives (Christensen, 1997). The theory explains that a low-end market entry, or building a new market that gives access to unserved consumers, can create great success and result in disrupting leading incumbents (Christensen *et al.*, 2015). This has also been noticed in the digital economy where, for instance, the rise of video streaming by Netflix caused video stores such as Blockbuster to go bankrupt (Anthony, 2016). The competitive advantage framework of industry five forces is also a popular approach for business strategy (Porter, 1979). The concept is that a company strategy should help in defending its position against competitors, buyers, suppliers, new entrants, and substitution of products and services (Porter, 1979). In a DT context, multiple case studies have shown that although the forces of industry have shifted around, they are still prominent (Porter and Heppelmann, 2014, 2015). The authors argue that companies should leverage digital technologies to sustain the defense of their position within an industry.

In this section, the DBS has been described as predominantly emergent. Moreover, execution of the DTS depends significantly on the maturity of dynamic capabilities. However, there was no evidence in the literature on leveraging dynamic capabilities for the realization of the emergent DBS. This relationship is considered a gap in the literature as presented in section 2.7.

2.5 Digital Transformation Capabilities

Operating in the digital economy requires building certain organizational capabilities: digital capabilities and transformation capabilities (Westerman *et al.*, 2014). Digital capabilities are required to transact and interact in the digital economy (Westerman *et al.*, 2011). However, digital technologies are changing faster than organizations, which makes transformation capabilities critical for business continuity and survival (Westerman, 2019). Research shows that digital technologies will continue to grow in importance and transformation capabilities should be seen as an ongoing process (World Economic Forum and Accenture, 2016; Westerman, 2019). It has also been empirically proven that digital innovation is mediated by organizational agility (Murawski *et al.*, 2018). This section explores the digital and transformation capabilities as well as the digital technologies required for DT.

2.5.1 Digital Capabilities

The literature presents digital capabilities from a value creation perspective (Vial, 2019). There is a consensus that it includes the business model, customer experience, and operational processes (Westerman *et al.*, 2014; Matt *et al.*, 2015; Sebastian *et al.*, 2017; Vial, 2019). Spil *et al.* (2016) found that more companies focus on operations as a cost-saving strategy, followed by customer experience (products and services), and very little effort is placed on business model innovation.

Berman (2012) provided a conceptual model for reshaping the customer value proposition, with three options for the DT of customer experience, by: (1) enhancing, by augmenting physical products, services and touchpoints with digital offerings; (2) extending the physical offering with digital experience for new revenue streams by adding new offerings and integrating the customer experience across all touchpoints; and (3) redefining customer value by replacing physical offerings with new digital offerings or building fully integrated digital/physical experiences. There are arguments that customer experience should lead the DT efforts (Davenport and Spanyi, 2019). Moreover, there is a clear move toward becoming service oriented in different sectors such as manufacturing (Frank *et al.*, 2019; Kohtamäki *et al.*, 2019) and logistics (Heilig *et al.*, 2017). This is also true for service-dominant industries such as banking (Mbama *et al.*, 2018), retail (Filgueiras *et al.*, 2019), and public service (Filgueiras *et al.*, 2019). Digital customer experience can be seen as providing digital channels for customer engagement or supplementing products and services with digital features

(Sebastian *et al.*, 2017). Amazon Marketplace is an example of customer engagement where decision analytics is enhancing the shopping experience for physical goods (Newell and Marabelli, 2015; Günther *et al.*, 2017). Others also focus on bridging the customer experience from physical to digital through digital channels such as social media (Westerman *et al.*, 2014). Apple's integration of iTunes and the App Store to the physical mobile phone and making it a smart phone is an example of a digitized solution to enhance the customer experience (Sebastian *et al.*, 2017). Digitized solutions can also enhance product features, as in the case of Tesla's vehicles (Porter and Heppelmann, 2014). The scope of digital customer experience requires a good understanding of customer expectations. A recent survey involving hundreds of consumers found that 62% are happy to spend more money if the digital experience was effortless (Kony, 2019). Understanding the "jobs" customers are trying to accomplish can create insights and influence the direction of the digital customer experience (Christensen *et al.*, 2016).

There are two aspects to the DT of operations. One aspect is the use of digital technologies to improve productivity, efficiency, and agility of physical operations (Westerman *et al.*, 2014). Another is to build an operational backbone to support the execution of the digital customer experience (Sebastian *et al.*, 2017). The two aspects are not mutually exclusive and both are common in the Industry 4.0 approach to smart factories (Alcácer and Cruz-Machado, 2019). Research also shows that the forecasted adoption rate of technologies such as robotics, Artificial Intelligence (AI), and blockchain would make digital operations a prerequisite for interacting with partners across the supply chain (Hartley and Sawaya, 2019). Moreover, there is a consensus on the importance of enabling operational ambidexterity to support both the exploration of digital innovation as well as the exploitation of existing resources (Westerman *et al.*, 2014; Dixon *et al.*, 2017; Sebastian *et al.*, 2017; Vial, 2019). The theory of ambidextrous organizations first appeared in a California management review paper by Tushman and O'Reilly (1996). The theory argues that for organizations to sustain success, they must pursue evolutionary and revolutionary change simultaneously.

Digital technologies have enabled business models that were not possible before. Alexander Osterwalder developed a standardized structure that captures business models focusing on all the activities that happen around the value proposition (Osterwalder and Pigneur, 2010). A business model is defined as *"The way a firm creates, delivers, and captures value"* (Gupta, 2018, p.31). The study of 10,000+ business models of publicly traded companies showed that

there are 16 possible business model archetypes (Malone *et al.*, 2006). The archetypes consists of four rights to be sold against four types of assets. Digital platforms enabled new ways for brokering and lending both physical and digital assets (Remane *et al.*, 2016). Bock and Wiener (2017) analyzed various digital business models and proposed a taxonomy of five different dimensions: digital offering, digital experience, digital platforms, data analytics, and digital pricing. Westerman, Bonnet and McAfee (2014) identified five common archetypes for business model reinvention using digital technologies:

1. Reinventing in established industries; ride-hailing mobile apps are an example
2. Substituting products or services; this can be seen in the movement from physical to digital media
3. Creating new digital business units in parallel to the established business
4. Reconfiguring the value delivery model, as Amazon did when integrating the shopping experience with data for seamless product delivery
5. Rethinking the value proposition, as insurance companies did when they started to offer micro insurance for a few hours' skiing, or hiring an exotic car for a day, through mobile apps.

Henriette, Feki and Boughzala (2015) found that business model innovation with digital technologies can extend industry scope by enabling new revenue streams, reshaping value propositions and accommodating changes within markets. This supports the findings of Westerman, Bonnet and McAfee (2014) as well as Porter and Heppelmann (2014), while Berman (2012) takes a slightly different angle by arguing that the key is to enable flexible and iterative changes to business models, always striving to optimize the business model and to find the best fit with the customer.

Digital capabilities fall under the three mentioned categories of customer experience, operations, and business model. However, as discussed, these capabilities can be configured in different ways. Selecting suitable digital capabilities depends on the formulated strategic options (Subramaniam *et al.*, 2019) as well as market validation (Gurbaxani and Dunkle, 2019). A summary of the researched digital capabilities is presented in Table 2.4.

Table 2.4: Summary of digital capabilities

Options for digital capabilities	
Digital customer experience	Customer engagement, digitized solutions
Digital operations	Efficient processes, agile operations, ambidexterity
Digital business model	Enhance, extend, redefine

2.5.2 Transformation Capabilitties

Transformation is arguably the difficult part in DT. Studies show that DT is significantly more likely to fail than succeed. A recent study showed that around 34% - 16% of companies embarking on DT achieved a significant improvement in business performance (Correani *et al.*, 2020). While there are various reasons for failure, they are commonly organizational and not technological (Gupta, 2018). Forcing transformation on rigid organizational practices can lead to stagnation and resistance (Vial, 2019). Researchers have covered a range of transformation capabilities as listed in Table 2.5. Those capabilities revolve around the management and execution of DT. They can be clustered into four themes:

1. Developing a digital vision and strategy
2. Engaging the organization
3. Enabling digital innovation and agility
4. Building digital ecosystems

The digital vision defines the scope for DT (Vial, 2019). A strategic vision is seen as a clear, simple, meaningful, and exciting articulation of future outcomes (Shenhar and Holzmann, 2017). In a DT context, it can refer to re-envisioning the customer experience, business model, and operational processes (Westerman *et al.*, 2014). The authors characterized DT vision as: (1) identifying strategic assets; (2) creating transformative ambitions; (3) defining clear intent and outcomes; and (4) evolving over time. Most approaches to DT are explaining it as a moving target with high uncertainty (Chanias and Hess, 2016; Yeow *et al.*, 2018; Chanias *et al.*, 2019; Warner and Wäger, 2019). DT of a company can have a range of future states between the current state and fully transforming the customer experience, business model, and operational processes. In such high uncertainty situations, strategic foresight and scenario planning can help in proactively managing uncertainty (Courtney *et al.*, 1997). Both scenario planning and strategic foresight have been used to build strategic vision and manage innovation under uncertainty (Adegbile *et al.*, 2017). The digital vision is then used as a basis for formulating

digital strategy (El Sawy *et al.*, 2016). Organizations also hire chief digital officers to lead the execution of the digital vision and strategy (Tumbas *et al.*, 2017). However, many high-profile DT initiatives failed to achieve an inflated technology-driven vision (Davenport and Westerman, 2018). It is therefore critical to have a vision that targets the core value proposition of an organization (Kane *et al.*, 2015).

Table 2.5: *Criteria of transformation capabilities*

Author(s)	Digital transformation strategy criteria
Westerman *et al.* (2014)	• Craft the digital vision • Engage the organization at scale • Govern the digital transformation • Build technology leadership capabilities
Sebastian *et al.* (2017)	• Define a digital strategy • Invest in an operational backbone • Architect a digital services platform • Design the digital services platform with customers in mind • Adopt a services culture
Vial (2019)	• Design a cross-functional organizational structure • Build organizational culture that fosters collaboration and innovation • Incorporate DT as a critical component of leadership priorities • Align and develop employee roles and skills
Chanias *et al.* (2019)	• Set digital transformation governance structure • Establish cross-functional collaboration • Adopt a multi-channel communication plan • Drive a customer-centric, agile, and innovation-oriented culture • Leverage the partner ecosystem

While a DT vision is critical for organizational buy-in (Chanias and Hess, 2016), there is more to be done to maintain organizational engagement at scale by adopting a multi-channel communication approach (Westerman *et al.*, 2014). A culture of openness that encourages experimentation is also critical for DT, given the associated uncertainty (Feher and Varga, 2017). However, with the rise of alarming studies about workforce displacement by digital technologies (World Economic Forum, 2018), resistance to digital change is expected (Kane *et al.*, 2016). Cady *et al.* (2014) described how it takes more than a compelling vision to engage and inspire the whole organization, as it would require following the change equation: ($D*V*F>R$), where D is the Dissatisfaction with status quo, V is the Vision of what is possible,

F is the First easy and practical step, and R is Resistance to change. For the change to succeed, the product of dissatisfaction, attractiveness of the vision, and ease of the first step should be greater than the resistance to change. The change equation was first published in the Sloan Management Review (Beckhard, 1975) for managing large-scale strategic change. As described in this section, engaging the organization at scale is both a critical and challenging transformation capability.

Moreover, structuring DT efforts can take many forms, from a distributed effort across various business functions all the way to spinning off independent business units, as shown in Table 2.6 (Kaltenecker *et al.*, 2015). Selecting a suitable structure for transformation efforts depends on organizational structure, culture, and size. However, there are opposing views on spinning off a separate digital unit. Some case studies showed that efforts will focus on new capabilities while neglecting core capabilities (Davenport and Westerman, 2018). Moreover, integrating those capabilities back to the business is challenging and can result in diminishing their value (Gupta, 2018). Despite these challenges, Hummel, a B2B sports fashion company, managed to successfully create an independent B2C digital unit (Yeow *et al.*, 2018), and Mastercard has a successful independent digital innovation lab tasked with developing new digital products (Gupta, 2018). The question remains whether the goal of DT is to transform the core value proposition or offer complementary digital capabilities. Audi have established a digital innovation hub that supports different business units with their digital initiatives, this hybrid model has been reported as a success (Dremel *et al.*, 2017). Moreover, there is no evidence that different DT structures are mutually exclusive.

Digital innovation uses digital technologies for creating, developing, diffusing, and assimilating new organizational value (Nambisan *et al.*, 2017). Studying digital technologies demonstrated three traits (Yoo *et al.*, 2012). First, digital platforms can produce value while also acting as a complementor for further innovation, as seen with Apple's App Store. Second, the connectivity of digital technologies allows for distributed innovation through the use of open data, application programming interfaces (APIs), and software developer kits, as seen from the open-source software movement. Finally, digital technologies allow for combinatorial innovation where their integration can create new value, as seen with Google Maps connecting with Google My Business. However, the success of digital innovation requires set of enablers. In terms of infrastructure, multiple case studies demonstrated the importance of a digital workplace that allows employees to connect and collaborate (Dery *et al.*, 2017). Horlach,

Drews and Schirmer (2016) carried out a systematic literature review on bimodal IT, also known as two-speed IT. The authors argue that for enabling the workforce to innovate, IT should work in two modes: mode one is for business as usual, with a focus on service continuity, risk aversion and cost reduction; mode two should be closer to the customer, with fast-paced agile delivery and continuous co-creation with the business for digital innovation.

Table 2.6: *DT structure (Source: Kaltenecker et al. (2015))*

Strategy	Explanation
Spin-off	An independent spin-off, or a separate organizational unit, could help prevent resource allocation conflicts and allow the company to more easily follow potentially disruptive innovations
Leader	Preparing the company early and stepping into the market as a leader could be a wise strategy
Expert opinion	Gathering information from a wide range of sources (technological staff, cooperation partners, customers, and external experts) and sticking to the adopted path despite resistance (e.g. from shareholders) seems to be a promising strategy to support the transformation process
Trial and error	Test products and test markets could be an important step toward achieving fully developed software. This is especially recommended if the intention is to roll out high quality products (robustness, stability, etc.) in the B2B market
Recruitment	Recruiting innovative and experienced staff could help the transformation process. Ideas and innovation may also emerge from cooperation with universities or lead customers
Direct sales	It might be best to distribute on-demand software directly. As an alternative, companies could initially financially incentivize resellers to promote on-demand sales
Step by step	The transformation might be best organized as a step-by-step approach focusing on smaller software solutions in the beginning. Over time, smaller on-demand solutions could expand along with their customer base and thus gain the attention of larger clients
Partnership and ecosystem	Committing to a strong technological partner could help companies adapt faster to a disruptive technology, as this allows companies to gain access to technology and expertise
Visionary top management	Inspiring top management can accelerate a transformation and is important to motivate employees

Skills and expertise also play a critical role in digital innovation. Some authors argue that acquiring digital innovation skills should take place on an organizational level through upskilling, continuous learning, and digital talent acquisition (Nylén and Holmström, 2015).

Moreover, an in-depth case study of digital innovation showed the importance of collaboration between business domain experts and digital technologies experts (Pershina *et al.*, 2019). The authors found that such collaboration led to more effective and efficient prototyping and subsequent deployment of digital innovation. The success of digital innovation is assessed against desirability by users, feasibility to develop and operate, and viability of the commercial proposition (Chasanidou *et al.*, 2015). Design thinking can be used to ideate and evaluate digital opportunities using a rapid prototyping and testing approach (Gurusamy *et al.*, 2016; Feher and Varga, 2017). One of the strengths of design thinking is that it is user-centered, which is critical for digital innovation success in terms of desirability (Pershina *et al.*, 2019). Moreover, the lean startup approach of building MVPs as a learning approach before scaling up is also commonly practiced in digital innovation (Xu and Koivumäki, 2019). Building and deploying an MVP allows for evaluating feasibility while customers' response can be used as an indication of desirability and commercial viability (Ries, 2011). Deploying MVPs is critical to managing the uncertainty of new digital innovation (Chanias *et al.*, 2019) and provides insight into scaling up the solution (Chanias *et al.*, 2019). Agile frameworks can also offer an integrated approach to digital innovation practices and principles (SAFe, 2019).

Considering that DT, as argued in this section, cuts across the whole organization and its surrounding industry, it requires a shift from organizational governance toward orchestration of the digital ecosystem. Kauffman, Li and van Heck (2010) state that business networks combine their digital capabilities to create value that they would not be able to produce alone. The challenge for leadership is the shift in authority and control away from individuals to be distributed across the digital ecosystem. This is in line with network-centric innovation, where companies have managed to create greater value by leveraging external networks alongside their internal resources for innovation (Nambisan and Sawhney, 2011). More specifically to DT, open innovation can aid the management of uncertainty by exploiting internal and external ideas and paths to market (Bogers *et al.*, 2018).

Transformation capabilities set the enablers and practices required to build digital capabilities. Organizations follow a wide variety of approaches. Building transformation capabilities is a maturity journey rather than a milestone. These capabilities are essential for starting with DT and crucial for operating as a digitally enabled business. Transformation capabilities are also considered crucial for executing, validating, and refining the digital strategy. A summary of transformation capabilities criteria can be found in Table 2.7.

Table 2.7: *Summary of transformation capability criteria*

Transformation Capabilities Clusters	Transformation Capability	Criteria
DT Enablers	Developing a digital vision and strategy	• Formulation of digital vision and strategy • Prioritizing digital initiatives
	Building digital ecosystems	• Setting partnerships • Enabling a networked workforce • Reconfiguring IT services • Implementation of enabling technologies • Leveraging digital ecosystems
DT Practices	Engaging the organization	• Communication of digital vision and strategy • Management of change • Setting structure and governance
	Enabling digital innovation and agility	• Development of digital skills and expertise • Adoption of agile practices • Embracing a data-driven decision making approach

2.5.3 Digital Technologies

Digital technologies is an umbrella term used to refer to technologies that connect the physical and digital mediums (Ghobakhloo, 2019). There are two views of digital technologies in DT literature. One is from an application perspective; example technologies are SMACIT (Westerman *et al.*, 2014). SMACIT is shorthand for the mentioned technologies as well as digital platforms, AI, robotics, blockchain, augmented reality (AR), and virtual reality (VR) (Sebastian *et al.*, 2017).

The other view of digital technologies has categorized it based on functionality. Those functionalities are information, communication, computing, and connectivity (Bharadwaj *et al.*, 2013; Vial, 2019). However, information is conveyed *through* digital technologies rather than *being* one. This view has also been extended to include digital platforms, operating technologies, and human–machine interactions (Ghobakhloo, 2019). Digital technologies can also be viewed hierarchically, as a set of layers, to include a device layer, network layer, content layer, and service layer (Berger *et al.*, 2018). Viewing digital technologies as layers has also

been used to design the enterprise architecture for DT. These layers include cyber security, data, business applications, and platform ecosystems (Zimmermann *et al.*, 2019).

The World Economic Forum's research on DT initiatives identified seven digital technologies with the highest impact on the transformation of various industries (World Economic Forum and Accenture, 2018): AI; autonomous vehicles; big data analytics and cloud computing; 3D printing; IoT and connected devices; robots and drones; and social media and platforms. Other digital technologies that are not strongly visible in the DT mainstream literature include quantum computing and digital twins. Moreover, the convergence of digital technologies has enabled combinatorial applications. For instance, integrating IoT with blockchain provides IoT-enabled smart contracts, which can be used for efficient supply-chain management (Hasan *et al.*, 2019). Another example is decentralized AI which allows access to data while preserving privacy (Harris and Waggoner, 2019). An example use case of the latter could be the development of a machine learning model for diagnosing disease without invading the privacy of patients (Rieke *et al.*, 2020). Moreover, quantum machine learning was found to speed up the training of models and further optimize their performance beyond what is possible with classical computing (Biamonte *et al.*, 2017).

The review of digital technologies demonstrated that it has a wide range of applications and implications. However, data sits at the core of it to be manipulated for generating added value (Vial, 2019). Moreover, the choice of digital technologies is driven by the business application or digital capability to be developed (Westerman *et al.*, 2014). A summary of digital technologies and their respective categories can be found in Table 2.8.

Table 2.8: *Summary of digital technologies by category*

Technology category	Digital technologies
Control	3D printing, robotics
Communication	Blockchain, mobile, social media, AR, VR
Computing	AI, analytics, cloud computing
Connectivity	IoT

2.6 Roadmapping

This section of the literature review chapter provides an overview of the application of roadmapping as a strategic planning framework. More specifically, it aims to understand the

value that roadmapping can add to the DTS. Section 2.6.1 provides a general background on roadmapping practice. Section 2.6.2 investigates the current application of roadmapping for DT, its suitability, and current limitations.

2.6.1 Roadmapping Practice

Roadmapping is a strategic planning framework for navigating uncertainty and aligning resources to market opportunities (Phaal *et al.*, 2004b) . The value of roadmapping for strategic planning has already been established through hundreds of case studies (Phaal *et al.*, 2004b, 2007, 2012).

The first identified application of roadmaps was in 1963 by NASA for planning space missions (Kerr and Phaal, 2020), and was followed by leading US-based aerospace companies in the late 1960s and 1970s (Kerr and Phaal, 2020). However, the first research publication on roadmapping appeared in the manufacturing industry in the late 1980s by Motorola (Willyard and McClees, 1987). It was used to map car radio product features and technology over time (Farrukh *et al.*, 2003). Technology-focused roadmaps started becoming more popular in the 1980s for consumer electronics manufacturers, where Philips and Lucent Technologies were among the most notable adopters (Groenveld, 1997; Albright and Kappel, 2003). The application of roadmapping went beyond technology to cover product planning, program planning, and strategic planning (Phaal *et al.*, 2004b). However, successful roadmapping was found to be challenging in terms of starting the roadmapping practice, deploying a robust process, and keeping the roadmap "alive" (Farrukh *et al.*, 2003). To overcome this challenge, a "fast-start" approach was developed, enabling a robust roadmapping process to be quickly and economically deployed (Phaal *et al.*, 2011).

A roadmap is a manifestation of the 5W1H framework: why, what, how, when, where, who (Kerr *et al.*, 2019). It aims to align resources to market and business needs through products, services, or systems, whether through market-pull or technology-push (Barker and Smith, 1995). Roadmaps have a wide range of formats, from plain text to illustrative graphics (Phaal *et al.*, 2004b). A common illustrative form of roadmap is shown in Figure 2.5.

2.6.2 Roadmapping for DT

The use of roadmapping for DT is considered a core component for DTS formulation and is embedded in current organizational practice (Westerman *et al.*, 2014; Parviainen *et al.*, 2017;

Chanias *et al.*, 2019). Multiple strategic planning tools have been used to aid the DTS process, such as industry five forces (Porter and Heppelmann, 2014), business model canvas (León *et al.*, 2016), technology foresight (Turovets *et al.*, 2019), and scenario planning (Turovets *et al.*, 2019). A comparison of the identified strategy tools in relation to roadmapping demonstrated the following four points in favor of adopting roadmapping for DT:

1. Roadmapping is well integrated in the research and practice of DT (Chanias *et al.*, 2019). Therefore, leveraging tools that practitioners are adopting can productively build on existing practice and potentially enhance success of DT initiatives
2. There is no identified conflict between the identified strategy tools and roadmapping in the context of DT
3. Integrating these tools with roadmapping can provide dynamic context by leveraging the time dimension on roadmaps (Toro-Jarrín *et al.*, 2016; Hussain *et al.*, 2017).
4. Roadmapping can also act as a platform for integrating other strategic planning tools toward a shared goal (Kerr *et al.*, 2017).

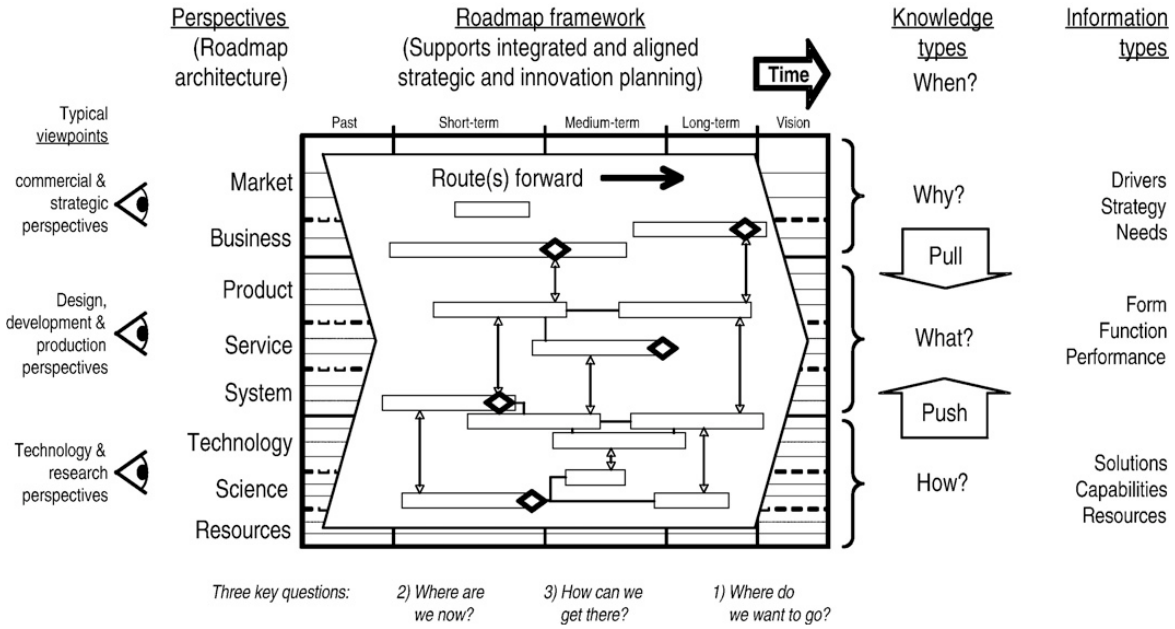

Figure 2.5: *Illustration of the roadmap architecture (Source: Phaal & Muller, 2009)*

However, there is no common framework for roadmapping DT. Researchers have argued that DT investment should start by focusing on a specific digital capability (Westerman *et al.*, 2014; Sebastian *et al.*, 2017). Three DT roadmapping approaches are discussed in this section.

Westerman, Bonnet and McAfee (2014) found that successful digital leaders use roadmaps to focus their DT efforts. Parviainen *et al.* (2017) developed a model for planning DT that has been synthesized from multiple case studies of industrial DT in Finland. And a case study has been carried out on the DT of business models within the manufacturing industry (Schallmo *et al.*, 2017). The roadmapping activities suggested by each author are presented in Table 2.9.

The three presented DT roadmapping approaches have some similarities, differences, and limitations. They all focus on translating the digital vision to a DT journey (Westerman *et al.*, 2014; Parviainen *et al.*, 2017; Schallmo *et al.*, 2017). This falls in line with the goal of formulating a DTS as presented in section 2.3.2. The prioritization of DT goals and objectives is another common point. One difference is identifying digital needs based on an internal assessment of the current state (Schallmo *et al.*, 2017) against focusing on future digital opportunities (Parviainen *et al.*, 2017). Prioritizing internal vs external needs or identifying current vs future opportunities is context-specific and can be decided based on drivers of DT (Tekic and Koroteev, 2019; Vial, 2019).

Table 2.9: *Approaches to DT roadmapping*

Authors	DT roadmapping approach
Westerman *et al.* (2014)	1. Translate the vision into strategic goals that demonstrate what achieving the transformation vision would look like 2. Develop a roadmap of the digital initiatives to guide the organization toward the transformation vision
Parviainen *et al.* (2017)	1. Assess current digital reality 2. Set DT objectives and prioritize goals 3. Design options future digital business model 4. Evaluate organizational fit for the identified options 5. Design the implementation of the DT
Schallmo *et al.* (2017)	1. Identify potential digital opportunities and set the goal of DT 2. Identify the current state of the business for the transformed areas 3. Develop an action plan in the form of a roadmap to bridge the identified gap 4. Implement the roadmap and validate it by learning iteratively from proof of concept

There are three limitations of the proposed frameworks in the literature. First, authors take a static view of roadmapping as a one-off activity. This is not an accurate representation as DTS formulation is an ongoing activity (Chanias and Hess, 2016; Chanias *et al.*, 2019) that

requires updates to be reflected on the roadmap to keep it alive (Phaal *et al.*, 2007). Moreover, the discussed frameworks focus only on digital capabilities, giving very limited consideration to transformation capabilities. Transformation capabilities play a critical role in succeeding at DT and thus require an explicit focus (Westerman *et al.*, 2014). Furthermore, there is no account of the roadmapping process to be evaluated by researchers or implemented by practitioners. Therefore, this is considered a gap in the DT body of knowledge and was investigated further in section 5.4.

2.6.3 The Roadmapping Process

Roadmapping as a process can range from expert-based to computer-based (Kostoff and Schaller, 2001). The practice of roadmapping commonly takes the form of an expert-based workshop process aimed at strategic planning (Vatananan and Gerdsri, 2012). Computer-based roadmapping uses computational linguistics and analytics to act as a decision support system (Son and Lee, 2019). Two of the more popular roadmapping processes in terms of research and practice are "T-Plan" (Phaal *et al.*, 2004b) for technology roadmapping and "S-Plan" (Phaal *et al.*, 2007) for strategic roadmapping (Kerr *et al.*, 2019). This fast-start approach adopts the concept of rapid prototyping for fast and iterative learning (Phaal *et al.*, 2011). Strategic roadmapping is more appropriate for the research of this thesis given the strategic nature of DT. However, some authors stress the importance of contextual adaptation of the roadmapping process rather than identical adoption (Farrukh *et al.*, 2003). This have encouraged a framework for the customization of roadmapping context, roadmap architecture, and roadmapping process (Phaal *et al.*, 2004a). Customizing the roadmapping process involves integrating suitable activities to address the application at hand (Kim *et al.*, 2018). However, the DT literature is missing a detailed account of DT strategic planning process and activities to aid the customization of roadmapping. Therefore, this has been identified as a gap in the literature to be addressed by the present research, as outlined in section 2.7. A deeper investigation of roadmapping customization has been carried out in chapter 5, based on the findings of the exploratory case study in chapter 4.

2.7 Literature Summary, Knowledge Gaps, and Research Questions

The present literature review in this chapter investigated the state of the art of DT. Specific focus was given to digital strategy formulation and the value that roadmapping can add to the process. Section 2.2 provided an overview of the DT literature landscape which shaped the

following sections. Section 2.3 identified that the DT journey usually starts by formulating a DBS to translate the vision to a set of tangible business goals. DTS, on the other hand, focuses on managing the transformation journey. The theoretical underpinning of digital strategy was covered in section 2.4. Section 2.5 showed that DT requires the building of both digital and transformation capabilities. DT roadmaps were found to be a recurring theme to support digital strategy formulation and implementation. The DT roadmapping literature is covered in section 2.6 and limitations of existing approaches were identified.

Investigating the literature demonstrated a few gaps in the DT body of knowledge. Relevant to this research are three research points that are presented in this section. First, the digital strategy literature presented in section 2.3 demonstrated that there is no detailed account of a formulation process. Authors have acknowledged the existing limitations in capturing the details of digital strategy formulation process and activities (Chanias *et al.*, 2019), and identified that the relationship between digital capabilities requires deeper investigation (Vial, 2019). Second, digital strategy formulation was identified in section 2.3 to be an on-going process to build the digital and transformation capabilities that were identified in section 2.5. However, this aspect is not covered sufficiently by existing literature. Moreover, section 2.6 showed that while roadmapping can act as a framework supporting the formulation process, it was presented in a static view. Therefore, a dynamic framework for managing digital strategy formulation process is warranted. Third, an empirical investigation of digital strategy archetypes is needed to guide the formulation process (Tekic and Koroteev, 2019). The knowledge gaps in the DT literature that have implications on digital strategy formulation can be summarized in the following points:

1. There is a lack of guidance on digital strategy formulation process activities and outcomes.
2. Limited consideration is given to the iterative nature of digital strategy formulation and validation.
3. There is insufficient empirical investigation of digital strategy archetypes that are implemented by organizations.

These three knowledge gaps hinder sufficient understanding of how to formulate and evaluate a digital strategy. Therefore, the main research question is framed accordingly:

RQ: ***How may digital strategy be effectively formulated and validated?***

The framing of the main research question is designed to reflect the scope, philosophy, and knowledge gaps in a way that provides a meaningful contribution to existing research. An elaboration on the wording of the research question wording is presented here.

- **how:** reflects the need for an applied investigation of digital strategy formulation
- **may:** reflects the pragmatist view that multiple approaches can be taken to answer this research question
- **digital strategy:** encompasses both the DTS (RQ-1) and the DBS (RQ-3)
- **effectively formulated and validated:** acknowledges the nature of the digital strategy as a dynamic and ongoing process (RQ-2).

This overarching research question has been deconstructed into three sub-questions to investigate each identified knowledge gap, following the same sequence:

- **RQ-1:** What are key process inputs, activities and outcomes required for formulating a digital strategy?

- **RQ-2:** How may digital strategy benefit from being iteratively formulated and validated?

- **RQ-3:** What are the main digital strategy archetypes that may guide the formulation process?

The following objectives have been set to answer the research questions:

- **RO-1:** Identify key process inputs, activities and outcomes required for formulating a digital strategy

- **RO-2:** Develop and test an applied framework to aid the iterative formulation and validation of the digital strategy

- **RO-3:** Identify main digital strategy archetypes that may guide the formulation process

The research objectives are guided by the overall aim of the research:

To develop insights and tools that enhance the understanding and practice of digital strategy formulation within companies

This section highlights the applied nature of this research. Moreover, the practical focus, supported by theoretical underpinning, is motivated by the challenges that companies face in successfully leveraging DT to improve business performance. Therefore, this research aims to enhance both the understanding and the practice of digital strategy by developing supporting insights and tools.

Given the identified knowledge gaps, the research in this thesis addresses these points in three steps. First, an in-depth case study was carried out to understand the required process and activities for DT strategic planning. This is completed in chapter 4 to address RO-1. Second, an agile DT roadmapping framework is developed to support digital strategy formulation as an ongoing search process; this is addressed in chapters 5 and 6 for RO-2. Finally, chapter 7 presents an empirical investigation of DBS archetypes to address RO-3.

3. RESEARCH DESIGN

3.1 Introduction

This chapter presents the research design used to investigate and answer the research question. Section 3.2 presents a summary of the research objectives to address the identified knowledge gaps. In Section 3.3 the philosophical position of this researcher is presented. Section 3.4 sets the research design and the methods employed. Section 3.5 presents the consideration given to the reliability, validity, and ethics of the research. Finally, the chapter ends with a summary of the research design.

3.2 Research Questions, Aim, and Objectives

The main observation from the literature review is that the literature on DT, as an emerging body of knowledge, provides only preliminary findings on digital strategy formulation. Thus, practical and applied contributions to digital strategy formulation are limited, as outlined in section 2.7. Moreover, the research questions, aim, and objectives are also detailed in section 2.7. Figure 3.1 illustrates the link between the identified gaps and the research objectives.

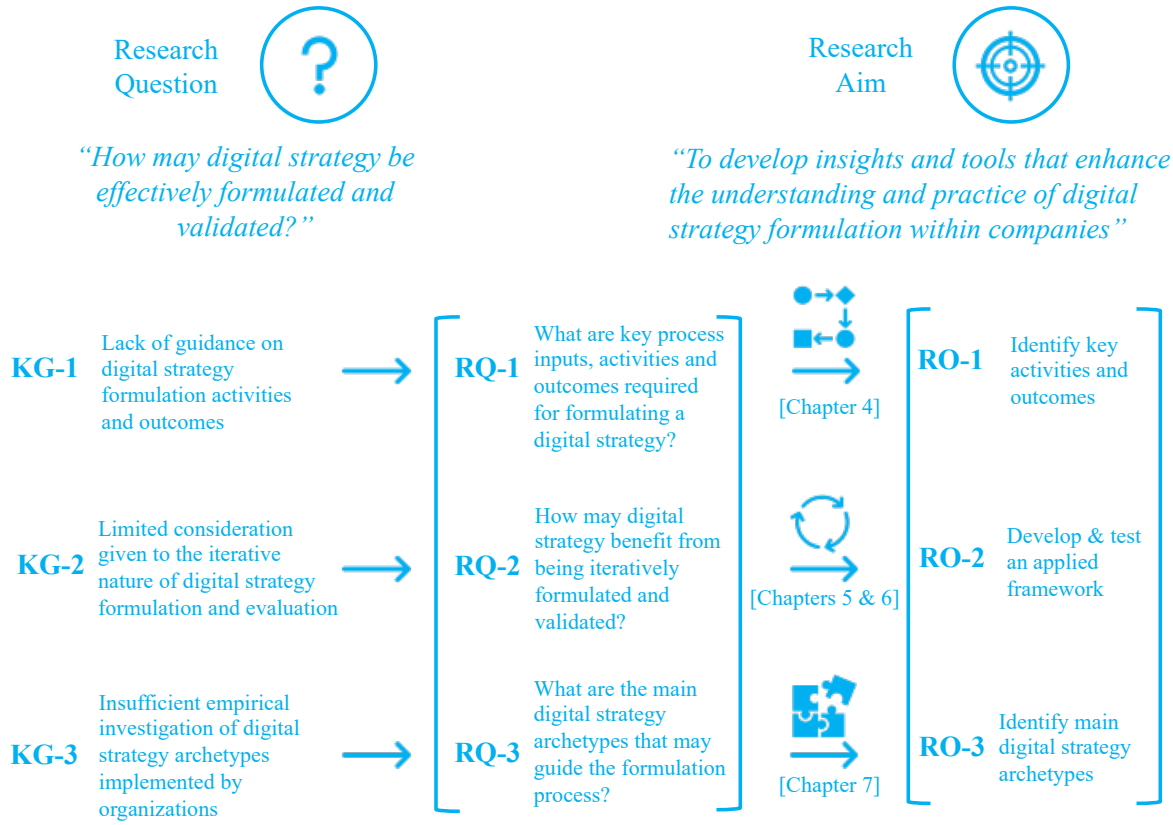

Figure 3.1: Research design flow (KG: knowledge gap; RQ: research question; RO: research objective)

3.3 Research Philosophy

Scientific investigation is based on underlying assumptions of the nature of reality (ontology) and the perception of knowledge (epistemology) (Saunders *et al.*, 2008). Philosophical positions on ontology can be placed on a spectrum between two extremes: objectivism and subjectivism (Saunders *et al.*, 2008). Objectivists view reality as a single truth that exists independent of human consciousness. Subjectivists view reality as consisting of multiple truths based on the perceptions and actions of its social actors. Pragmatism falls between the two extremes, where the research philosophy is driven by the research question (Robson, 2011). Considering that this thesis is concerned with investigating a socio-technical system—DT—the research ontology is that of a pragmatist.

Epistemology is viewed as an extension of ontology based on what constitutes acceptable knowledge. Epistemology also ranges from positivism—knowledge as objective quantifiable facts—to realism, in which knowledge is perceived based on the observation of the researcher (Saunders *et al.*, 2008). A pragmatist view of knowledge is more appropriate for this research, where truth is "simply what works" (Robson, 2011). A pragmatist epistemology is suitable for this research, given its practical and applied nature. Therefore, both quantifiable facts about the digital strategy formulation and the perception of the actors involved in the formulation process constitute acceptable knowledge. This is also reflected in the use of mixed methods to answer the research question, as discussed in Section 3.4.4.

3.4 Research Design

This section covers the research design and methods employed to answer the research questions. Research design is concerned with turning research questions into a set of projects that attempt to answer the research question (Robson, 2011). The design of this research follows Robson's research design framework as shown in Figure 3.2. This is done by defining the purpose and framework to specify the research question, which then helps in choosing the research method and sampling strategy. Robson provided a set of questions to help define each of the five phases of the process. The questions have been used as a guide for the research design section of this chapter.

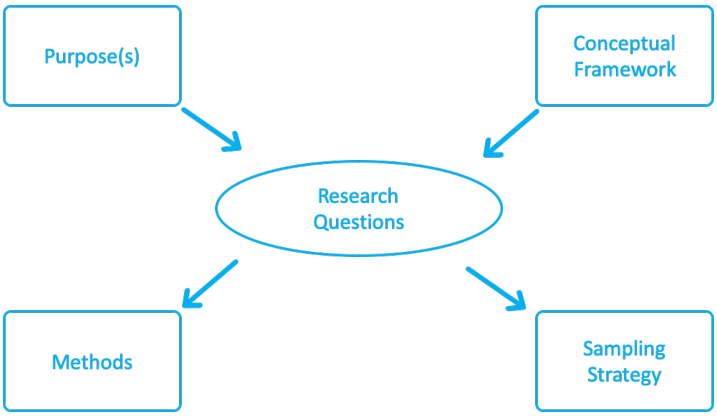

Figure 3.2: *Research design framework (Robson, 2011)*

3.4.1 Research Purpose

The research purpose can be categorized as exploratory, descriptive or explanatory (Saunders *et al.*, 2008). As described in section 1.1, DT is an emerging phenomenon that has attracted significant attention from both strategy practitioners and researchers. However, there are still many open questions in managing a successful DT. The purpose of this research is to gain a better understanding of the formulation and evaluation of the digital strategy.

3.4.2 Conceptual Framework

From a theoretical perspective, digital strategy can be highly emergent (Chanias and Hess, 2016). This is usually in response to the inherent uncertainty in digital innovation (Chanias and Hess, 2016; Chanias *et al.*, 2019) and the dynamic changes in the trends and drivers for DT (Yeow *et al.*, 2018; Vial, 2019). However, an understanding of how the realized digital strategy converges remains limited. Therefore, the conceptual framework of the present research is that continuous iteration between planning and experimentation can create evidence-based planning. Such an approach to planning would accelerate the realization of the emergent digital strategy. This conceptual framework is detailed in chapter 5.

3.4.3 Research Question

Yin (2014) states that the research question consists of "substance" (what is the research about?) and the "form" of the question—*what*, *why*, *who*, *where*, or *how*. It was identified from the literature gap that the substance of the research is digital strategy formulation, while the form is how can it be done effectively. Therefore, as stated in section 3.2, the main research question is:

RQ: *How may the digital strategy be effectively formulated and validated?*

3.4.4 Research Methods

Robson (2011) states that the research method is about choosing techniques to collect and analyze data as well as establishing the trustworthiness of findings. We also need to understand whether the research method will be mono-, multi- or mixed-method (Saunders *et al.*, 2008; Robson, 2011). Table 3.1 provides an overview of various research strategies to help evaluate their suitability for the present research project. There are two main aspects to digital strategy formulation—context and content—as presented in section 2.3. Given these two aspects, multiple methods are needed.

Table 3.1: *Overview of commonly used research strategies(adapted from Saunders et al., 2012; Robson, 2011; Yin, 2014)*

Strategy	Summary	Form of research question	Requires control of behavioral events?	Focuses on contemporary events?
Experiment	Testing the link between two variables	How, why?	Yes	Yes
Survey	The use of standardized questionnaires to collect high volume data for quantitative analysis	Who, what, where, how many, how much?	No	Yes
Archival analysis	The use of administrative records and documentations as main unit of analysis	Who, what, where, how many, how much?	No	Yes/No
Case study	Empirical investigation of contemporary phenomena within its real-life context using multiple sources of evidence	How, why?	No	Yes
Action research	Process research, usually within organizations, for diagnosing the research problem, planning an intervention, taking action, and evaluating results in an iterative way	How?	No	Yes

The context of digital strategy formulation refers to the activities, tools, and methods used to create a DT plan. Thus far, there has been no detailed reporting of the formulation process within the literature. Moreover, while some case studies referred to agile development for DT,

incorporating agility into the digital strategy has received limited attention. Digital strategy content, on the other hand, requires an understanding of the different approaches that companies have been considering. There is an opportunity to learn from large successful companies' approaches to DT. Therefore, a mixed-methods approach is required: qualitative techniques to explore the strategy context, and a quantitative technique to explore the strategy content. Table 3.2provides a breakdown of the research strategy, from the main research question to the individual research project, and the research methods for each sub-question are detailed in the following section. The methods employed to answer research questions 1–3 are discussed in sections 3.4.5–3.4.7.

Table 3.2: *Summary of this research strategies*

Research question	Sub-questions	Research strategy	Research projects
How may the digital strategy be effectively formulated and validated?	**RQ-1:** What are the key process activities and outcomes required for formulating a digital strategy?	Exploratory case study (qualitative method)	In-depth investigation of DT strategic planning process within an organization [Chapter 4]
	RQ-2: How may the digital strategy benefit from being iteratively formulated and validated?	Action research (qualitative method)	Design of a framework and testing it through three pilot studies [Chapters 5 & 6]
	RQ-3: What are the main digital strategy archetypes that may guide the formulation process?	Archival analysis (quantitative method)	Data science analysis of Fortune 500 digital strategy archetypes [Chapter 7]

3.4.5 Digital Strategy Formulation Process

Research question 1 requires a detailed understanding of the digital strategy formulation process:

RQ-1: *What are the key process inputs, activities and outcomes required for formulating a digital strategy?*

Only a few case studies have examined digital business and transformation strategy (Chanias and Hess, 2016; Sia *et al.*, 2016; Yeow *et al.*, 2018; Chanias *et al.*, 2019). The in-

depth focus of those case studies unveiled some of the hidden details of DT strategic planning. For instance, by conducting an in-depth case study, Chanias *et al.* (2019) was able to unpack the activities that triggered recurring episodes of digital strategy formulation. As RQ-1 is focused on capturing digital strategy formulation process details, an in-depth investigation is required. Therefore, a qualitative research method is chosen to address RQ-1. The main unit of analysis is the planning process, including activities, tools, and outcomes. This research question is answered through an in-depth exploratory case study. The following criteria have been set for selecting a suitable case study company:

- a company that will allow access to multiple data sources for triangulation
- a Fortune 500 company, to demonstrate digital strategy formulation at scale
- a company that is known for innovation and will be likely to demonstrate good practice
- a company that operates in a sector the author is familiar with, to allow for deep investigation and understanding.

The organization selected is within the transport sector. It is known for its innovative customer experience, it operates globally, and it has more than 80,000 employees. The unit of analysis is the planning process, which makes the case study strategy a single and embedded case (Saunders *et al.*, 2008). The author of this thesis took an embedded approach to this case study, being an active participant of the DT initiative within the organization for six months. The data collection covers multiple sources, including interviews, observations, documents, and metrics. A narrative structuring approach to data analysis is adopted to construct and present the results in chronological order (Saunders *et al.*, 2008). The case study is presented in chapter 4 and the case study design is elaborated further in section 4.2.

3.4.6 Agile DT Roadmapping Framework

The reviewed literature showed insufficient investigation of the utility of incorporating agility into the digital strategy formulation process, specifically into DT roadmapping, to aid the iterative nature of digital strategy formulation. Moreover, it was identified that digital strategy formulation happens episodically throughout planning and implementation based on a feedback loop from testing components of the strategy (Chanias *et al.*, 2019). However, there is no structured approach to manage this learning process between formulation and validation. Therefore, the second question this research project aimed to answer is:

RQ-2: *How may the digital strategy benefit from being iteratively formulated and validated?*

This research question is answered in two stages. First, a conceptual framework is designed by building on the findings from chapter 4; the conceptual framework is presented in chapter 5. Second, the framework is tested and calibrated by following an action research approach in chapter 6.

The full formulation and deployment of a detailed DT strategic plan can take more than a year (Chanias *et al.*, 2019). Conducting multiple longitudinal studies is beyond the time scope of this PhD; therefore, pilot studies have been adopted as an efficient and meaningful substitute. A pilot study is a small-scale implementation of the full model (Robson, 2011). Moreover, it provides rich learning opportunities that require an action research method for adapting the framework between pilot cases. The pilot case selection for the present study was based on the following criteria. A large organization or division that:

- is preparing to undergo DT
- is looking to formulate a DT plan and roadmap
- is ready to dedicate two days to a planning workshop with main stakeholders
- agrees to provide feedback after two months of implementation as a leading indicator
- gives permission for the data from the project to be presented as an anonymized pilot case study in this thesis.

Three pilot studies were conducted with companies in different sectors, with different levels of digital maturity and different levels of scope for DT. Data were collected from multiple sources, including a workshop preparation document, workshop content, workshop participant feedback, and a two-month follow-up interview. Each pilot study took 8–12 weeks from start to finish, excluding the follow-up interview. The pilot study is presented in chapter 6 and the detailed pilot study design can be found in section 6.2.

3.4.7 Digital Strategy Archetypes

Research question 3 is designed to complement findings from previous questions by giving focus to the content of the digital strategy as expressed here:

RQ-3: *What are the main digital strategy archetypes that may guide the formulation process?*

The focus of companies on digital and transformation capabilities can vary by size, sector, and digital maturity. In contrast with RO-1 and RO-2, RO-3 requires the prioritization of breadth over depth. Therefore, a quantitative approach is required. The challenge, however, is in accessing DT information for a wide variety of companies. Therefore, the data sources chosen for this question have been limited to secondary data and, more specifically, publicly available information. Large publicly traded companies have more public information to meet regulations and satisfy investors' interest. For this reason, Fortune Global 500 companies (Fortune.com, 2019) have been selected as a quota sampling strategy (Saunders *et al.*, 2008). While the Global 500 might not be representative of all companies embarking on DT, this is a deliberate decision. Aside from data access constraints, Global 500 companies generate more than $30 trillion in annual revenue, which makes it a critical segment of the global economy. Moreover, the scale and performance of these companies makes them useful for exploratory research.

The choice of data for this research phase aims to provide a better understanding of companies' digital and transformation capabilities. This information is not readily available in a structured format in the public domain. As an alternative, companies' public documents that are likely to describe digital activities are considered. The list of potential document types has been evaluated based on the similarity of document structure across companies and the richness of digital activities coverage. Table 3.3 provides a summary of this analysis. After evaluation, quarterly earnings call transcripts were found to be the most suitable and descriptive in terms of DT activities. News articles, annual reports and patent data could potentially play a secondary role in enriching the findings and are recommended for use in future research. Earnings calls data have been supplemented with company information as well as financial results. The digital strategy archetypes are investigated in chapter 7 and the research design is elaborated in section 7.2

Table 3.3: Sources for digital activities of companies

Data source	Standardization across companies	Richness of digital activities	Selected
Website	Score: Low High variety of website design and content	Score: Low Few companies describe digital activities on their website	No
News	Score: Medium News article formats are relatively similar except for slight variations in length	Score: Medium Large number of articles dedicated to companies' digital activities. Can be biased toward technology giants	No
Twitter	Score: High All tweets have standard format with set character limits	Score: Low Limited and sparse information on digital activities	No
Industry reports	Score: Low Wide variety of report structure and format	Score: Low Information is mostly aggregated, with limited traceability to specific companies	No
Patents	Score: Medium Similar structure but filing can belong to subsidiaries of a company, which makes tracking difficult	Score: Medium Provide evidence of digital effort but no description of how it is used in the company	No
Annual report	Score: Medium American filings follow a standard format, but others can vary in format	Score: Medium Most companies provide an overview of their digital investments	No
Earnings calls	Score: High Call transcripts are relatively similar	Score: High Most companies provide details on digital activities	**Yes**

3.5 Research Reliability, Validity and Ethics

Established research design principles were adopted to ensure this investigation is reliable, valid, and ethical. Reliability refers to the consistency of data collection and analysis that makes the findings reproducible (Saunders *et al.*, 2008). Transparency was also aimed for by documenting the data collection and analysis procedures to allow for further reproducibility.

Validity refers to the degree to which the research findings reflect the actual phenomena (Saunders *et al.*, 2008). Validity aspects are internal validity, construct validity, and external validity. The exploratory nature of this research makes internal validity inapplicable as causality is not a research objective. Construct validity requires suitable operational measures

to be established for the study. Leveraging multiple data sources can reduce research biases and enhance the rigor of the findings (Robson, 2011). In the present study, this was done through multiple research projects to address the research question from different angles, as well as using data triangulation where possible.

External validity is concerned with the generalizability of the findings beyond the study setting. This was addressed in four ways. First, the exploratory case study in Chapter 4 was investigated in-depth for a period of six months to capture the details of how DT unfolds in practice. Second, the case study was followed by three pilot studies to test some of the findings in practice. Third, in the discussion of Chapter 6, findings were evaluated against existing literature where case studies were conducted in companies of different sectors. The context and a few findings were similar which demonstrates the generalizability of the findings from the case studies beyond the study settings. Fourth, to supplement the focused qualitative studies, a qualitative analysis of 304 global companies from 15 sectors were investigated in Chapter 7. This analysis was also found to complement and build on existing literature that conducted a similar quantitative analysis. Therefore, the findings can be generalized to the extent of the proposed research questions.

Research ethics were of high importance, especially because this research required access to sensitive information within organizations. Therefore, sensitive information has been anonymized. All case and pilot studies incorporated a mutual non-disclosure agreement to protect both parties, and participants' consent to using the collected data for research was acquired verbally and in writing. In addition, publicly available data were used where possible to avoid any confidentiality issues, as demonstrated in chapter 7.

3.6 Chapter Summary

In summary, the main research question addressed by this PhD research is *How may the digital strategy be effectively formulated and validated?* Answering this overarching research question was accomplished over three stages as indicated by the research sub-questions. This chapter presented the research design used to answer each research question as summarized in Table 3.4. The following chapters of this thesis present the conducted research to answer each question.

Table 3.4: *Research design summary*

Research objective	Data collection and analysis	Results
RO-1: Identify key process activities and outcomes required for formulating a digital strategy	In-depth exploratory case study using interviews, archival records, and observations	Documentation of a DT strategic planning process
RO-2: Develop an applied framework to aid the iterative formulation and evaluation of the digital strategy	Three pilot studies using strategy formulation workshops for action research	An agile DT roadmapping framework
RO-3: Identify the main digital strategy archetypes that may guide the formulation process	Quantitative analysis of Fortune 500 earnings call transcripts employing data science techniques	Four digital strategy archetypes

4. EXPLORATORY CASE STUDY

4.1 Introduction

This chapter presents an in-depth exploratory case study on the DT planning process. The case study covered the planning activities and outcomes of a Global 500 company operating in the transport sector. Section 4.2 presents the case study design while Sections 4.3 and 4.4 elaborate on the data collection and analysis methods used. In Section 4.5 the case study is presented as a narrative to highlight the evolution of the DT plan. The chapter ends with a discussion and outlines implications of the findings.

4.2 Case Study Design

This research project has been designed to be investigative in nature to understand how large multinational companies plan for their DT. The exploratory case study approach lends itself well to this research, considering that the aim is to understand the DT planning process as a phenomenon in its real-life context (Yin, 2014). The case study follows the process illustrated in Figure 4.1 (Runeson and Höst, 2009). A critical aspect of case study research is differentiating between planning the case study activities and designing its scope (Yin, 2014). Although the diagram shows a linear flow, in practice case studies are iterative in nature due to new aspects emerging and the design being adjusted according. For instance, data collection went through multiple iterations to find the most suitable sources for data triangulation.

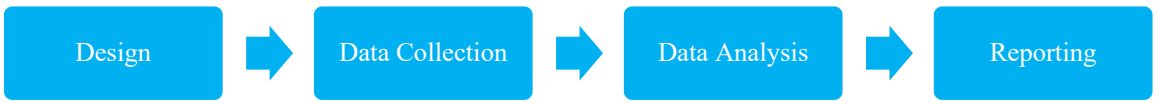

Figure 4.1: *Case study process (adapted from Runeson and Höst (2009))*

The design of the case study aims to define the logical sequence in moving from a research question to building a reliable and valid conclusion. Different methods can be used to design a case study (Runeson and Höst, 2009; Robson, 2011; Yin, 2014). This chapter follows a hybrid approach by employing Yin's case study design method while also incorporating existing DT planning theory as a frame of reference for evaluating the findings. The five steps of case study design are: (1) case study questions; (2) proposition or purpose; (3) unit of analysis; (4) linking data to proposition; and (5) criteria for interpreting findings. The remainder of this section presents these steps in sequence.

4.2.1 Case Study Question

This case study is the first project and is exploratory in nature, with the aim of understanding how large companies plan for DT. Therefore, the question to be answered by this case study is:

RQ-1: *What are the key process activities and outcomes required for formulating a digital strategy?*

The digital strategy is an integral component of the DT plan as identified in this study. Therefore, this chapter takes a broad view to investigate the planning process while focusing specifically on the digital strategy formulation.

4.2.2 Study Proposition

The proposition of this research is based on the preliminary findings from the literature review as presented in section 2.3. The proposition here is that companies plan for DT as an efficient and effective strategic response to trends and drivers that are influenced by the digital economy. More specifically, companies formulate a DT plan that identifies the need for DT and propose a strategic response that includes the DBS, DTS, and DT roadmap. Moreover, agile development is used to facilitate digital innovation.

4.2.3 Unit of Analysis

The unit of analysis is the process that was followed during the DT planning phase. This includes all major activities and outcomes. The process starts from initiating the DT program and ends with producing the DT plan outcomes, as identified in the study proposition. The planning phase is commonly the first step in any large-scale program and marks the starting point of the unit of analysis.

4.2.4 Linking Data to Proposition

Data analysis allows for moving from raw data to findings that can then be interpreted through a theoretical frame or proposition. Given that the unit of analysis is the planning process, a narrative structuring analysis is used to reconstruct the planning process chronologically from the collected data (Saunders *et al.*, 2008). The study proposition of the process activities and outcomes is then used for interpreting the findings. This has been demonstrated throughout the case study report in section 4.5.

4.2.5 Critera for Interpreting Findings

The criteria for assessing the effectiveness of the process would ideally be measured by the success of the program in improving digital maturity and financial performance. However, as this is early stage research, leading indicators have been chosen instead. The two criteria that were used to assess the effectiveness are the ability to execute the plan and the perceptions of key stakeholders.

4.3 Data Collection

The data collection took place over a period of six months from August 2017 to February 2018. The researcher adopted the "participant as an observer" role (Saunders *et al.*, 2008) for data collection by participating in the DT program full-time throughout the whole period. The six months started during the revision of the DT plan and ended after the first phase of execution, as illustrated in Figure 4.2. Multiple data sources were used for triangulation to represent the case study as accurately as possible. The collected data included semi-structured interviews, observations, internal documents, metrics, and financial reports (Table 4.1). Each data source is discussed in the following paragraphs.

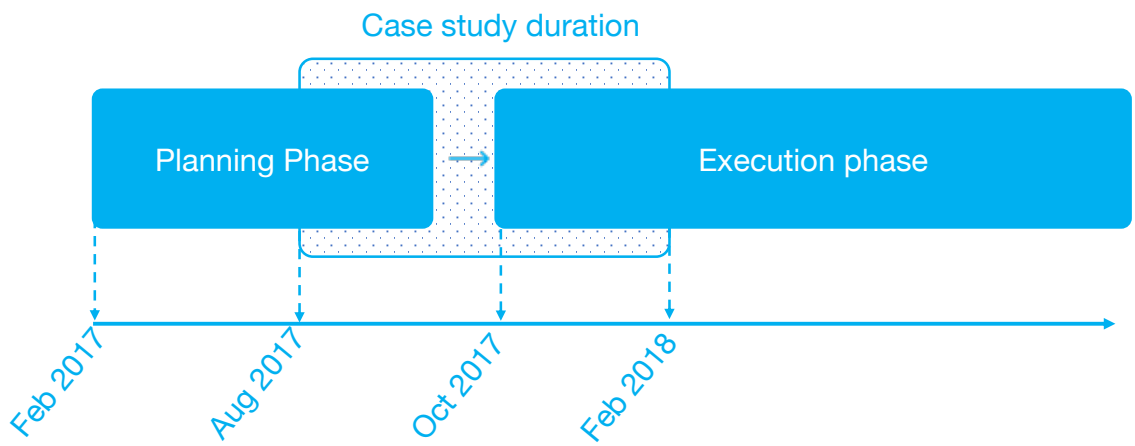

Figure 4.2: *Case study duration*

Interviews were selected to capture the DT program phases with a focus on the planning and execution activities. Semi-structured interviews were selected to be used as a checklist and to allow for probing into areas of interest during the interviews. The flow of questions followed the sand watch approach, beginning with general questions, then focusing on the area of interest, and finally asking general reflective questions about the future (Runeson and Höst, 2009). The general questions concerned the interviewee's role and how the program started.

The areas of focus were the activities that happened during the planning phase and their outcomes. The final set of questions focused on understanding the implementation phase and its anticipated challenges. Six interviewees involved in the planning and initiation of the program were selected from various management roles within the DT team: the head of digital innovation and transformation (HDIT), the head of project delivery (HPD), two DT leads, the agile coach, and the service designer (SD). One interview was conducted with each interviewee after the completion of the planning phase and the start of the execution. Interview durations ranged between 1-2 hours for each interview. The interview questions are presented in Appendix B 1.

Table 4.1: *Case study data collection summary*

Type	Description	Source	Quantity	Total length	Objective
Interviews	Semi-structured	Recorded in person	6 interviews from 6 interviewees	45 pages	In-depth understanding of the planning process
Observations	Weekly reflective log	Weekly observations	6 logs (1 for each 2 weeks sprint)	6 pages	In-depth understanding of the program design, culture, and practices
Internal documents	Presentations and reports	Program management	4 presentation & 1 report	165 pages	Documentation of planning process and program progress
Metrics	Development metrics	Program dashboard	1 dashboard metric snapshot	6 pages	Execution of the plan
Public documents	Annual reports	Company website	10 annual reports	2,000 pages	Investigate the financial drivers for DT

The second data source is observations captured in the form of a reflective log. The researcher was involved during the execution of the program for a period of six months, as both an observer and a project member. This enabled an in-depth understanding of the planning activities, identification of suitable data sources, and iterations through data collections. The aim was to understand the business and technical terminology, program design, and team dynamics, and to identify interviewees, experience DT first-hand, and reflect on the practice. The reflective logs were generated every two weeks based on daily field notes. Two weeks was

chosen because execution of the DT followed an agile approach where work was broken down into two-week sprints. Therefore, the reflective log was used to capture the learnings from each sprint. The reflective log had three questions:

1. What during happened this sprint?
2. Why is it important?
3. How it can influence the understanding of this research?

The third data source is internal documents related to the DT program. Internal documents are used to capture and communicate different aspects of the DT program, including the plan, vision, structure, and progress. The aim of using internal documents was to have an explicit and detailed description of the program planning and implementation. Table 4.2 provides a summary of the documents and their description.

Table 4.2: *List of internal documents used for analysis*

Title	Description	Length
Digital transformation program summary	A presentation summarizing the planning activities and outcomes	32 slides
Digital transformation progress report, status, and next phase	A report for executive management summarizing the digital strategy, rationale behind it, progress, and implementation plan	56 pages
MVP1 user scenario	A presentation providing the MVP target process design for each of the four teams	4 slides
Digital transformation update	A presentation detailing the program, vision, strategy, roadmap and solution architecture	19 slides
Agile framework	A presentation detailing the program development activities following an agile approach	52 slides

The fourth data source is metrics. The team used an agile software tool that records project requirements and measures progress against deliverables. One of the standard metrics is the burndown chart, which tracks progress in terms of the number of completed deliverables against the plan. This can quantitatively measure the percentage of progress toward the program increment objectives. Progress metrics provided leading indicators for assessing the usability of the plan. While such metrics cannot be used to evaluate the effectiveness of the plan, they provide secondary evidence on the success or failure of a given stage of the program.

The final data source is public documents relevant to the studied organization. The main document type used here is the annual report. Annual reports for the last 10 years (2009–2018) were collected from the organization's website. The main purpose of using these documents was to understand the organization's financial performance, strategic direction, and focus on DT. Using annual reports enabled the validation of some findings from other data sources.

4.4 Data Analysis

A structured narrative data analysis approach was taken (Saunders *et al.*, 2008). A *narrative* is broadly defined as a sequenced account of an experience, indicating a flow of related events, told in a way that conveys meaning to the researcher (Coffey and Atkinson, 1996). This approach to data analysis was deemed suitable for preserving the events that influenced the evolution of the DT plan throughout the formulation process.

The case study narrative was structured over three stages, as presented in sections 4.5.2, 4.5.3, and 4.5.3. The first stage describes the events that triggered the need for DT. The second stage is the planning process with a detailed account of its activities. The third stage is the outcomes of the planning process based on quantifiable facts as well as the perception of the involved actors—the senior stakeholders.

The primary source of the planning process was the "Digital transformation program summary" document, as it holds a documented and approved version of the process. However, this was the planned process, not the actual one. Therefore, the aim of the data analysis was to enable interpretation, validation, enrichment, and reflection of the planning process. Annual reports were used to understand the financial performance as a source of influence that triggered the need for DT. Interviews played a critical role in the interpretation and enrichment of the documented planning process across the three stages of the narrative. Recorded interviews were first transcribed by a transcription professional and then reviewed by the author. Finally, observations and performance metrics were used to enrich and validate the findings. The data analysis resulted in the identification of 24 constructs that shaped the overall narrative. The data sources that informed this analysis are presented in Tables 4.3, 4.4, and 4.5.

4.5 Case Study Report

This section presents the case study report, covering the overview, planning process, planning outcomes, and approach evaluation. Each point is described and critically evaluated.

4.5.1 Overview

The researched company is an airline, here referred to as Airco, based in Asia. Airco is considered a successful international carrier in terms of revenue, growth, and customer experience. The fleet of aircrafts is modern and consists mainly of large long-haul aircraft. Airco is well known for its passenger experience and has won multiple awards for innovation.

The airline has experienced rapid growth over the last two decades. Its financial performance indicates that this has been a successful strategy, but the business landscape has started to increase in complexity. The executive management and the chief information officer realized in 2015 that the current organization setup is effective for continuous improvement but that it is very difficult to incorporate transformational changes within it. Therefore, with a mandate from the chief executive officer (CEO), a DT program was commissioned in mid-2016. The team is led by a chief digital officer (CDO) who presents digital efforts across the business to the board. The CDO role can also be seen as a digital evangelist, as categorized by Singh and Hess (2017). Consequently, a centralized DT Unit has been created to focus on transforming the airline's core business. This team was led by the head of DT and innovation (HDTI).

4.5.2 The Need for DT

The need for DT was not recognized overnight, nor was the organization limiting its innovation efforts. Multiple indicators cumulatively led to the leadership realizing the need for DT. Those indicators were a combination of internal drivers based on business needs, and external trends based on the market directions. The internal drivers were decreasing profitability, limited organizational agility, and the need for enabling digital innovation. External trends were changes in customer expectations, risk of disruption, and opportunities enabled by digital technologies. The links between the drivers for DT and the data sources can be found in Table 4.3.

The first driver was profitability. Although the organization has remained profitable, its profits and yield have been declining (in airlines, yield measures the revenue per passenger per flown kilometer). Figure 4.3 shows the profit margin over the last 10 years, from 2009 to 2018. The graph shows high volatility and a negative trend. This is taking place while the overall growth rate has almost reached a plateau, which drove the realization that defending the competitive advantage requires a differentiated offering, as described by the HDTI. He commented:

"I'm not seeing so much that the physical transportation layer changes dramatically. I think there are some new innovations as far as aircraft are concerned, but they are available to everyone in the airline industry. … Long-range aircraft … are not uniquely available to us, so I think this will not be a competitive advantage. I think the advantage comes from the way we offer our products and services … in the most responsive and personalized way."

Table 4.3: *Trends and drivers linked to data sources of Airco*

Trends and drivers	HDTI	HPD	Lead 1	Lead 2	Status report	Annual reports	Reflective log
Enabling agility	x			x		x	x
Customer expectations	x					x	x
Protecting revenue			x		x	x	
Risk of disruption		x	x	x	x		x
Enabling digital innovation	x			x			x

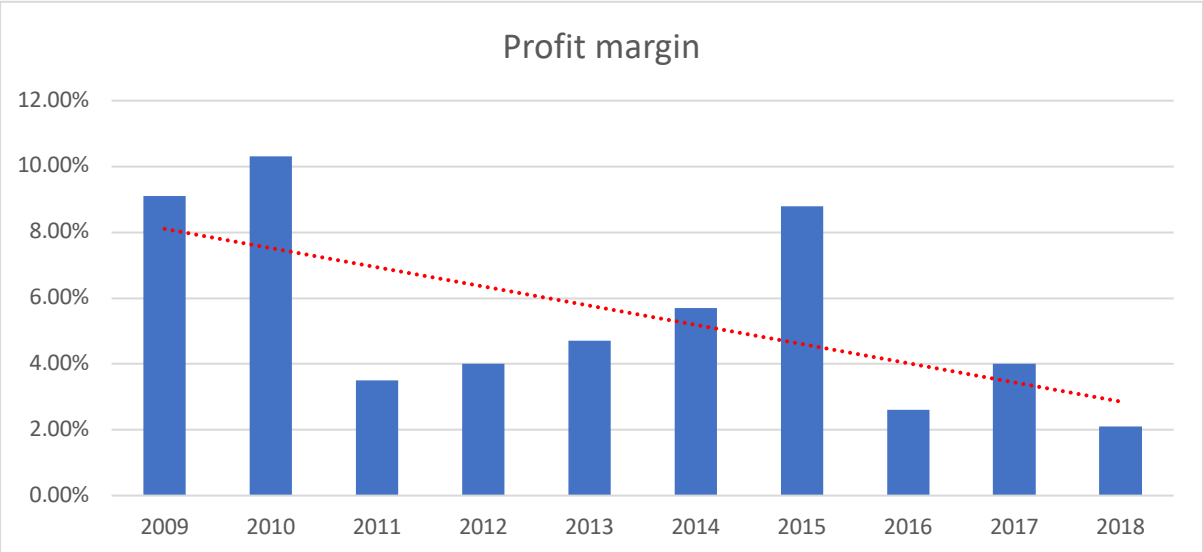

Figure 4.3: *Profit margin, 2009–2018*

The second challenge was limited organizational agility. This realization also came from two different areas. Before the DT program was initiated, there was a program that operated in 2014–2018 that aimed to transform the passenger experience across all travel touchpoints. However, after the program was initiated, the team soon learned that there is a greater need to improve today's customer experience before working on a transformational customer experience. Therefore, the leadership decided to dedicate this program to improving the current passenger service platform, while leaving future transformation to a different program, which later became the DT program. This realization triggered an audit of the technology landscape in 2015–2016, which identified more than 900 IT systems costing the company few hundred million US Dollars in licensing and maintenance. The number of interactions grew exponentially, which led to increased complexity and slower agility. This technical debt in the technology landscape has been attributed to the high growth rate over the last 20 years. The DT Lead 2 commented on this:

"The company has been focusing on growth … but it was all done in a way that actually is not as interconnected as it should be, and therefore, when you become big … you start seeing the effects of inefficiency because of [a] lack of integration."

As a result, there was a clear need to streamline and simplify this technology landscape. This required moving away from some of the legacy systems to new digital platforms. This was deemed especially critical for enabling digital innovation.

The first trend is the change in customer expectations. The need for differentiated customer experience has already been established. New customer segments and expectations have emerged. First, with the emergence of technology startups, seamless digital experience is an expectation. Moreover, Airco estimates that by 2021, around 30% of their carried passengers would be senior citizens aged over 65. Therefore, the leadership recognized that different customer segments require personalization that meets their needs.

The final trend is the opportunities provided by digital technologies. This is a critical trend in respect to other trends and drivers. Innovation with digital technologies is perceived to enable new revenue streams, simplify the technology landscape for agility, and enable a differentiated customer experience. Figure 4.4 illustrates the inductive structure of the trends and drivers, and their relationships.

In summary, trends and drivers can influence and enhance each other. For instance, technological opportunities were perceived to improve customer experience and enable organizational agility. Moreover, a personalized customer experience was identified as an opportunity for a higher profit margin. The implications of this relationship are discussed in section 4.6.

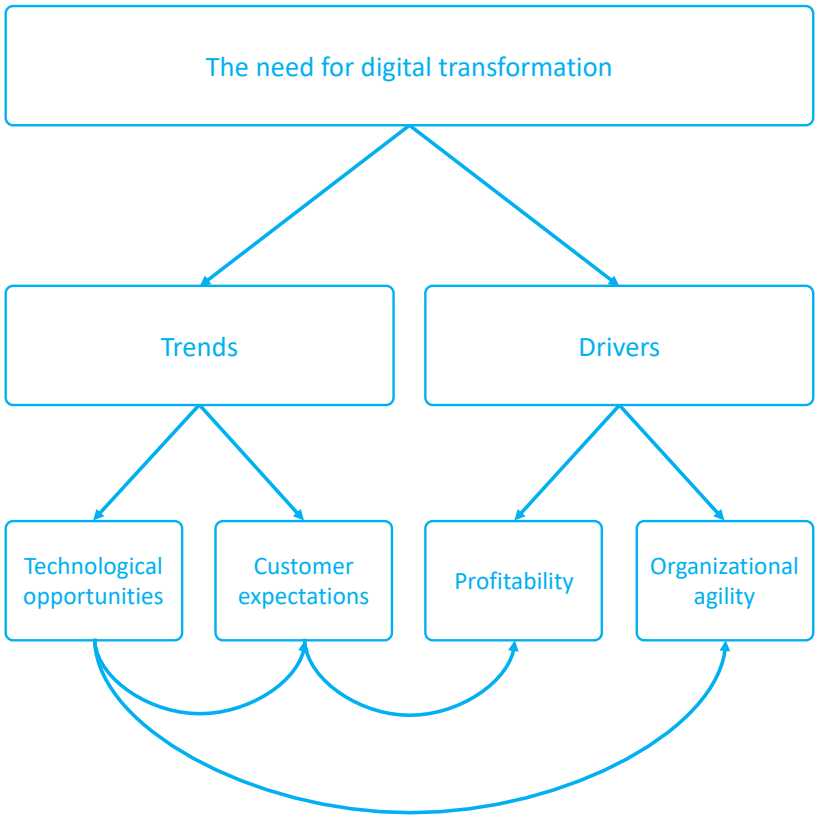

Figure 4.4: *Inductive structure of digital transformation trends and drivers*

4.5.3 The Planning Process

The first stage in the DT program was planning. The leadership team asked the CDO and HDTI to propose a DT plan and strategy as a response to the identified trends and drivers. However, it was critical for the DT team that this plan came from the business and was not imposed by technology people with no domain expertise. A principle followed by the HDTI is that adoption and buy-in starts with involvement from ideation, not at deployment. An external consulting team was hired to help facilitate the planning process. The planning process happened over a period of six months, from February to August 2017. To ensure that all business units were involved, departments heads were requested to nominate a business representative to participate in the planning process; 50 employees were chosen as business

representatives to be involved for four weeks out of the whole six months. The workload was distributed over three teams: the DT team, which drove the digital strategy; the business representatives, who shared their departments' priorities and contributed to the planning activities; and the consulting team, which facilitated the planning activities.

The planning process was documented in detail in the "program summary" document. However, it was documented as a plan rather than a reflection, so it was important to investigate how the plan unfolded and how its participants perceived it. Therefore, the planning process and activities were enriched by interviews and notes from the reflective log, as shown in Table 4.4. The planning process went through four stages: discovery of trends and drivers; definition of priorities; design of the digital business; and consolidating findings into a DT program (Figure 4.5). Each stage is described in the subsequent paragraphs.

Table 4.4: *Planning activities linked to data sources*

Planning activities	HDTI	HPD	Lead 1	Lead 2	SD	Plan document	Reflective log
Market research	x		x	x	x	x	x
PESTLE analysis			x	x	x	x	x
DT goals		x	x			x	
Ideation	x	x	x	x	x	x	x
DT scope	x	x	x	x		x	x
Process design			x		x	x	
Business functions		x	x	x	x	x	
Technology landscape		x		x	x	x	x
Prototype design		x	x	x	x	x	x
Structure	x	x			x	x	x
Roadmap		x				x	x

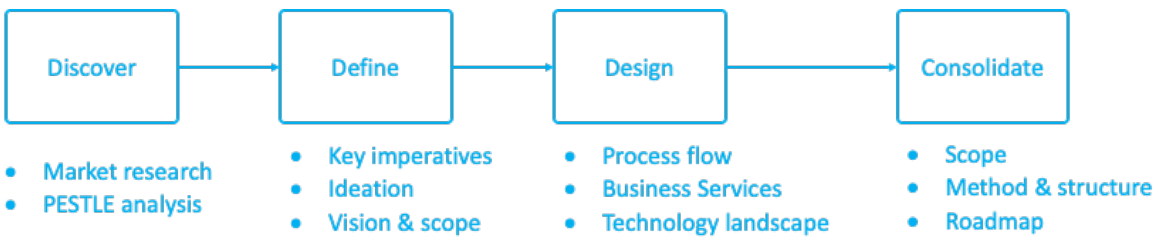

Figure 4.5: *Planning process stages and activities*

The first stage was “Discover,” which focused on understanding the need to pursue DT. While a clear need was the reason for commissioning this initiative, it was important to capture it in a detailed and inclusive way. The trends and drivers were perceived to determine the future direction of the organization’s DT, so these were the focus. The Discover stage comprised two main activities that took place over two weeks. The first activity was market research to understand emerging technologies, competition, business needs, and customer expectations. The second activity focused on analyzing the market research using a PESTLE (political, economic, social, technological, legal, and environmental) analysis tool as a lens. This allowed the categorization of the findings and the assessment of their implications in the digital strategy. A sample of the analysis is presented in Appendix B2. The team gathered 50 trends and drivers across the six PESTLE categories, consolidated the findings, and presented them to the participants for final review. These findings were then used as an input to the next stage.

The second stage was “Define,” which focused on defining the goals and objectives of DT. Three activities took place during this stage over a period of four weeks. The first activity was defining the DT goals. From the 50 identified trends and drivers, the team was able to identify three themes that recurred across the board: customer experience, value proposition, and business operations. Through thematic analysis, the team set nine goals that reflect each theme and its corresponding trends and drivers. This document formed what the team referred to as the “digital imperatives” —the digital principles the organization agreed to adopt. This formed clear boundaries within which the organization could start with ideation. The second activity was ideation for the defined DT goals. Following the design sprint process, the team defined 11 broad digital concepts that can be clustered under three digital capabilities: customer experience, business model, and operations (Figure 4.6). The third activity was setting the vision of the DT. The common theme was the customer experience; the team found that customers care mostly about the travel experience at the destination rather than just the flight journey. The HDTI outlined it as follows:

“So my vision is that on the product side, … we are able to offer a wide range of products and services that respond to the customer needs.”

Therefore, the DT vision was focused on Airco being a travel experience provider rather than just a carrier. This would require a significant expansion of the airline’s business scope.

Once the digital imperatives, goals, and vision were identified, the team was ready to design the digital business.

The third stage was "Design," which focused on designing the digital enterprise process activities. This stage covered three activities over a period of six weeks. The team found it challenging to move from a handful of goals to designing the new digital enterprise blueprint. The challenge was embodied in understanding the reflection of these goals on existing business functions and processes. Therefore, the team designed an activity where a matrix was used as a brainstorming tool, with business functions listed on the *x* axis and the 11 goals listed on the *y* axis. This provided a systematic process to propose ideas on way that business functions can contribute to the attainment of the digital goals. The DT Lead 1 commented on this during the interview:

"There was no [other] ideation exercise that really put the big audacious theme right in the context of that business activity. We thought about it through a discussion about that what [digital goal] means and how [it] affects the way we do business in that [a given] section of that [a given] process flow."

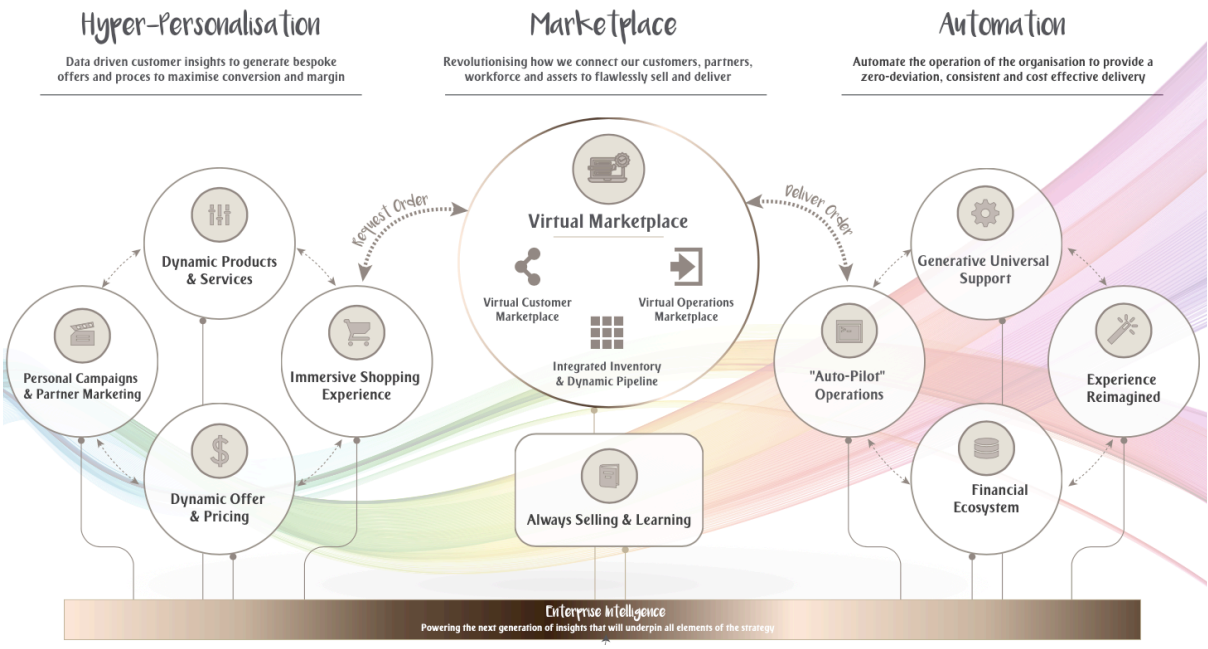

Figure 4.6: *Summary of digital capabilities as presented by the "digital transformation program summary" document*

The second activity of this stage used the generated ideas to design the new business processes and functions. The team broke down the end-to-end value chain into four parts—planning, selling, operating, and disruption management—where each part is a journey map. Each user journey map was then detailed into multiple business processes describing how each business function will support the new digital enterprise operations. There were many new business activities that could not be supported by existing IT systems. Therefore, the third activity was to design the technology landscape. The technology solution was designed specifically to support the execution of the newly designed digital enterprise. This involved the different architectural layers, including data, applications, and interfaces. It was evident that the scope of the DT was beyond readily existing technology and current organizational capabilities. Therefore, they held a hackathon-style activity where 50 potential technology partners of all sizes provided a pitch on how they can co-create the desired solutions with the organization. Five partners (two startups and three large technology providers) were selected.

The fourth and final stage of the process was “Consolidation”. This only involved the DT team and the consulting team, with the business representatives only consulted as needed. The objective of this stage was to consolidate the generated content from the planning process into a DT program plan. This was the strategic plan that was then presented back to the leadership team as a proposal. There were three activities at this stage: designing the program roadmap, setting the development team structure, and finalizing the scope. As the scope of the digital enterprise involved a high level of uncertainty, the team decided to follow an experimental approach. The program followed agile development to support the rapid experimentation of various technologies and concepts. Accordingly, the program roadmap had four phases over four years: Design, Prototype, Productionize, and Rollout. The roadmap can be seen in Figure 4.7.

The program structure was dependent on both the scope and solution development approach. There were four mini innovation labs that were formed to develop each four stages of the user journey. Each lab included an agile team to develop the corresponding part of the user journey. Nonetheless, there were daily standups where all lab owners discussed their progress and ensured alignment with others. This was meant to maintain an integrated user journey across all touchpoints. Finally, an MVP was scoped for each lab to develop the first program increment over 90 days. Each MVP had six sprints of two weeks each. At the end of the 90 days an MVP demonstration to leadership and business stakeholder was designed to take place

for feedback and to act as a go/no-go stage gate. This charted the end of the planning process and the team was ready to start the program pending leadership approval.

The DT team have detailed the progress and planning outcomes of the DT efforts into a progress report. Moreover, the report included the following stages, anticipated outcomes, and the required budget. This proposal was sent to all senior business stakeholders and specifically the leadership team. The DT plan was signed off by the CEO and the team was given the approval to proceed with implementation.

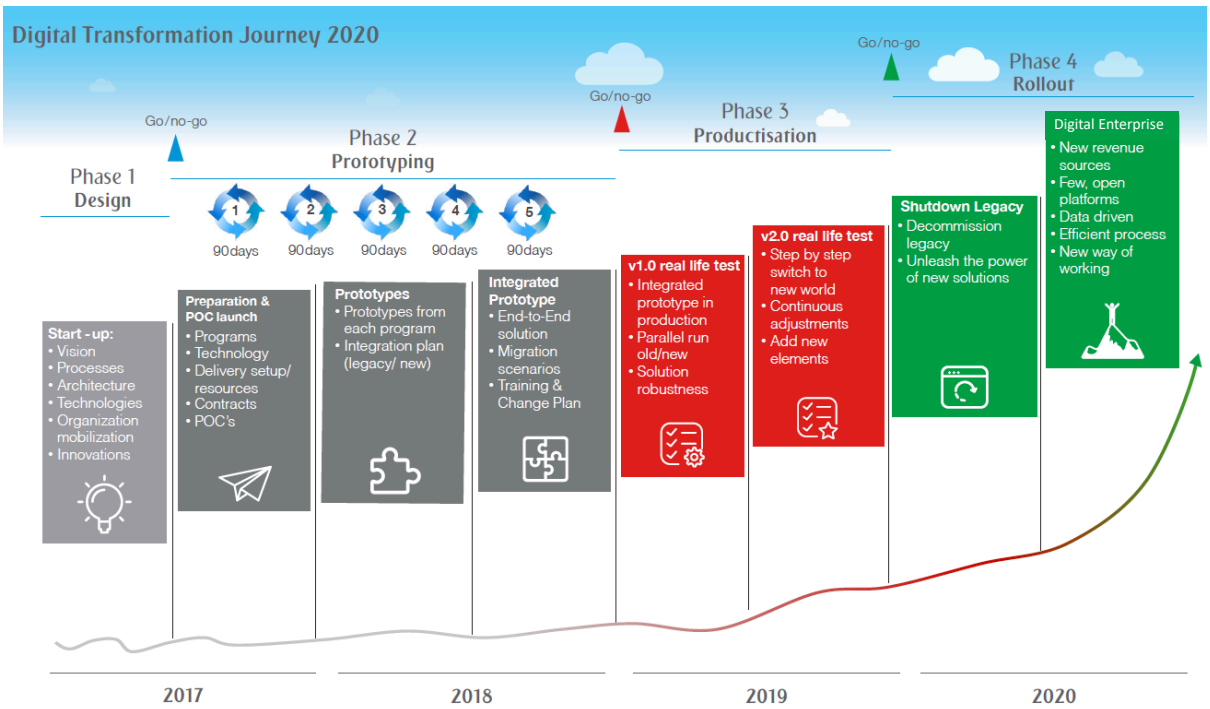

Figure 4.7: *Airco's DT program roadmap*

4.5.4 Planning Outcomes

A set of tangible and intangible outputs and outcomes emerged from the planning process. The tangible outcomes included a prioritized set of trends and drivers, a summary of the digital enterprise vision, a formulated DBS, a formulated DTS, a DT program roadmap, technology solution architecture, and the program and team structure. While the formulation of the DBS and DTS were not explicitly labeled, they were created in the process. The outcome of the Design stage was the future digital state, which meets the definition of a DBS (Sebastian *et al.*, 2017). Moreover, the outcomes of the consolidation stage formed the organizational journey toward the future digital enterprise, which meets the definition of the DTS (Chanias *et al.*, 2019). The most prevalent intangible outcomes were clarity of the digital vision and journey,

as well as the buy-in from senior stakeholders to proceed with the DT initiative. A thematic link between the planning outcomes and data sources can be found in Table 4.5.

Evaluating the outcomes based on the plan's success and fitness for purpose is not a trivial task. It is even more challenging when studies show that the vast majority of DT efforts fail to meet or exceed expectations. The team was aware of the high level of uncertainty that drove the adoption of agile experimentation to continuously improve the plan and its outcomes. Therefore, planning is seen as a continuous process across all stages of the program, and as influenced by learning from evidence. The HDTI's comment on this was:

"It's a continuous process of adopting it, and I think the vision and strategy will always change, just like the technology. But it always needs to be agreed where we aim and what we aim for, at least for a certain period."

Table 4.5: *Planning output linked to data sources*

Planning output	HDTI	HPD	Lead 1	Lead 2	SD	Plan document	Reflective log
Digital vision	x	x	x	x	x	x	x
Digital strategy	x		x	x	x	x	x
Digital enterprise blueprint			x			x	x
Process maps			x	x	x	x	x
Technology architecture	x	x	x	x		x	x
DT roadmap					x	x	
Program structure	x	x	x	x	x	x	x
Prototype design		x	x	x	x	x	x

During the prototyping phase, learning and feedback was solicited from three sources. First, there was a monthly open-house event where employees from across the business would take a tour through the DT labs and provide their feedback. The second learning source was from technology feasibility in terms of functionality. For instance, different features were evaluated based on their ability to meet a functional objective. Finally, at the end of each MVP, the outcomes were presented to the leadership team for feedback on suitability, and approval to take it forward. The researcher was involved in the case study until the end of the first MVP. The team had managed to complete around 85% of the user stories and had a functioning demo. Figure 4.8 is an example of the burndown chart the team used to track progress. This snapshot

was taken at the end of the first MVP. The leadership did attend the demo session, provided feedback on the scope, and approved the continuation of the program to the next stage of prototyping.

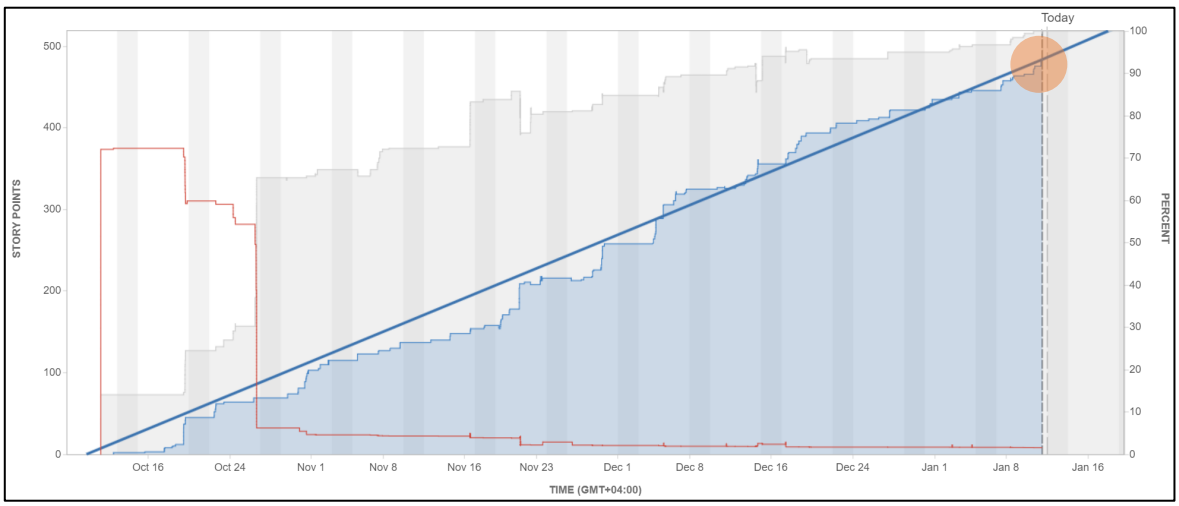

Figure 4.8: *Example burndown chart from MVP 1*

4.6 Discussion of Findings

4.6.1 DT Trends and Drivers

The first finding is the structure of DT trends and drivers. Two trends and two drivers were identified. The first trend was customers' expectations for a seamless and personalized experience. The second trend was the opportunities made possible by digital technologies. In terms of drivers, the first one was declining profits and the second one was securing the organization's competitive advantage. The findings are in line with the Vial (2019) categorization of DT trends and drivers to include the competitive landscape, customer expectations and behaviors, and technological opportunities. Trends and drivers demonstrate hierarchy and relationships. For instance, companies that are not facing financial pressure have leveraged digital technologies to capture new market opportunities (Yeow *et al.*, 2018; Chanias *et al.*, 2019). Nonetheless, companies have also used DT to respond to threats and capture new opportunities simultaneously (Sia *et al.*, 2016). Moreover, maintaining a competitive advantage was found to be dependent on both organizational agility and meeting customers' expectations. Stated differently, when facing financial pressure, companies align their trends and drivers to improve financial performance. In this case, technological opportunities were seen as valuable to improving the customer experience (revenue) and organizational agility

(cost), for an overall improvement in financial performance. Figure 4.9 provides an illustration of this relationship.

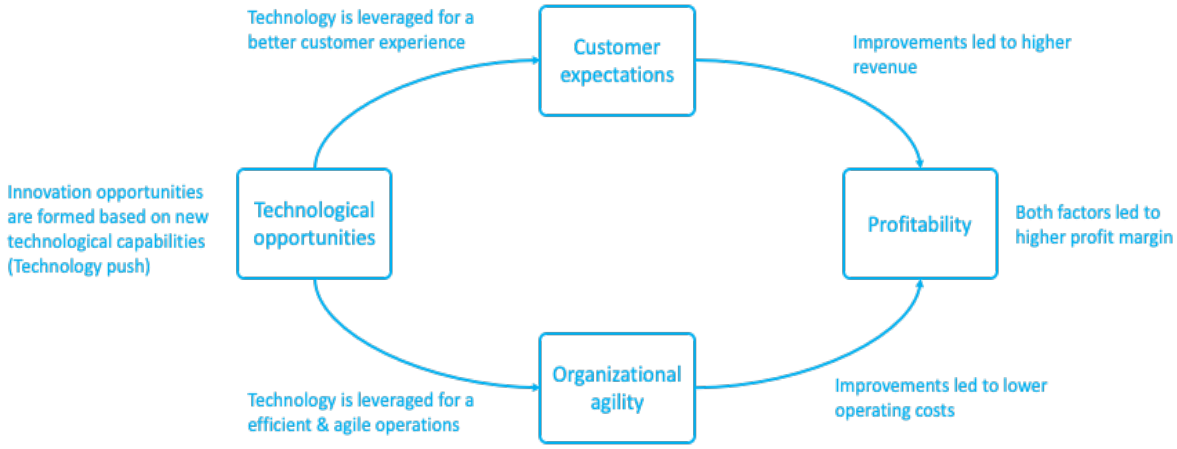

Figure 4.9: *Inductive relationship between DT trends and drivers*

4.6.2 DT Planning Process

The second finding is the planning process. Previous case studies have addressed DTS formulation (Chanias *et al.*, 2019) and a list of the main DT planning activities (Warner and Wäger, 2019). However, there has not been a detailed report outlining the DT planning process. The present investigation into the planning process uncovered several novel insights into the process:

1. A detailed description of all the planning stages and activities in the form of a process
2. Its main components are the trends and drivers, digital vision, DBS, DTS, and roadmapping
3. It focuses on converting the trends and drivers into a strategic response in the form of a DT program
4. It follows a series of design sprints to tackle the creativity and collaboration needed to formulate the DT plan
5. It focuses on unconstrained thinking to focus on what is "right" and then limits the scope to what is "possible".

The planning process provides means for addressing the planning activities. For instance, Warner and Wäger (2019) found that the planning activities are critical for leveraging dynamic capabilities for DT, and that for digital sensing, companies go through digital scouting, digital scenario planning, and digital mindset crafting. Following the planning process, Airco

managed to address all these requirements. Moreover, Vial (2019) found that companies formulate their DBS and DTS as a response to the identified trends and drivers. However, in this case study, it was identified that setting the DT goals and crafting a vision, as done in the Define stage, was critical for digital strategy formulation. Moreover, new activities were identified. Specifically, the digital matrix from the Design stage was paramount to helping the team in formulating the DBS and detailing the future digital enterprise blueprint. Researchers found that grounding digital innovation into current organizational structure is challenging (Gupta, 2018; Lichtenthaler, 2020) and this tool provided a pragmatic approach to resolving it.

Airco acknowledged that the DT planning process is a dynamic and ongoing process, which is in line with existing literature (Yeow *et al.*, 2018; Chanias *et al.*, 2019; Warner and Wäger, 2019). However, both in this case study and in the literature, it is planned and executed as a one-off activity (Yeow *et al.*, 2018; Chanias *et al.*, 2019). Missing a formalized approach to revising the plan led to it being an ad-hoc process (Chanias *et al.*, 2019). This is a known challenge to strategic planning, where companies find it difficult to keep the plan "alive" (Phaal *et al.*, 2011). Chapter 5 is dedicated to developing a conceptual framework for the iterative formulation and validation of the digital strategy.

4.6.3 Digital Business Strategy

The third finding is related to the DBS. The literature suggests that the DBS could choose from focusing on the customer experience, operational processes, or business model (Westerman *et al.*, 2014; Sebastian *et al.*, 2017), but Airco have incorporated all three capabilities into their DBS. Some Authors recommend prioritizing one capability to drive a focused digital investment (Westerman *et al.*, 2014; Sebastian *et al.*, 2017). However, in this case study, the results demonstrated that there are dependencies between digital capabilities. While the focus was on customer experience, it required specific operational and business model digital capabilities to make it happen. In this sense, parts of the operations and business model that directly influence the customer experience had to be prioritized as well. Hence, integration between different capabilities was seen as a critical priority from the beginning. Moreover, open innovation is a critical pillar of the DBS with which to address the limitations in current organizational expertise in developing planned digital capabilities (Bogers *et al.*, 2018).

4.6.4 Digital Transformation Strategy

The fourth finding concerns the DTS. Given the novelty of DT, and the amount of uncertainty surrounding it, agile development and continuous learning was perceived as critical to the plan's continuous improvement. However, the DTS embodied in the roadmap illustrated that real-life testing will only happen two years down the line, resulting in a delayed feedback loop. Other case studies also demonstrated that this can take one to two years (Yeow *et al.*, 2018; Chanias *et al.*, 2019). Chanias *et al.* (2019) found that realizing parts of the digital strategy triggers a new episode of DTS formulation and forming a feedback loop. Hence, delaying testing and experimenting with the strategy would result in delayed feedback for a new formulation episode. The Scaled Agile Framework (SAFe 5.0) recently emphasized the importance of testing each product increment or MVP against desirability, feasibility, and viability (Scaled Agile Inc, 2020). Therefore, delaying real-life testing would limit feedback to technical feasibility and "perceived" desirability. Such an approach would result in following an agile process without realizing the full value of agility, as agility requires rapid iteration between strategizing, testing, and implementation (Detoya and Gempes, 2020). Incorporating learnings as a feedback loop is a core requirement for agile practices to yield organizational agility (Cheng *et al.*, 2020).

In summary, reflecting on the case study question, a DT strategic plan that included four stages and 12 activities over a period of six months was identified and documented (see Figure 4.5). The outcomes of a DT strategic plan consist of four components:

1. Identification of digital trends and drivers as a basis for the strategic response for DT
2. Formulation of a DBS that shapes the vision and the design of a digitally enabled enterprise
3. Formulation of a DTS that outlines the transformation journey through strategy execution
4. Design of a DT roadmap that consolidates the first three points into a coherent strategic plan

The four components were the outcomes of following the four-stage process identified in this case study. Moreover, dependencies exist between the digital trends and drivers. When formulating a DT plan, these dependencies take place between different digital capabilities. The DT strategic plan can take the shape of a direct response to the specific trends and drivers that organizations face. Furthermore, the driving focus of the digital investment should not blindly limit the scope to one digital capability, as dependencies from other capabilities can be

critical for success. Finally, realizing agility requires learning from rapid business experiments where evidence from desirability, feasibility and viability is utilized.

4.6.5 Theoretical Implications

Dynamic capabilities in the context of DT require digital sensing, digital seizing, and digital transforming. It was found that strategizing activities embodied in the form of a planning process can form a clear path between sensing and seizing. Moreover, feedback generated from implementation was found to be the main source that stimulates the realization of the emergent strategy. Therefore, focusing on experimentation can accelerate the realization of the emergent strategy, resulting in a steep reduction in uncertainty. This phenomenon is explored further in chapter 6.

4.6.6 Practical Implications

This study has clarified the DT planning process, providing practitioners with a baseline that can be further calibrated for specific contexts. The digital matrix is a novel tool for converting digital priorities into a digital enterprise blueprint. Furthermore, agile development should focus on experimental learning that leverages evidence from desirability, feasibility, and viability. This learning can act as a feedback loop to continuously improve the digital strategy and demonstrates a clear difference between agile development as a process and agility as an organizational capability.

4.6.7 Limitations and Future Research

As with any research, there are a few limitations to this study. There is no evidence that Airco will continue to succeed in their DT. Moreover, the role of business experiments in the success of DT is yet to be proven. Future research can investigate the explicit incorporation of agility and experimentation into the DT plan. Understanding the resulting benefits and challenges would shed the light on how companies can further address the high failure rate of DT. Bearing in mind these caveats, the value of this case study to the literature is the identification and documentation of the activities and outcomes of DT strategic planning. The uncovered importance of incorporating agility into DT strategic planning for success led to further research: chapter 5 builds on the identified DT strategic planning process by designing an agile DT strategic planning conceptual framework focusing explicitly on roadmapping being the integrator of the strategic plan. Moreover, in chapter 6, the framework is tested and refined through a series of action research-based pilot studies.

4.7 Chapter Summary

Chapter 4 has presented an in-depth case study of the DT of a multinational airline. The investigation identified the key activities and outcomes of the digital strategy formulation, as well as the role of roadmaps as integrators of the components of the DT strategic plan.

5. AGILE DT ROADMAPPING FRAMEWORK

5.1 Introduction

This chapter builds on the exploratory case study findings from chapter 4 to form a conceptual framework for agile DT roadmapping. Section 5.2 presents the approach taken for the framework design. Section 5.3 and 5.4 reviews the literature that is related to roadmapping customization with a specific focus on DT. In Section 5.5 the concept of agility in relation to digital strategy is explored. The conceptual framework is presented in Section 5.6. Finally, the chapter ends with a summary.

5.2 Framework Design

The iterative formulation and evaluation of the digital strategy (RO-2) requires the design of a framework that can be tested. Therefore, the objective of this chapter is to design a conceptual framework that can be used as a research instrument to collect data on the utility of agile roadmapping for DT strategic planning. This is accomplished over three stages: the customization of roadmapping, the deployment of roadmapping as an agile process, and the configuration of the framework into a research instrument.

The customization of roadmapping is accomplished using the approach, recommended by Phaal *et al.* (2004a). Following the customization approach required blending the relevant literature with the findings from chapter 4.

It is also the objective of this chapter to embed the customized roadmapping process into an agile framework. As identified from the results of chapter 4, an integrated feedback loop needs to be created between the formulation of the DT strategic plan and its validation. This was accomplished by reviewing the literature of agile frameworks and leveraging some of its tools. This is discussed in section 5.5.

> **RQ-2:** How may the digital strategy benefit from being iteratively formulated and validated?

To answer the research question, it was important to configure the framework into a research instrument. This was critical to aiding the collection of data on the utility of agile DT

roadmapping. Therefore, this can be seen as necessary preparation for the primary research conducted in chapter 6.

5.3 Customizing Roadmapping

It was identified in Chapter 4 that a roadmap can act as an integrator of the DT plan. This section builds on the findings from the exploratory case study by customizing roadmapping for DT. The practice of roadmapping commonly takes the form of a workshop process aimed at strategic planning (Vatananan and Gerdsri, 2012). Two of the more popular roadmapping processes in terms of research and practice are "T-Plan" (Phaal *et al.*, 2004b) for technology roadmapping and "S-Plan" (Phaal *et al.*, 2007) for strategic roadmapping (Kerr *et al.*, 2019). This fast-start approach adopts the concept of rapid prototyping for fast and iterative learning (Phaal *et al.*, 2011). However, authors stress the importance of contextual adaptation of roadmapping process rather than identical adoption (Farrukh *et al.*, 2003). Roadmapping frameworks can also vary in terms of decision approach and level of content abstraction (Phaal and Muller, 2009). Decisions can range from expert-based to analytical and computer-based (Kostoff and Schaller, 2001), whereas abstraction level can range from detailed scientific foundation all the way to sector-level aggregation (Phaal and Muller, 2009).

The success of roadmapping has encouraged the customization of the framework to many applications of interest. Customization of roadmapping varies from adapting a reference process for a specific context (Kerr *et al.*, 2019) all the way to redesigning a new process (Lee and Park, 2005). Moreover, a customization framework for roadmapping has been developed and tested for strategic appraisal, business reconfiguration, and process development (Phaal *et al.*, 2004a). Exploring the roadmapping literature shows that the customization of roadmapping should consider the requirements of three aspects (Phaal *et al.*, 2004a):

1. **The context** of the domain of interest triggering the roadmapping activity, such as the scope and aim (Phaal *et al.*, 2004a).
2. **The architecture** of the roadmap in terms of time (industry chronological speed) and layers (taxonomy of the system) (Phaal and Muller, 2009).
3. **The process** and activities required to satisfy points 1 and 2 in terms of ideation, prioritization, and synthesis (Farrukh *et al.*, 2003; Kim *et al.*, 2018).

5.4 Customizing Roadmapping for DT

Customizing roadmapping is specific to the context of the domain of interest. This is in line with the findings from Phaal and Muller (2009) that customizing roadmapping should satisfy the purpose of the activity, referred to as design considerations (Kerr *et al.*, 2019) or design principles (Kim *et al.*, 2018). The contextual alignment aims to include design principles specific to the desired applications. For instance, design roadmapping considers the use of customer experience research to identify core design opportunities (Kim *et al.*, 2018) while strategic roadmapping uses a clustering technique of the strategic landscape to identify core strategic opportunities (Phaal *et al.*, 2007). The remainder of this section provides a discussion on the customization of context, architecture, and process for DT.

5.4.1 Customizing The Roadmapping Context for DT

The customization of roadmapping context to the domain of interest is defined by the scope, purpose, and unit of analysis (Phaal *et al.*, 2004a; Phaal and Muller, 2009). The scope of DT can be understood from its definition as a strategic response to the trends and drivers. Specifically, its purpose is to articulate this response by integrating the DT plan components identified in chapter 4 and facilitate their communication. Another critical purpose is to enable agility by explicitly incorporating agile principles into the roadmap. Furthermore, DT tends to cut across business functions, requiring the involvement of a cross-functional team early on in the planning process (Chanias *et al.*, 2019). This was found critical for both buy-in and functional expertise. Therefore, the unit of analysis can be the whole organization or a specific business function, as appropriate for the strategic response. Achieving the roadmapping context is facilitated by customizing the roadmap architecture and the roadmapping process (Phaal *et al.*, 2004a). A summary of the context customization approach is illustrated in Table 5.1.

Table 5.1: *Summary of context customization for DT roadmapping*

Context	Approach	Outcome
Scope	DT definition (section 2.2)	Guided by response to trends and drivers
Purpose	Integration of DT strategic plan components (section 4.6)	• DT trends and drivers • DTS • DBS
Unit of analysis	Ranges from a business function to the whole organization	Guided by impact of trends and drivers

5.4.2 Customizing The Roadmap Architecture for DT

Architecting the roadmap requires customization of the time dimension and its layered structure (Phaal and Muller, 2009). The time dimension on the roadmap is used to understand the dynamic evolution of various aspects (market and resources) between the vision and the current state. The layers, however, are used to link the dimensional structure of the domain of interest. The broad layer structure of a roadmap constitutes three levels which, from top to bottom, are know-why, know-what, and know-how (Phaal and Muller, 2009).

There are no detailed accounts in the literature of architecting a roadmap for DT. The general consensus is that it outlines a strategic response to the market and business trends and drivers (Vial, 2019). Moreover, DT journeys should be agile and focused on building MVPs in an iterative fashion (Westerman *et al.*, 2014; Chanias *et al.*, 2019). Although digitally transforming a large company can take a long time, as seen from the case study in chapter 4, the time interval of the intermediate steps should be adapted toward incremental MVPs as well. The customization of the purpose of each roadmap layer is outlined in Table 5.2.

Table 5.2: *Roadmap layer customization for DT*

Roadmap layer	Layer purpose	DT customization
Top layer: Market and Business (Know-why)	Identification of relevant external trends and internal drivers (Phaal and Muller, 2009)	Capturing digital trends and drivers to identify digital economy opportunities (Vial, 2019)
Middle layer: Product, Service and System (Know-what)	Evolution of systems, products, or services that can capitalize on the identified opportunities (Phaal and Muller, 2009)	Developing digital capabilities to capitalize on the identified opportunities (Westerman *et al.*, 2014; Sebastian *et al.*, 2017)
Bottom layer: Technology and Resources (Know-how)	Resources (tangible or intangible) that can be leveraged to deliver the desired solutions (Phaal and Muller, 2009)	Leveraging existing resources to deliver the required capabilities such as financial (Hess *et al.*, 2016), technical (Sebastian *et al.*, 2017), and business resources (Chanias *et al.*, 2019)

It is also critical that the roadmap architecture supports the articulation of the roadmap's purpose, as described under context customization in section 5.4.1. The purpose is to act as an integrator of the DT strategic plan, consisting of the DT trends and drivers, the DBS, and the DTS. The three components have been mapped to the layers of the roadmap as illustrated in Figure 5.1. However, it is important to realize that a roadmap aggregates information to

facilitate a holistic view, rather than listing all details (Phaal and Muller, 2009). The mapping for each DT strategic plan component is described here:

1. **Digital trends and drivers:** This component already exists on a baseline roadmap as the top layer. Digital trends and drivers are also referred to as market, business, or customer trends and drivers.
2. **DBS:** This component describes a future state of the DT, which a roadmap holds as a vertical column on the right-hand side. This is also referred to as the roadmap vision.
3. **DTS:** This component describes the journey of DT from the current state toward the digital vision. The middle layer maps the evolution of digital capabilities, while the bottom layer illustrates the required enablers as transformation capabilities and resources.

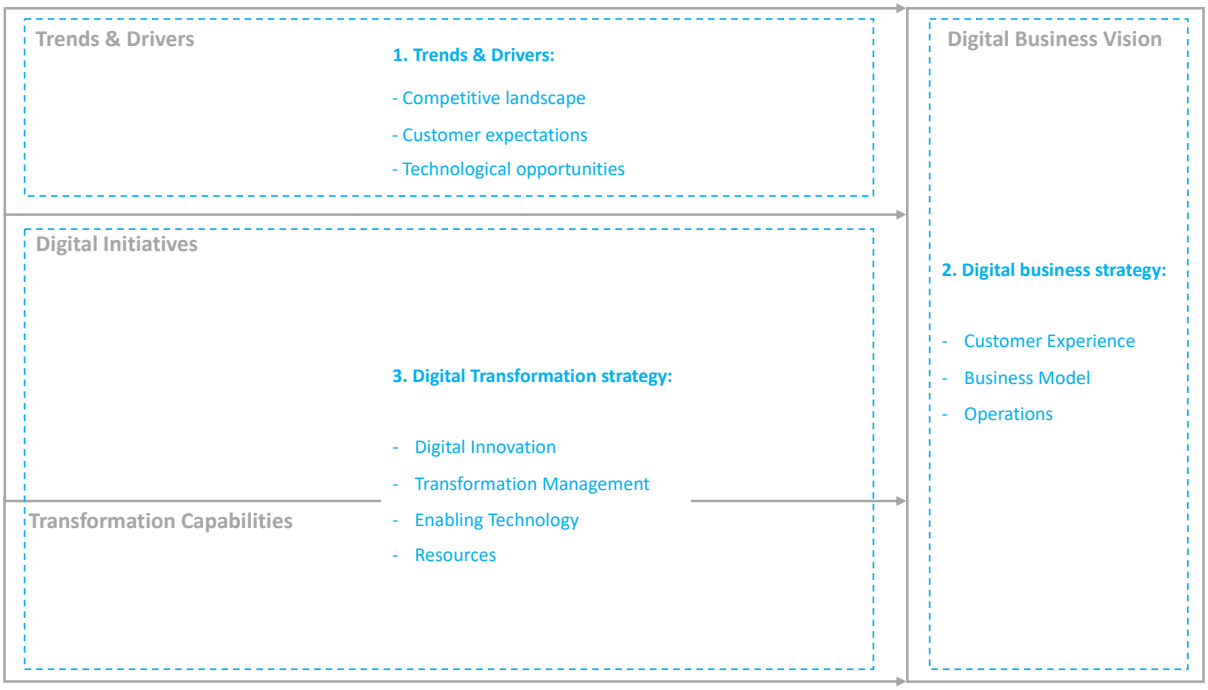

Figure 5.1: *Mapping the DT strategic plan components to the roadmap architecture*

Figure 5.1 elaborates on the criteria of each component. The literature review in section 2.2.1 showed that the trends and drivers consist of forces exerted on the business in the form of challenges and opportunities. These were the competitive landscape, customer expectations, and technological opportunities. The case study in chapter 4 confirmed this and identified financial performance as a critical driver as well.

The DBS can be considered as the building blocks of the DT vision and the desired future state of the digital enterprise. In section 2.3.1 of the literature review, the DBS was identified as an illustration of the desired state of the digital capabilities being the customer experience, operations, and business model.

The DTS was described in section 2.3.2 as the blueprint of the DBS evolution. The middle layer outlines the development of the digital capabilities toward the DBS. The transformation capabilities required for executing the development and integration of digital capabilities were identified in section 5.2.5 and included enabling digital innovation and agility, managing transformation and change, leveraging enabling technologies, and managing resources.

5.4.3 Customizing The Roadmapping Process for DT

From a high-level view, a roadmapping process goes through ideation, divergence, convergence, and synthesis (Phaal and Muller, 2009). The importance of roadmapping as a process to guide the navigation through DT uncertainties has been well argued (Westerman *et al.*, 2014; Valdez-de-Leon, 2016; Parviainen *et al.*, 2017). The stages of roadmapping in DT have been broadly captured to include: (1) developing the digital vision; (2) prioritizing digital initiatives; (3) mapping the digital journey; and (4) iterating over the roadmap (Westerman *et al.*, 2014; Parviainen *et al.*, 2017; Schallmo *et al.*, 2017; Sebastian *et al.*, 2017). Incorporating agile practices into the DT strategic plan has also been a recurring theme (Chanias *et al.*, 2019). However, a process with a clear set of activities for formulating a DT roadmap remains underdeveloped (Parviainen *et al.*, 2017).

The activities and desired outcomes of the roadmapping process can be adapted from the exploratory case study strategic planning process in Figure 4.5. The planning process stages were Discover, Define, Design, and Consolidate. As described in the case study, the stages of this planning process is an adaptation of the Google design sprint methodology (Google, 2017). Design sprints have been adapted from multiple design practices at Google, including design thinking (Araujo *et al.*, 2019). The design sprint methodology is used for solving problems and testing ideas in a rapid process (Knapp *et al.*, 2016).

Several roadmapping processes are outlined in the literature, but none have been specifically tested for DT strategic planning, which makes the proposed process from the case study in chapter 4 the only tested and suitable option. Moreover, while multiple well-proven

roadmapping processes can be customized for DT, design sprints has multiple advantages for this customization in a number of ways. First, the methodology emphasizes rapid prototyping which supports the requirements of roadmapping in taking an iterative approach. Second, design sprints adopt the user-centered design from design thinking, while being focused on eliciting requirements for software projects (Araujo *et al.*, 2019). Third, the design sprint methodology was originally developed for designing digital projects at Google GV (previously known as Google Ventures) which makes it a tighter fit to DT (GV, 2019). Therefore, design sprints methodology is selected as the DT roadmapping process for customization.

The objective of the customized roadmapping process is to aid the formulation of the three planning components as an integrated roadmap. The process of design sprints is a one- to five-day workshop that rapidly moves from understanding the challenge to testing prototyped solutions with users. The process follows six stages, as can be seen from Figure 5.2:

- **Understand** the challenge and develop a shared knowledge base across participants
- **Define** the context and desired outcomes to establish focus
- **Sketch** a broad range of ideas to be considered further and refined
- **Decide** and finalize the direction or concept to be prototyped
- **Prototype** a low-fidelity concept enough to validate the hypothesis
- **Validate** findings with real users or stakeholders

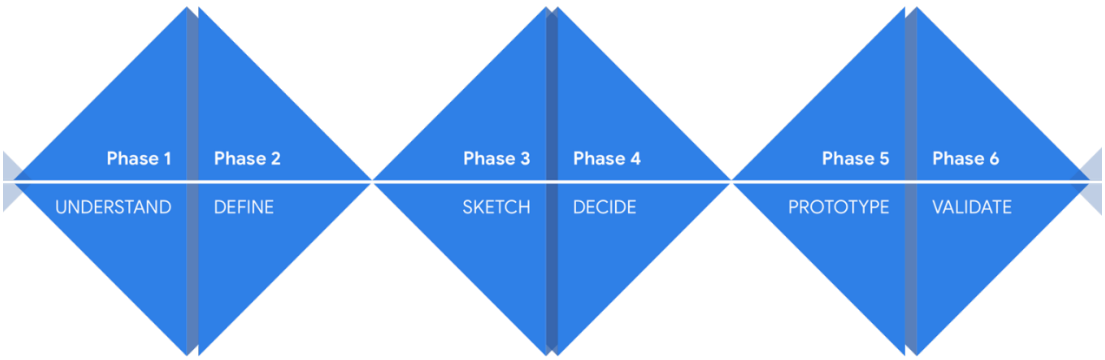

Figure 5.2: *Design sprint process phases (Source: Google (2019a))*

The design sprint has spun out of the practice community and is still in early stage research. Design thinking has been used to develop business strategy as an applied hands-on approach (Cagnin, 2018). Design sprints has also been deployed to develop the vision of digital solutions

(Keijzer-Broers and de Reuver, 2016). While there is no evidence from the literature on the use of design sprints for developing a strategy, there are a few example case studies from practice communities (Google, 2018). The present research proposes a novel application of design sprints for roadmapping DT. The challenge to solve is how to create a DT strategic plan that is integrated into a roadmap. Based on this understanding, a DT roadmap would be prototyped to be validated with relevant stakeholders. The following adaptation to the process is proposed, where stages one and two are merged:

- **Understand** the digital trends and drivers and their impact on the organization
- **Sketch** a broad range of digital solutions and ideas to be considered further and refined
- **Decide** on the digital initiatives to form the DBS
- **Prototype** a first-cut DT roadmap that illustrates the DTS
- **Validate** the roadmap with relevant stakeholders and sponsors to identify next steps

Table 5.3: *Summary of roadmap customization for DT*

Customization	Definition
Context	**Scope:** Strategic response to DT trends and drivers (based on DT definition in section 2.2) **Trends and drivers:** Market competition, customer expectations, technology opportunities **Purpose:** Integration and articulation of DT strategic plan components **Unit of analysis:** Dictated by scope
Architecture	**Top layer:** Digital opportunities **Middle layer:** Digital capabilities **Bottom Layer:** Transformation capabilities **Structure:** Illustrated in Figure 5.1
Process	Adaptation of design sprint methodology

The fast-start approach to roadmapping demonstrated that a first-cut roadmap can be generated in one to two days (Phaal *et al.*, 2011). Moreover, design sprints are focused on prototyping solutions that can be validated (Knapp *et al.*, 2016). Therefore, it is hypothesized that having a sprint approach to roadmapping can allow organizations to compress their efforts and prototype a first-cut DT roadmap in a few days. While the outcomes might not be deployable from the first roadmapping iteration, the process would clarify gaps in the knowledge and understanding of DT, and therefore, clarifying the next steps for refining the roadmap. There might be a need for a few more design sprints to synthesize the roadmap, but subsequent sprints tend to be shorter and smoother (Knapp *et al.*, 2016). Moreover, digital

technologies are developing at an accelerating rate and the combinatorial effect of multiple technologies is driving new innovations. Having such a rapid process allows for efficient assessment of the impact of new trends and drivers on the existing DT roadmap, thus enabling a continuous enhancement of the DT plan. A summary of roadmap customization for DT can be found in Table 5.3 and the customized DT roadmapping process is illustrated in Figure 5.3.

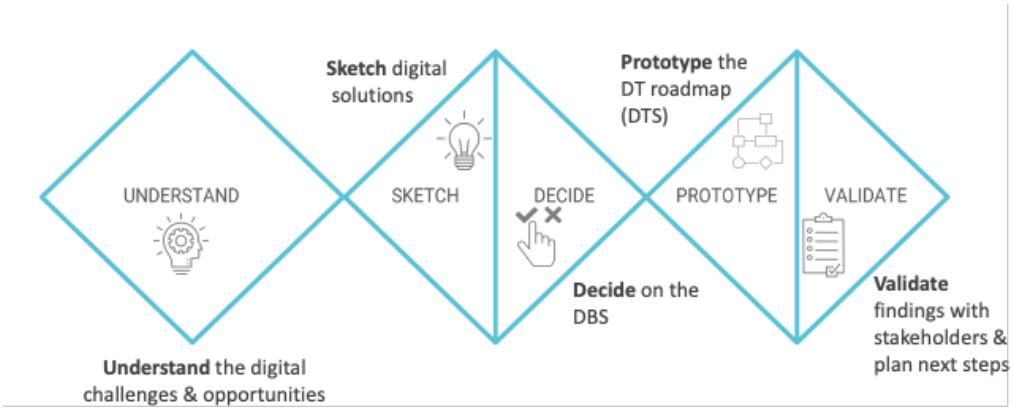

Figure 5.3: *DT roadmapping process (adapted from design sprint methodology)*

5.5 Incorporating Agility

Agility is defined by as "The ability to move quickly and easily" (Walter, 2013, p. 28). This is a critical aspect to consider when dealing with an ongoing process. Moreover, given that digital strategy formulation is dynamic and requires continuous iteration and validation, spending several months formulating a plan in advance is not justifiable. Therefore, agile methods can enable "quick and easy" iterations over the digital strategy. The first iteration would prototype a plan and act as a quick diagnosis of knowledge gaps followed by a series of design sprints for continuous refinements. Additionally, each digital initiative would require a dedicated design sprint for further details and validation of its desirability.

Enabling iteration over the DT strategic plan and its validation requires a guiding framework. It has been established that this iterative approach can influence the realization of the emergent strategy. Therefore, following an agile approach is suggested for the validation and rapid refinement of the DT roadmap. Several agile frameworks can be leveraged for this research. The case study in chapter 4 followed the Scaled Agile Framework (SAFe) (SAFe, 2019). However, other scaled agile frameworks such as large-scale scrum and scaled agile technology tend to take a very similar approach in terms of governance (Theobald *et al.*, 2019).

SAFe is “an online knowledge base of proven, integrated principles, practices, and competencies to implement Lean, Agile, and DevOps at scale” (Orvos, 2019). As a framework, it is popular within large companies that attempt to follow agile development, such as Airbus, Intel, Sony, AstraZeneca, Accenture and many more (Scaled Agile Inc, 2019). Academic research was also conducted to validate the framework’s rigor (Putta *et al.*, 2018). This makes it appropriate for the scope of this research.

While the entire SAFe methodology is considered useful, two main principles deserve emphasis. It was established in section 2.5.2 of the literature review that there is a consensus among authors on the adoption of agile development for DT. However, the case study showed that agile practice does not necessarily result in agility, resulting in a limited focus on experimentation to validate the digital strategy.

The two principles are agile product delivery and organizational agility from SAFe 5.0 (Orvos, 2019). Agile product delivery focuses on continuous and incremental delivery of solutions in a customer-centric way by ensuring desirability, feasibility and viability (Orvos, 2019), whereas organizational agility focuses on strategy agility by rapidly adapting the strategy when needed (Orvos, 2019). The common thread between the two is the developed solution. A solution is defined as a product, service, or system that is developed to add value to the customer, whether internal or external (Orvos, 2019), which occupies the middle layer on a roadmap (Phaal and Muller, 2009). A strategy is translated into a set of solutions that are developed through agile product delivery (Orvos, 2019). Setting of the strategy and solutions is based on hypotheses. The lean startup thesis is that validating a product hypothesis can be done in a lean way by building an MVP and testing it in real-life settings, as shown in Figure 5.4 (Ries, 2011).

Given that the hypothesis is validated against desirability, feasibility and viability (Orvos, 2019), it is argued here that validation can be achieved in a more efficient and incremental process. For instance, validating customer desirability can be done by prototyping a mockup without real-life deployment in a matter of days. This has been the premise of Google design sprints, as shown in Figure 5.5 (Google, 2017). Moreover, feasibility can be validated by developing the MVP and operating it. Finally, commercial viability can be tested by measuring customer response and demand for the product in real-life settings. Figure 5.6 provides an

illustration of the proposed integration of desirability, feasibility, and viability into the MVP process as an *agile MVP*.

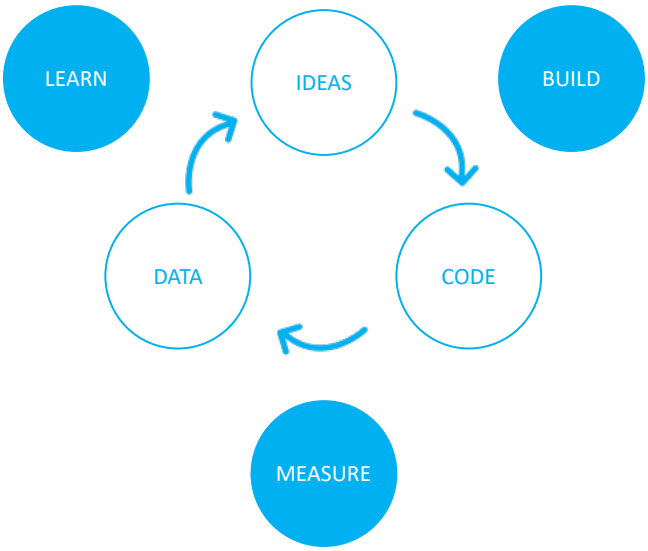

Figure 5.4: *Lean startup cycle (Ries, 2011)*

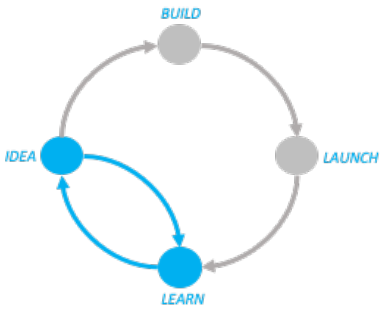

Figure 5.5: *Design sprint cycle (Source: (Google, 2017))*

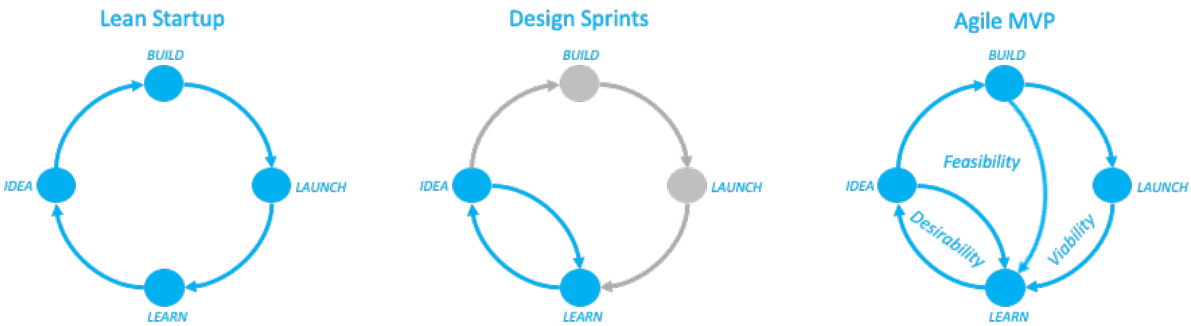

Figure 5.6: *Adaptation of an agile MVP from the lean startup cycle and design sprint process*

Running business experiments with the digital solutions that make up the digital strategy can provide evidence for their fit as a strategic response for DT. It is hypothesized in this

research that such evidence can enable DT agility by learning from a "minimum viable strategy" (MVS). This term is used here to refer to the smallest subset of the digital strategy that can be used for testing and validation its suitability. Figure 5.7 illustrates this concept. As discussed in this section, the validation of the DT strategic plan takes an iterative form based on evidence from the evaluating the desirability, feasibility, and viability of the digital strategy. Given that digital strategy formulation is an ongoing process throughout the DT journey (Yeow *et al.*, 2018; Chanias *et al.*, 2019), the DT roadmap will need to be iterated to keep it "alive." This cyclical approach is presented in Figure 5.8.

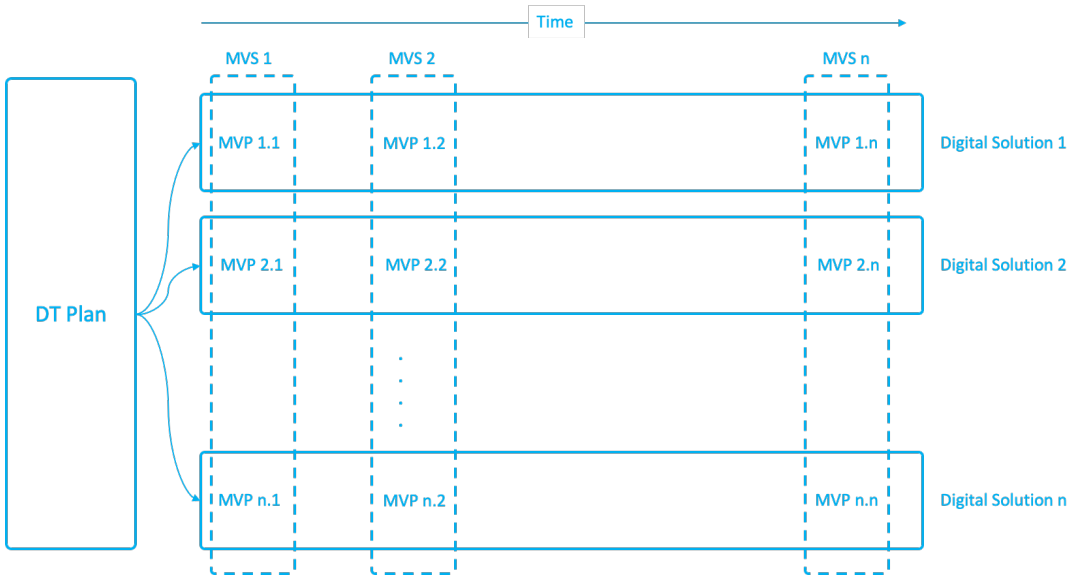

Figure 5.7: *Minimum viable strategy*

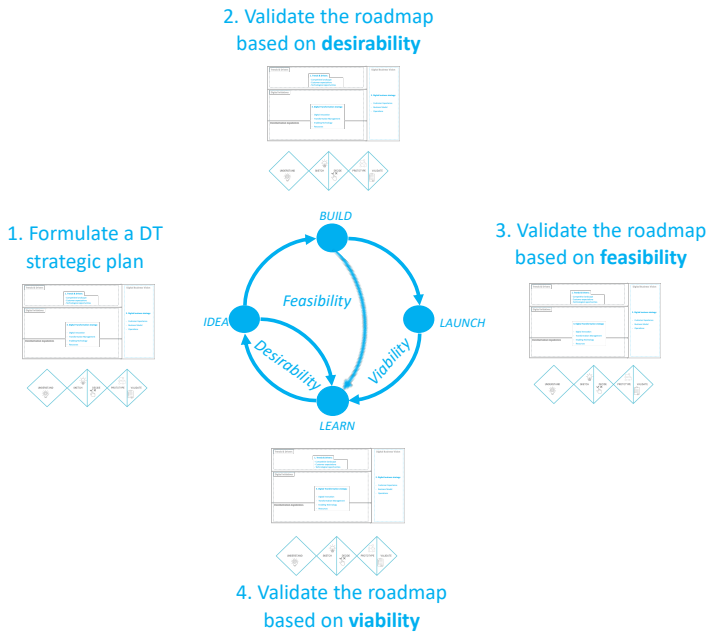

Figure 5.8: *Agile DT roadmapping framework*

5.6 Agile DT Roadmapping as a Research Instrument

Finally, the design sprint for roadmapping DT can act as a research instrument to assess the value of incorporating agility into the digital strategy. The goal of the framework is to enable the validation and adaptation of the DT strategic plan in an efficient and incremental way. Therefore, it is possible to assess the framework objective based on the perceived value of the framework outcomes within organization. This can be achieved by conducting pilot studies with organizations, in the form of workshops, where a DT roadmap is formulated and data on its suitability is collected. The data collection is triangulated to include data from before, during and after the workshop as detailed in section 6.2. The pilot study process is illustrated in Figure 5.9.

The agile DT roadmapping process activities is detailed in Table 5.4 to be used for the workshop. The table shows a summary of the objectives of each phase, and descriptions of activities. The sprint phases and most activities were adapted from the original design sprint framework. A detailed description of activities can be found on Google's official design sprint kit website (Google, 2017) or in the framework author's book, *Sprint* (Knapp *et al.*, 2016).

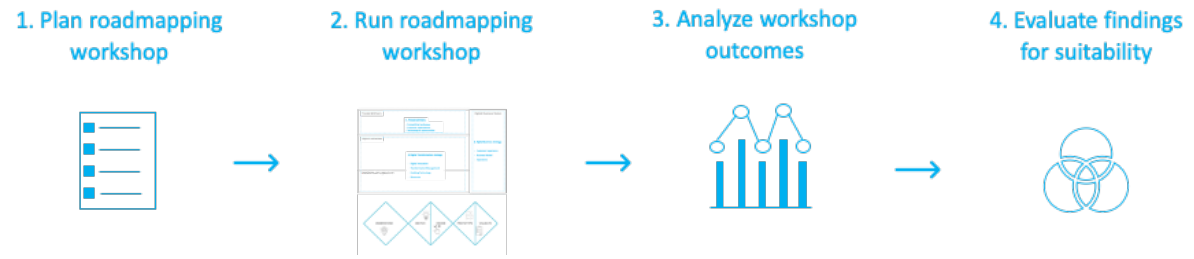

Figure 5.9: *Pilot study process*

The alteration of the design process took two considerations which are the use of four additional activities and the organization of generated content on the roadmap. The four added activities can also be viewed as the adoption of two existing tool and the development of two new tools. The first adopted tool is value chain mapping. It was identified that value chain mapping can facilitate the integration of DT initiatives outcomes for value creation (Iftikhar *et al.*, 2019). This tool is also chosen to broaden the focus of design sprints from a single product to be on a strategy level which can potentially cover the whole organization. The second adopted activity is the opportunity and feasibility scoring. Design sprints also focus on voting for ideas to select the top one. However, in the context of DT there would be multiple initiatives

that have to be prioritized for driving focus of the digital investment (Westerman *et al.*, 2014). Therefore, using predefined criteria for project selection using opportunity and feasibility allows for a systematic decision making process (Mitchell *et al.*, 2014). This approach is particularly useful for large organization to build a justified business case for digital investments.

Two activities were developed and added to the design sprint reference process to make it relevant to the research objectives. First, a "Digital Trends Tweets" activity was added to emphasize the main digital trends and drivers. In this activity, participants were tasked with clustering and prioritizing the trends and drivers. This was followed by reframing the top five clusters in a way that demonstrated relevance and impact to the business. A supporting template was created, which can be found in Figure 5.10. This task and template were developed by the researcher of this thesis as an adaptation of the "start at the end" activity which is one of the main design sprint activities (Knapp *et al.*, 2016). This activity is intended to give participants the chance in framing trends and drivers in a way that is aligned with their business and their priorities in a concise manner that senior management can agree with.

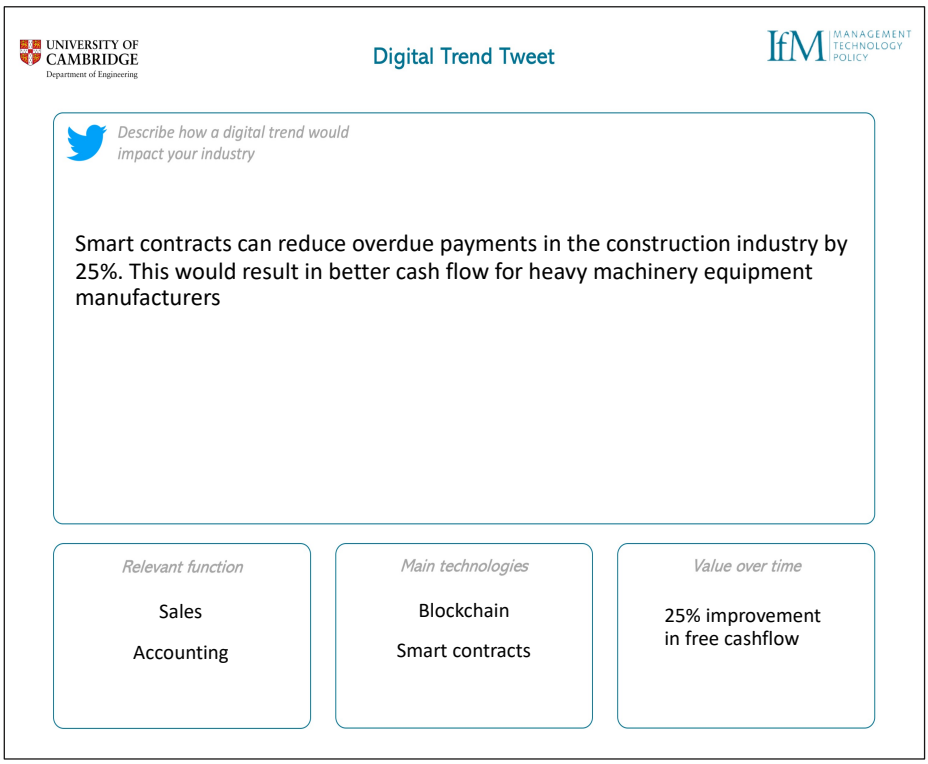

Figure 5.10: *Example of the "Digital Trends Tweets" exercise template*

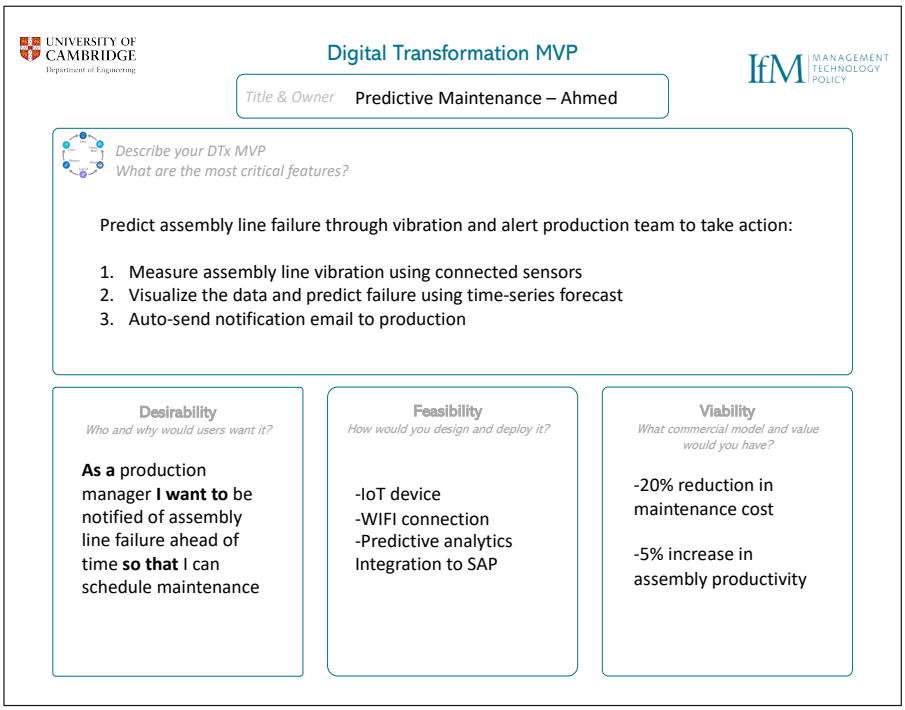

Figure 5.11: *Example of the "MVPing" exercise template*

Second, an "MVPing" activity was added by the author of this research, which allowed participants to define the scope of an MVP for the selected digital initiatives. This was an approach suggested to incorporate agility into the DT strategic plan in a way that was directly cascaded from the DBS. This is instrumental to indicating the utility of incorporating agility. The activity included a concise definition of the MVP scope, list of the top three features, and documentation of the hypotheses to be tested in terms of desirability, feasibility, and viability. A template was created to aid this activity, which can be found in Figure 5.11. This template has been developed as there is no common tool for designing the scope of an MVP.

5.7 Chapter Summary

This chapter proposed the customization of roadmapping to act as an integrator of the DT plan. This was done by customizing the context for DT, the roadmap architecture, and the roadmapping process. The customization incorporated findings from the exploratory case study to create a conceptual version of the framework. In addition to the potential practical value of this framework, it was developed as a research instrument for investigating the value of incorporating agility into the DT strategic plan. Chapter 6 tests this framework in real-life settings through a series of pilot studies by following an action research approach.

Table 5.4: *Design sprint workshop activities for agile DT roadmapping research*

Understand	Sketch	Decide	Prototype	Validate
• Understand the impact of digital economy on our industry • Identify digital opportunities for our business	• Brainstorm ideas that target the identified opportunities	• Select digital concepts to be taken forward	• Populate the roadmap with generated concepts • Fill in missing information • Identify gaps for next steps	• Pitch digital vision, goals, and roadmap to sponsor and stakeholders
Digital Trends Tweets Concise summary of the impact of the top five trends and drivers **Start at the End** Long-term DT goals **How Might We** Neutral framing of DT opportunities as questions for brainstorming **Value Mapping** 8–12 steps summarizing the business value chain **Digital Opportunity Mapping** Placing "How Might We" opportunities on the relevant point of the roadmap top layer	**Lightning Demo** Sketching and presenting relevant and inspiring digital examples **Doodle Sketch** A scribble of a potential digital concept **Crazy 8s** Sketching eight variations of the same digital concept **Solution sketch** A detailed sketch for a digital concept	**Solution Consolidation** Consolidating the individual solution sketch into a finalized digital concept **Storyboarding** Revising the value chain to incorporate the new digital concept **Opportunity vs Feasibility** Breaking down the new value chain into a set of digital initiatives to be scored based on opportunity and feasibility	**Map the Journey** Mapping the top five digital initiatives to the middle layer of the roadmap **MVPing** Defining an MVP scope for the selected initiatives **Map Resources** Defining the required resources for the digital initiatives **Roadmap Consolidation** Refining the roadmap content and flagging knowledge gaps for next steps	**Stakeholder review** Present outcomes to sprint sponsor for instant feedback **Recap and next steps** Agree on next steps for further refinement of the roadmap

6. AGILE DT ROADMAPPING PILOTS

6.1 Introduction

This chapter presents three pilot studies on the use of agile DT roadmapping as developed in chapter 5. The objective of this chapter is to evaluate the suitability of agile roadmapping for digital strategy formulation. The research design of this chapter follows an action research approach, detailed in section 6.2. Sections 6.3 and 6.4 provide an elaboration on the data collection and analysis. The plot study reports are then presented in sections 6.5–6.7. Finally, a discussion of the findings is presented in section 6.9.

6.2 Pilot Study Design

Thus far, this research has investigated the process of formulating a DT strategic plan. The literature review in chapter 2 identified its critical components and chapter 4 documented its formulation process. Findings from both chapters have illuminated the role of roadmapping in formulating and integrating the plan. Incorporating agility into the planning process was also identified as a critical aspect for the continuous and efficient adaptation of the plan. However, empirical evidence is needed on the utility of agile roadmapping in supporting the formulation and validation of the digital strategy. Therefore, this chapter aims to answer research question 2:

RQ-2: *How may the digital strategy benefit from being iteratively formulated and validated?*

The research in this chapter includes an implicit task and an explicit task. The implicit task is to evaluate the ability of the framework and its processes to incorporate agility into the DT strategic plan. The explicit task is to evaluate the utility of agile roadmapping to the DT strategic plan. Therefore, this chapter has been designed as a series of pilot studies. Conducting multiple studies allowed more opportunities to refine the framework and its process. Moreover, it enabled the generation of sufficient empirical evidence to evaluate the underpinning theoretical proposition. The pilot study design process is shown in figure 6.1

6.2.1 Pilot Activities

DT planning is an ongoing process that has been incorporated into the conceptual framework, illustrated in Figure 5.8, by agile iteration over desirability, feasibility, and viability. It was important to design this research allowing for sufficient demonstration of the

framework while illuminating insightful findings. Therefore, a pilot study, which is "a small-scale implementation of the full scale model" (Robson, 2011), was deemed an appropriate method for collecting sufficient data to answer the research question as shown in Figure 5.9.

Figure 6.1: *Pilot study design process*

Each pilot was designed as a two-day design sprint workshop that would result in a first-draft DT roadmap as an outcome. The perceived value of the outcomes enabled the framework to be calibrated while its utility was assessed. A pilot of the agile DT roadmapping framework is illustrated in Figure 6.2. The pilot activities are aligned to the action research process in section 6.2.2.

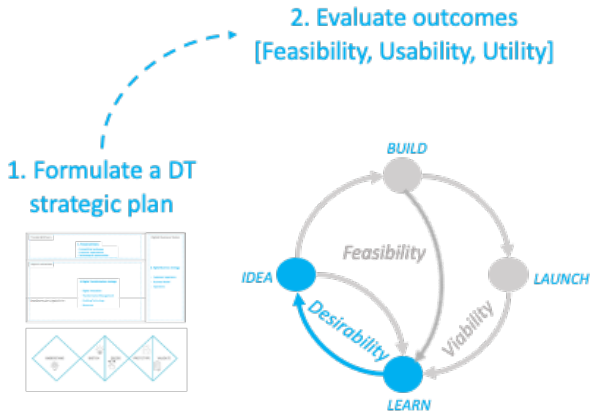

Figure 6.2: *Agile DT roadmapping pilot*

6.2.2 Action Research Process

This pilot study approach followed a structured action research process consisting of five stages (Susman and Evered, 1978): diagnosis, action planning, action taking, evaluation, and specifying learning. Using the agile DT roadmapping framework as a research instrument allowed for both testing the framework and generating learning on the utility of agility to DT plans. Following a spiral action research approach allowed the framework to be refined twice

between pilot projects (Saunders *et al.*, 2008). The agile DT roadmapping framework uses the design sprint process (Google, 2017) as detailed in chapter 5. As a research instrument, the process starts by scoping the roadmapping workshop, running a two-day workshop, and evaluating the workshop outcomes based on perceived value. This process has been aligned to the action learning framework, as outlined in Table 6.1.

Table 6.1: *Alignment of the action research process*

Action learning	Agile DT roadmapping pilot study	Objective
Diagnosis	Understand the need for DT	Define the DT objectives
Action planning	Workshop scoping and preparation	Agree on scope and outcomes
Action taking	Two-day workshop	Formulate an agile DT plan
Evaluation	Follow-up interview	Collect feedback on utility and value
Specifying learning	Results	Consolidate findings

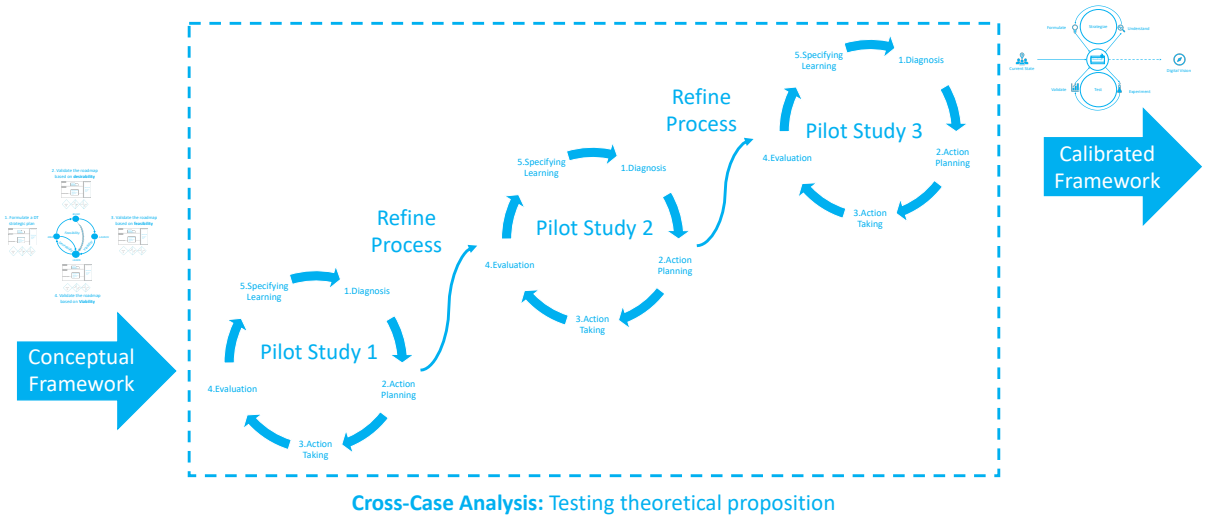

Figure 6.3: *Action research design*

From the theoretical implications in section 4.6.1 and the critical evaluation of incorporating agility in section 5.5, it was theorized that agile roadmapping would accelerate the realization of the emergent digital strategy. This was adopted as the theoretical proposition to be tested in this chapter. The action research design was used to accomplish this over two stages, illustrated in Figure 6.3. The first stage was at the pilot study level, where the framework and its process were tested to evaluate the ability of the framework to successfully incorporate agility into the DT strategic plan. The findings were then taken to calibrate the framework process at the end of each pilot study, to be used in the next pilot study. The second stage was conducted as a

cross-case analysis to evaluate the utility of agile roadmapping to the DT strategic plan. The findings from all pilot studies are consolidated in section 6.8 and were assessed in detail against the theoretical proposition. The evaluation criteria are outlined in section 6.2.3 and the data collection and analysis are elaborated in sections 6.3 and 6.4, respectively.

6.2.3 Evaluation Criteria

Evaluating findings of the framework requires the right criteria to draw a valid conclusion. The objective is to evaluate whether following the framework's process would enable agility of the DT strategic plan in a way that is perceived to be beneficial. This includes few implicit conditions which are:

1. The framework's process can be executed from start to end
2. The framework's process can be understood and used by others
3. The framework's process can yield useful outcomes

This pilot can be categorized under strategy process research. Platts (1993) proposed criteria for evaluating strategy process research outcomes. The criteria are feasibility, usability, and utility. The three criteria can be used to assess the three conditions respectively. Table 6.2 provides a definition and evidence for the three evaluation criteria of this pilot study.

Table 6.2: *Criteria for evaluating pilot study findings*

Criteria	Definition	Evidence
Feasibility	The ability to follow the process through and complete all the activities	• Workshop completed • DT roadmap created
Usability	The ability to perform all process activities with ease and understand their purpose	• Workshop survey • Workshop retrospective feedback • Reflective log
Utility	The ability to develop an agile DT plan that is perceived to be useful	• Workshop survey • Post-workshop interview • Reflective log

6.2.4 Case Selection

Three companies were selected for this pilot study. Participants were subscribers of the University of Cambridge's Institute for Manufacturing newsletter, where the workshop was

advertised. Ten companies responded to the advertisement and three were selected as fit for this research, as mutual value could be realized. The following criteria for selecting case companies were described in section 3.3.2.

A large organization or division that:

- is preparing to undergo DT
- is looking to formulate a DT plan and roadmap
- is ready to dedicate two days to a planning workshop with main stakeholders
- agrees to provide feedback after two months of implementation as a leading indicator
- gives permission for the data from the project to be presented as an anonymized pilot case study in this thesis.

Table 6.3: *Overview of pilot study case companies*

Description	Company 1	Company 2	Company 3
Industry	Chemicals	Oil and gas	Industrial equipment
Leading function	R&D	Manufacturing	R&D
Employee count	400	100,000	14,000
Turnover $ (M)	$140	$32,000	$4,400
DT scope	Company-wide	1 of 40 sites	1 product group of 8
Number of Participants	7	15	12

There was a balanced mix in the selected case companies in terms of scope, size, and digital maturity. The scope varied from company-wide to product-specific. Moreover, Company 1 is medium-sized and Company 3.12 is large-sized, both with limited DT efforts, whereas Company 2 had a few digital initiatives and wanted to trial this framework for a new manufacturing site. This mix provided a broader insight into the potential generalizability of the framework. A description of participating companies can be found in Table 6.3. A detailed description of each organization is outlined in the respective pilot study report in Sections 6.5, 6.6, and 6.7.

6.3 Data Collection

Data from the three pilot studies were collected between January and October 2019. Four sources were used: workshop preparation, workshop content, workshop feedback, and post-workshop interview. A summary of the collected data can be found in Table 6.4.

Table 6.4: *Pilot study data collection summary*

Name	Description	Source	Quantity	Length (pages)	Objective
Workshop brief document	Outline of workshop scope	Project lead	3 (1 per pilot)	12	In-depth understanding of the desired outcomes
Workshop content	Documentation of all workshop content	Workshop outcomes presentation	3 (1 per pilot)	73	In-depth analysis of the workshop flow and outcomes
Workshop feedback survey	End of workshop survey to collect feedback from participants	All participants	3 (1 per pilot)	3	Quantitative feedback on framework feasibility, usability, and utility
Retrospective feedback	Short focus group	All participants	3 (1 per pilot)	3	Qualitative feedback on framework feasibility, usability, and utility
Final interview	Semi-structured interview	Project lead	3 (1 per pilot)	26	Evidence on framework utility
Reflective log	Workshop observations	Researcher	3 (1 per pilot)	7	Evaluation of workshop outcomes

The first data source was the workshop brief, where the scope of the workshop and desired outcomes are documented. A workshop brief document is completed by the participating organization with the support of the researcher. The workshop brief includes summary of background information, workshop goals, the challenge to be addressed, deliverables, stakeholder information, participant information, and current or past DT initiatives. The workshop brief document was customized from Google design sprint resources (Google, 2019b); the customized template can be found in Appendix C1. Data on trends and drivers specific to the participating organization's industry were also collected. Trends data were collected from relevant industry reports that focused on the impact and opportunities of digital technologies on the industry of focus. Data on the drivers were collected from internal stakeholders by the project lead. The trends and drivers are then consolidated into the workshop brief and used as an input for the workshop.

The second data collection source is the content generated during the workshop. All content was documented by taking photographs and notes, and consolidated into a PowerPoint presentation and shared with the workshop participants. The main content generated as an

outcome of the workshop was the first draft of the roadmap. An MVP document is also created, which outlined the experiment for each digital initiative.

The third data source is workshop feedback. At the end of the workshop, feedback was collected from participants in two forms, a survey and a retrospective session. The survey included four questions on a 1–5 Likert scale. The survey questions were about the clarity of the workshop, its ability to meet its objectives, the utility of the outcomes, and participants' confidence in the effectiveness of the DT roadmap. A sample of the survey questions can be found in Appendix C2. The scale levels are:

- 1 – Very poor
- 2 – Poor
- 3 – Acceptable
- 4 – Good
- 5 – Very good

The workshop retrospective is a common agile practice where a team can reflect on a sprint's outcomes, and adjust and tune the process (Derby and Larsen, 2006). This open-session format allows participants to comment on what went well, what did not, and what can be done better. Another format is "Start, Stop, and Continue." Feedback was collected on a flipchart and documented for analysis. It was supplemented by a reflective log capturing the researcher's observations of the workshop. The reflection covered a summary of the workshop, learning points, and areas of improvement.

The final data collection source is an interview with the project lead. The interview took place two months after the workshop, leaving an opportunity for initial progress. The objective of this interview is to gather feedback on the utility of the framework. The interviews included 11 questions and took a semi-structured form to allow for probing into specific areas as needed. The interview questions can be found in Appendix C3. The aim of the interview is to provide participating organizations the opportunity to reflect on the perceived value and utility of the framework. More specifically, it aimed to explore the perceived impact of incorporating agility into the digital strategy based on implementation. Implementation in this context refers to the execution of all or some of the MVPs that were designed during the workshop. The aim is to identify organizational benefits or challenges in refining and executing the roadmap.

6.4 Data Analysis

The data analysis is designed to happen on two levels—at the level of each pilot project and as a synthesis across the three pilot studies. The objective of the data analysis was outlined in section 3.1 as the following research objective:

RO-2: *Develop an applied framework to aid the iterative formulation and evaluation of the digital strategy*

Given that the aim of the data analysis is to evaluate a predefined theoretical proposition, this makes it belong to the deductive data analysis approach (Yin, 2014). Deductive analysis can be conducted using a pattern-matching procedure (Saunders *et al.*, 2008). Pattern matching involves predicting a pattern of outcomes that can provide an explanation for the theoretical proposition, then comparing the findings to the predictions. Pattern matching requires the expected outcomes to be specified as dependent variables, and the implementation of a framework as an independent variable. In the case of this study, the theoretical proposition is that agile DT roadmapping can accelerate the realization of the emergent digital strategy. The independent variable is the deployment of the framework by the pilot companies. The dependent variables are the following expected pilot study outcomes:

- a first-draft DT roadmap integrating the DT trends and drivers, the DBS, and the DTS
- MVPs that enable rapid experimentation and validation of the digital strategy
- faster progress resulting from implementation and refinement of the roadmap, leading to the realization of the emergent digital strategy.

The data analysis process follows data categorization, also known as data chunking or data coding. The categories for data analysis were derived from the evaluation criteria presented in Table 6.2. Evidence from each pilot study was collected to evaluate feasibility, usability, and utility.

The first level of analysis was conducted independently at the end of each pilot study. As action research, this allowed the suitability of the framework process to be evaluated against the evaluation criteria while providing an opportunity for refining the process. The evaluation criteria (Table 6.2) required evidence to be gathered from multiple sources to assess feasibility,

usability, and utility. These findings identified specific opportunities for calibrating the process while adjusting the underpinning framework as needed.

The aim of the second level of analysis was to consolidate findings across all the pilot cases. This analysis went beyond the process activities to focus on understanding the impact of agile roadmapping on the formulation of a DT strategic plan. Twenty-one constructs were identified through the data analysis (consolidated in Table 6.28). A critical evaluation of the theoretical proposition and further refinement of the framework are presented in section 6.9.

6.5 Pilot Study 1

6.5.1 Overview

Company 1 was a medium-sized UK-based chemical manufacturing company. The organization is more than 100 years old and currently employs around 400 people. Company 1 offers a wide range of fragrance and flavor products to customers in 90 countries. The organization has enjoyed healthy and profitable growth over the past few years. Nonetheless, the leadership team is looking to maintain its success by leveraging digital innovation and transformation. The main objective of the DT is to improve efficiency and enable product mass customization.

6.5.2 Pre-Workshop Preparation

The workshop preparation objective was to scope, prepare, and document the workshop objectives and desired outcomes. This was done by completing the workshop brief document. Two conference calls preceded the workshop. In the first call, the framework was presented and the expected outcomes were explained; the second call took place to agree on the scope and discuss the next steps. Company 1 decided to focus on operational efficiency and product mass customization. This was anticipated to be achieved by the application of automation and advanced data analytics. The desired deliverable was a DT roadmap outlining a digital vision covering manufacturing, innovation, and procurement. The noticeable point was that there was insignificant focus on the customer experience. A summary of the workshop brief document can be found in Table 6.5.

The aim of the second activity was to identify the trends and drivers for DT. This was done by collecting information on trends from industry reports and on drivers from internal

stakeholders. The industry trends showed a growing interest in customer experience for B2B chemicals manufacturing. This brought customer experience to the attention of the participating team. Twenty-eight trends and drivers were identified as part of the workshop preparation, which formed the main input to the workshop.

6.5.3 The Workshop

The workshop took place over two consecutive days at the Institute for Manufacturing, part of the University of Cambridge Department of Engineering. It comprised six stages, each with one or more activities. The first stage was an introduction, which was followed by the five stages of the design sprint. The introduction covered a summary of the workshop brief, background information on DT, and the agenda for the two days. A snapshot of the workshop is presented in Figure 6.5 and a summary of the outcomes of each workshop stage is presented in Figure 6.4.

Table 6.5: *Summary of pilot study 1 scope*

Section	Summary
Workshop sponsor	Technical director
Sponsor's goal	Develop a plan for digital transformation to achieve operational efficiency and product mass customization
Workshop challenge	Design a DT strategy, focusing on the vision that by 2025 we are running as efficiently as possible, with maximum utilization of resources and infrastructure
Deliverables	A DT roadmap for what we need to achieve this vision, covering manufacturing, innovation, and procurement
Current state of DT	This is a very early stage undertaking. We have pockets of interest and activity throughout the company, but nothing joined up and no long-term vision
Participating functions	• R&D (1 participant) • IT (2 participant) • Marketing (1 participant) • Operations (1 participant) • Procurement (1 participant) • Business Transformation (1 participant)

Understand

The goal of the Understand phase is to identify suitable DT opportunities. There were five activities in this phase, as summarized in Table 6.6. The aim was to translate trends and drivers into specific opportunities that can be addressed by the DT.

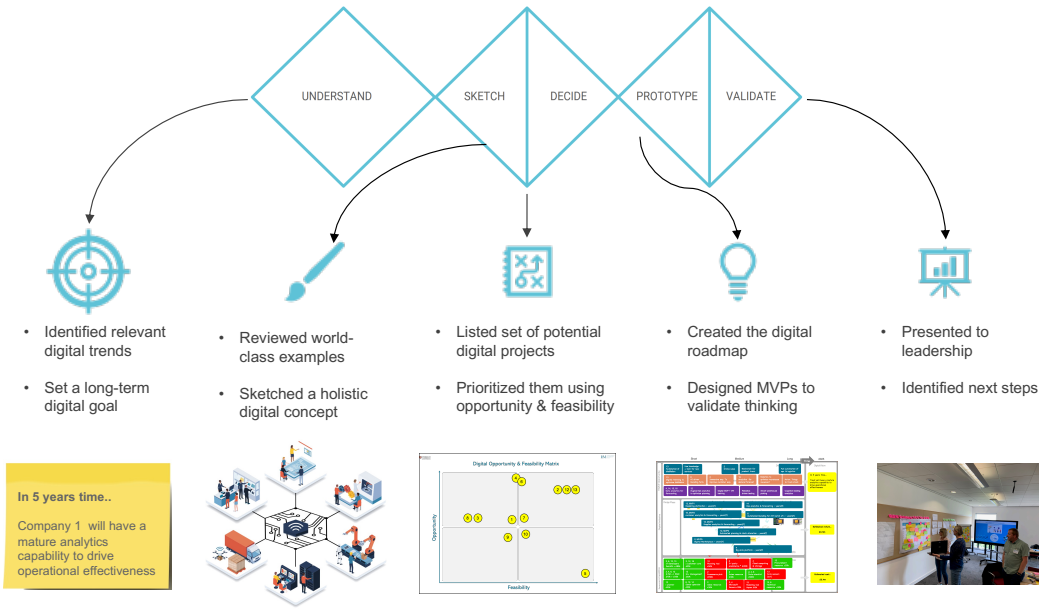

Figure 6.4: *Illustrative summary of workshop outcomes*

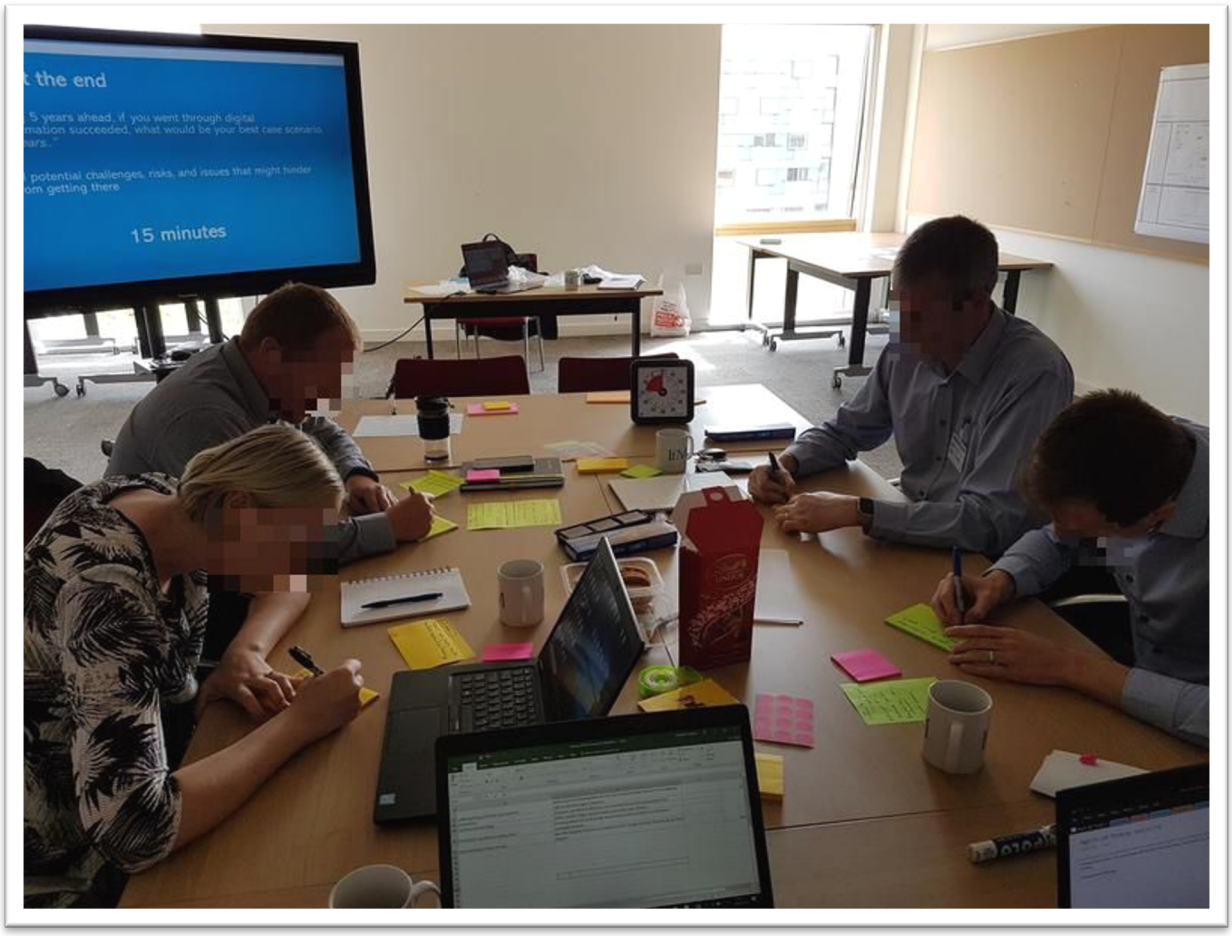

Figure 6.5: *Snapshot of Company 1 workshop*

The team reviewed the trends and drivers and prioritized them. The top five were selected and reframed as tweets (short social media posts). This formed the focus of the remainder of the workshop. Two of the top five were focused on the customer experience, which demonstrated that the interconnectedness of DT requires a tight alignment between different digital capabilities. This allowed for setting the digital vision through the "Start at the End" activity. The vision was set by articulating the ideal scenario of leveraging all the prioritized trends and drivers. It was identified that analytics can play a key role in improving operational efficiency by integrating the customer experience with the supply chain. The fourth activity was "How Might We," which was designed to frame the trends and drivers as opportunities that can be addressed by leveraging digital technologies. An example was *"How might we use customer analytics to forecast raw materials demand?"*. Twenty-one opportunities were listed, which were clustered into four groups. Finally, the opportunities were mapped to the top layer of the DT roadmap. Ending with digital opportunities provided alignment for having focused ideation activities.

Table 6.6: *Summary of the Understand phase from workshop 1*

Activity	Objective	Outcomes
1. Digital Trends Tweets	Reframe trends and drivers in a concise and company-specific way	Five prioritized trends and drivers: • End consumer analytics to track trends • Supply-chain transparency through blockchain • Robotics automation for manufacturing efficiency • Digital sales channels • Warehouse automation for space optimization
2. Start at the End	Articulate the vision in an unconstrained way	Integrated analytics capabilities for operational effectiveness
3. Review Value Chain	Validate the value chain map with all participants	Current value chain map explaining operations in 12 high-level steps
4. How Might We	Frame trends and drivers as specific digital opportunities	21 opportunities grouped into four clusters: • Customer analytics • Autonomous operations • Immersive training • Analytics-driven business model
5. Map Digital Opportunities	Populate the top layer of the roadmap with digital opportunities	17 opportunities mapped to the top layer of the DT roadmap

Sketch

The objective of the Sketch phase was to brainstorm ideas that target the identified opportunities from the Understand phase. Four activities were completed during this phase, as shown in Table 6.7. The first activity was the lightning demo, which was meant to give participants exposure to relevant digital initiatives that were done by other companies. Sketched examples came from many companies, including Microsoft, Amazon, and Cemex. The second activity was "Doodle Sketch," which allowed each team member to brainstorm ideas and express them in the form of a rough sketch. Those sketches were then consolidated by the team to form the overall digital solution. This took the shape of both sketching and textual description.

Table 6.7: *Summary of the Sketch phase from workshop 1*

Activity	Objective	Outcomes
1. Lightning Demos	Explore relevant digital solutions	Six digital initiatives from various companies including customer analytics, warehouse automation, and on-demand replenishment
2. Doodle Sketch	Express initial digital ideas	Six individual rough sketches for DT
3. Crazy 8s	Expand ideas by exploring 8 different variations	Six Crazy 8s sketches
4. Solution Sketch	Sketch a detailed digital solution	Six detailed digital solution sketches

Decide

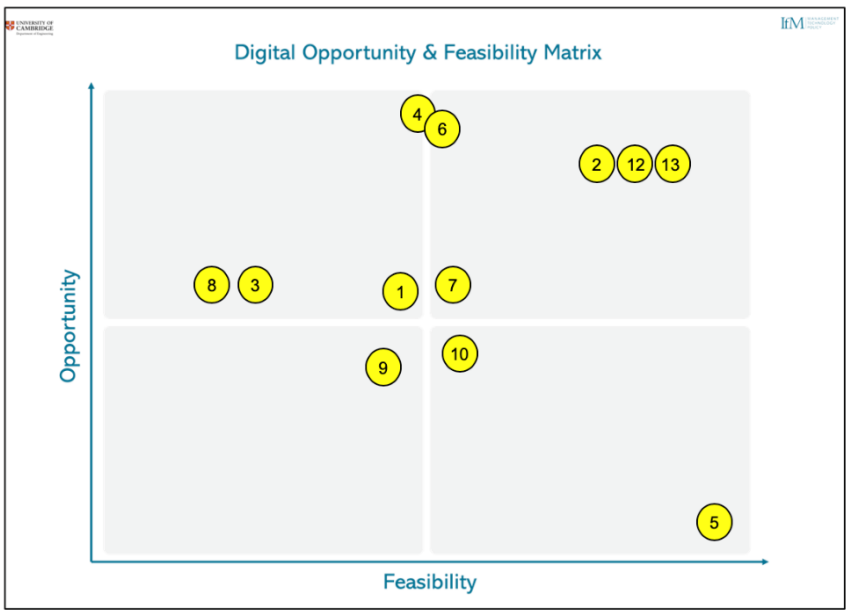

Figure 6.6: *Opportunity and feasibility matrix for pilot study 1*

The objective of the Decide phase was to prioritize digital initiatives. The final solution sketch was broken down into 13 potential digital initiatives, which were then prioritized by using the opportunity and feasibility matrix shown in Figure 6.6. The top five were prioritized as high-impact initiatives.

Prototype

The objective of the Prototype phase was to complete the first draft of the DT roadmap. The first activity was "Map Digital Initiatives," where the prioritized initiatives were mapped to the middle layer of the roadmap. The next activity was "MVPing." An MVP scope was developed for each of the five mapped initiatives. Desirability, feasibility, and viability were also specified as hypotheses to be tested by the MVP. Moreover, the timeline for each MVP was designed to range from three to six months. Finally, the last activity was "Define Resources," where the bottom layer of the roadmap was populated. This was done by estimating the required resources to deliver the mapped digital initiatives. This activity ended the prototyping of the DT roadmap and was ready for review and further refinement. The first-draft roadmap is shown in Figure 6.7.

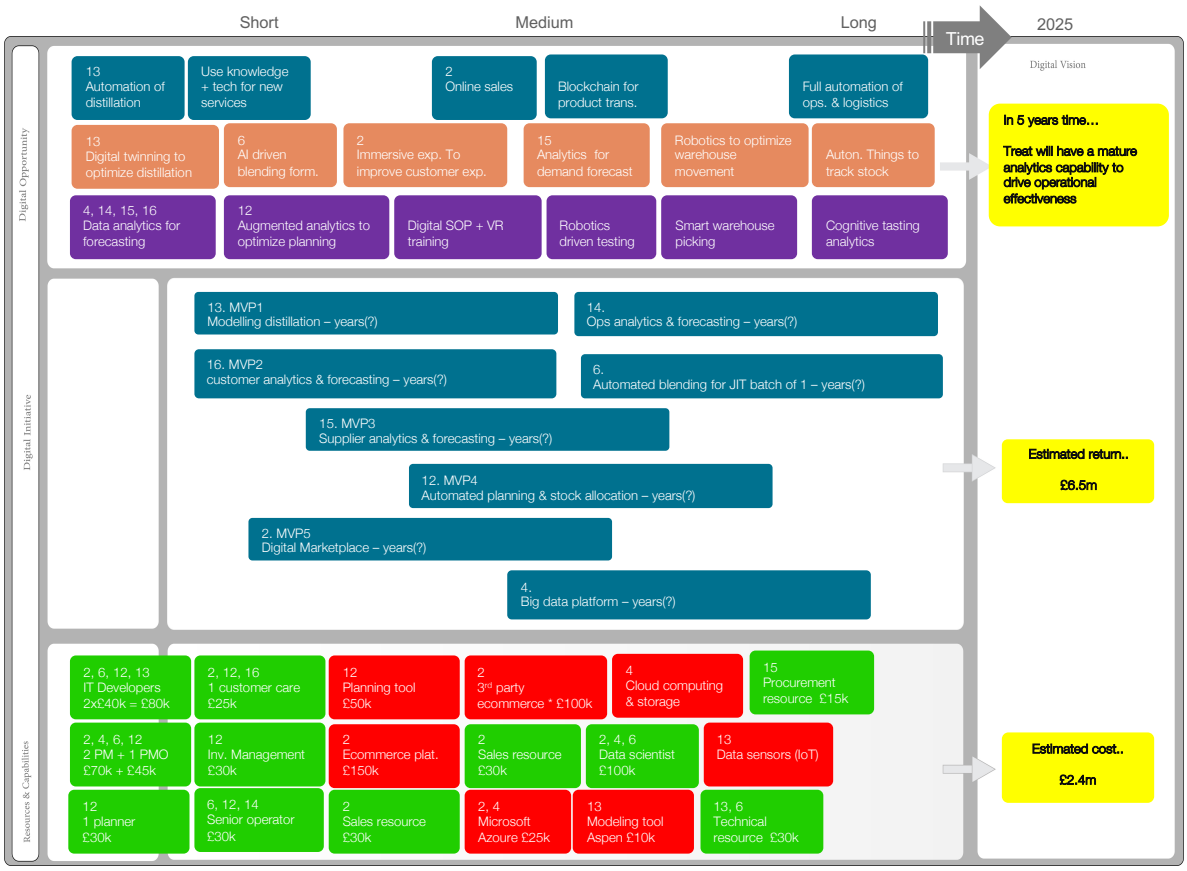

Figure 6.7: *First draft of pilot study 1 DT roadmap*

Validate

The objective of the Validate phase was to validate the content of the roadmap through rapid feedback. This was done by presenting the roadmap to the CEO through a video call. Although the content of this roadmap was not validated, the efforts were recognized, and further refinement was encouraged.

6.5.4 Framework Evaluation

The pilot study was a learning activity with a focus on testing and calibration. Therefore, critically evaluating learning was essential for the findings of this research. Participant feedback and critical assessment of the pilot outcomes were the main data sources. The evaluation followed the feasibility, usability, and utility criteria and are summarized in Table 6.8. This section discusses each criterion to allow a conclusion to be drawn from the findings.

Table 6.8: *Evaluation of pilot study 1 outcomes*

Criteria	Evaluation	Evidence
Feasibility	Feasible	The workshop was successfully completed, and all plan components were created
Usability	Usable—could benefit from minor improvements to some activities	Clarity of workshop objectives: 4.0 Ability to meet workshop objectives: 4.3
Utility	Useful	Post-workshop interview: Workshop outcomes were perceived as vital starting point

The feasibility evaluation was relatively straightforward. It demonstrated the physical possibility of completing the process. The process is considered feasible given that all tasks were successfully completed. This is evident from the workshop report of each stage as well as the successful creation of the DT roadmap.

Assessing usability is more nuanced. Therefore, two feedback sources were collected—a workshop survey and a retrospective feedback on the workshop. The average score of all four survey questions ratings ranged between 4.3 and 3.5 out of 5. The survey results can be found in Table 6.9. The overall workshop objectives were considered mostly clear. Moreover, meeting the objectives was considered “Good” (4.3 out of 5). This indicates that from a usability perspective, the participants were able to understand the objectives and produce the

desired outcomes. Therefore, from a high-level perspective, the process can be considered usable.

Although the participants could successfully understand and meet the objectives of the workshop, it does not mean that the workshop was perfect. Qualitative feedback from the retrospective session included positive aspects and areas for improvement. As presented in Table 6.10, two activities were not completed with ease— "Crazy 8s" and "Digital Trends Tweets". The "Crazy 8s" activity was found to be confusing and found not to add value; and only a single participant saw the value in the "Digital Trends Tweets" activity. In addition, a few points were raised that could have potentially improved the usability of the workshop. Participants felt they did not have enough understanding of digital technologies, their applications, and relevant trends. Moreover, pre-workshop preparation did not involve all team members, which made the Understand phase consume more time than anticipated. Furthermore, the activities should have been explained better, as design sprints were new to all participants.

Table 6.9: *Pilot study 1 feedback survey results*

No	Clarity of objectives	Meeting the objectives	Utility of outcomes	Confidence in roadmap
1	3	4	4	3
2	4	4	4	3
3	4	4	4	3
4	4	4	4	4
5	4	5	5	4
6	5	5	5	4
7	4	4	4	4
Mean	4.0	4.3	4.3	3.5

Table 6.10: *Pilot study 1 workshop retrospective feedback*

Start	Stop	Continue
• More material on digital trends • Explanation of digital technologies • Better explanation of the Sketch phase • DT case studies • Feedback on pre-workshop	• Using abbreviations • Crazy 8s activity is confusing • Tweets	• Presentation slides • Active engagement throughout • Using Post-it Notes • Opportunity–feasibility evaluation • Team discussions • Interactive activities • Value chain analysis

Utility measured the perceived usefulness of the agile DT roadmap. The utility of outcomes and the confidence in the roadmap both scored 4 out of 5 in the workshop survey. This demonstrated that participants had confidence in the business value of the outcomes. However, this was the general perception, and was not specific to agility. The interview with the lead participant allowed for more in-depth exploration of the framework's utility. The team managed to make some progress between the workshop and the interview. They were able to present the DT plan draft to senior management, revise the scope of the MVPs, and kick off the first digital initiative. The interviewee described the workshop as *"fundamental. It kicked off a lot of effort and prompted many discussions. It was vital."* In terms of utility, the interviewee expressed the following benefits:

1. Tangible outcomes have been presented to leadership
2. Clear priorities to focus on
3. Scoping MVPs made next steps tangible and specific
4. Progress was possible in a short period of time.

These benefits demonstrated that the first draft of the DT roadmap was perceived as useful to the organization's DT journey. Moreover, scoping MVPs played a significant role in enabling faster progress by being focused. While there is no evidence that the created DT plan will be successful, the framework's objective is to make learning and iteration as clear and tangible as possible. Therefore, in this case, the framework proved to be of valuable utility.

6.5.5 Specifying Learning

Reviewing the first pilot allowed for reflection on what was learned. Learnings came from three streams: tests, observations, and inferences. Testing of the framework generated learning about the framework's feasibility, usability, and utility, which has been documented. However, there were a few observations during and after the workshop that resulted in new learnings as well.

In terms of knowledge, it was observed that participants had limited knowledge of digital technologies, their applications, and solution providers. Moreover, participants were not accustomed to agile practices. In terms of technology, data management and analytics were demonstrated to be of fundamental importance to each digital initiative. In terms of implementation, the team required time and effort to align the digital strategy with the current strategy, refine the scope, and dedicate resources before being able to kick off digital initiatives.

Moreover, not all initiatives were started at once; the team prioritized a few digital initiatives due to limited resources and knowledge.

It was also possible to infer learnings from the pilot study by reflecting on what was learned. Given that the MVP hypotheses were directly linked to the digital strategy, validating the MVP will contribute to validating parts of the digital strategy. Validation of the digital strategy can also be based on its desirability to the customer or main user, feasibility of its implementation, and commercial viability to the organization's bottom line. A summary of learnings is presented in Table 6.11 and the actions taken to refine the process are presented in Table 6.12.

Table 6.11: *Learnings from pilot study 1*

Tested	Observed	Inferred
• MVPs were directly linked to DBS • MVPs enabled accelerated progress • Powerful cross-functional discussions	• Limited knowledge of digital • Limited agile practice • Data and analytics are fundamental components • Alignment with business strategy requires time • Initiatives kicked off sequentially • Dependencies between digital capabilities	• MVP feedback provides feedback on the DBS

Table 6.12: *Actions taken to calibrate framework*

No.	Learnings	Actions
1	Identifying trends and drivers consumed more time than planned	Ensure the involvement of participants in pre-workshop preparation and gathering workshop input
2	Crazy 8s activity was confusing	Remove the task from the process. No impact on process flow is anticipated as the activity is optional. It is also found to be early in the process to go in such details for strategy formulation
3	Participants had limited exposure to agile concepts and practices	Emphasize the nature of the workshop to manage expectations and participant selection
4	Alignment with business strategy, resource allocation, and plan refinement took significant time	Annotate the middle layer of the roadmap with a sequential start of digital initiatives to allow for prioritization and quick start

6.6 Pilot Study 2

6.6.1 Overview

Company 2 is a global oil and gas organization with more than 40 manufacturing facilities across the world. The company employs more than 100,000 employees and generated a revenue of $32 billion in 2018. Since then, Company 2 grew both organically and through acquisitions. The main objective for the DT is to reduce cost through operational efficiency and organizational agility. The workshop was led by the central manufacturing team. The team was interested in developing a DT roadmapping framework that can be used by each of the 40 manufacturing sites to develop their own DT plan. As a trial, this workshop was conducted at their manufacturing center in France. There were 15 participants forming a cross-functional team.

6.6.2 Pre-Workshop Preparation

Like the first pilot study, the pre-workshop preparation involved completing the workshop brief and preparing a list of trends and drivers to be considered for the workshop. The workshop objective was to set the DT strategy for manufacturing division with 2022 as a milestone. A summary of the workshop brief can be found in Table 6.13.

Thirteen trends and drivers were identified before the workshop. The focus was on operational efficiency, including automation, supply-chain integration, predictive maintenance, and organizational agility. Customer experience trends were also considered, such as digital services and omnichannel retail. The identified trends and drivers were then used as inputs for the workshop.

6.6.3 The Workshop

The workshop took place over two consecutive days at one of the company's main manufacturing sites in Paris. It comprised six stages, each with one or more activities. The first stage was an introduction, which was followed by the five design sprint stages. The introduction covered a summary of the workshop brief, background on DT, and the agenda for the two days. A snapshot of the workshop is presented in Figure 6.8 and a summary of the outcomes of each workshop stage is presented in Figure 6.9.

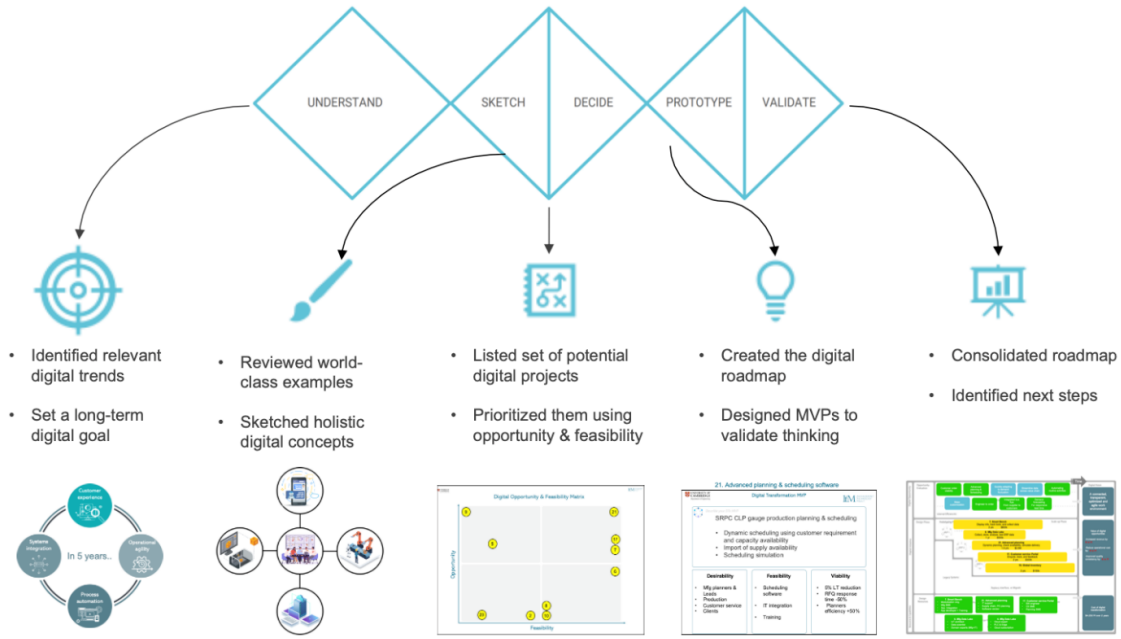

Figure 6.8: *Illustrative summary of pilot study 2 workshop*

Figure 6.9: *Snapshot of Company 2 workshop*

Table 6.13: Summary of pilot study 2 scope

Section	Summary
Workshop sponsor	Vice President of Manufacturing
Sponsor's goal	Improve profit margin through operational efficiency, agility, and business model innovation
Workshop challenge	Design the Manufacturing digital transformation strategy, focusing on core product lines with year 2022 as milestone
Deliverables	• High-level digital vision • Main digital initiatives • Clear next step • Prioritized list of projects • MVP or solution
Current state of DT	Digital factory technology roadmap completed
Participating functions	• Manufacturing (4 participants) • Operations (2 participants) • Quality (2 participants) • Marketing (2 participants) • Planning (1 participants) • R&D (2 participants) • IT (2 participants)

Understand

There were five activities that took place during the Understand phase with the objective of identifying relevant DT opportunities. A summary of the activities and their outcomes can be found in Table 6.14. The first activity refined and reviewed the prioritized the digital trends and drivers to form the "Digital Trends Tweets". Four trends and drivers were selected to be the focus of the workshop: three drivers on operational efficiency and one trend on real-time customer experience. The second activity was "Start at the End" where the team framed the long-term vision for their DT. Not far from the trends and drivers, the team's vision was to have connected, transparent, optimized, and agile operations. The third activity included reviewing the value chain map of the manufacturing operations. Given that the team was periodically updating their process maps, the activity was very brief as the team did not have anything to amend on the value chain map. The fourth activity was "How Might We," which generated 19 digital opportunities that were then clustered and prioritized to nine digital opportunities. In the final activity, the team mapped the nine opportunities to the top layer of

the roadmap. With clearly articulated digital opportunities, the team was ready to start brainstorming and ideating.

Table 6.14: *Summary of the Understand phase from workshop 2*

Activity	Objective	Outcomes
1. Digital Trends Tweets	Reframe trends and drivers in a concise and company-specific way	Four prioritized trends and drivers: • Digital sales channel for customers • Production agility to ramp production up and down • Production automation • Integrated business systems
2. Start at the End	Articulate the vision in an unconstrained way	Drive digital factory vision for a connected, transparent, optimized and agile work environment by 2022
3. Review Value Chain	Validate the value chain map with all participants	Current value chain map explaining operations in 12 high-level steps
4. How Might We	Frame trends and drivers as specific digital opportunities	Nine prioritized opportunities grouped into four clusters: • Digital customer service • Operational agility • Process automation • Systems integration
5. Map Digital Opportunities	Populate the top layer of the roadmap with digital opportunities	Nine opportunities mapped to the top layer

Sketch

The objective of the Sketch phase was to brainstorm ideas that target the identified digital opportunities. The team completed the four stages of sketching. But, because there were 15 participants, the individual activities were done in pairs to be more efficient. The team generated seven potential digital solutions. A summary of the activities in this phase can be found in Table 6.15.

Decide

The objective of the Decide phase was to select the digital concepts that will be taken forward. The first activity was to create a consolidated sketch of the digital solution illustrating

the DBS. The second activity was to redesign the value chain. However, this task proved to be confusing and was not completed as intended. The reason was that the digital concepts had negligible implications in the current value chain map. While this issue prolonged the activity without any tangible outcomes, it did not have an impact on meeting the objective of this phase. The third activity detailed the digital concepts into 21 potential digital initiatives. To recover time, 10 digital initiatives were selected by the team to be ranked using the opportunity and feasibility matrix shown in Figure 6.10. The top five initiatives were then taken forward to the prototyping phase.

Table 6.15: *Summary of the Sketch phase from workshop 2*

Activity	Objective	Outcomes
1. Lightning Demos	Explore relevant digital solutions	Seven digital initiatives from various companies
2. Doodle Sketch	Express initial digital ideas	Seven individual rough sketches for DT
3. Crazy 8s	Expand ideas by exploring eight different variations	Skipped
4. Solution Sketch	Sketch a detailed digital solution	Seven detailed digital solution sketches

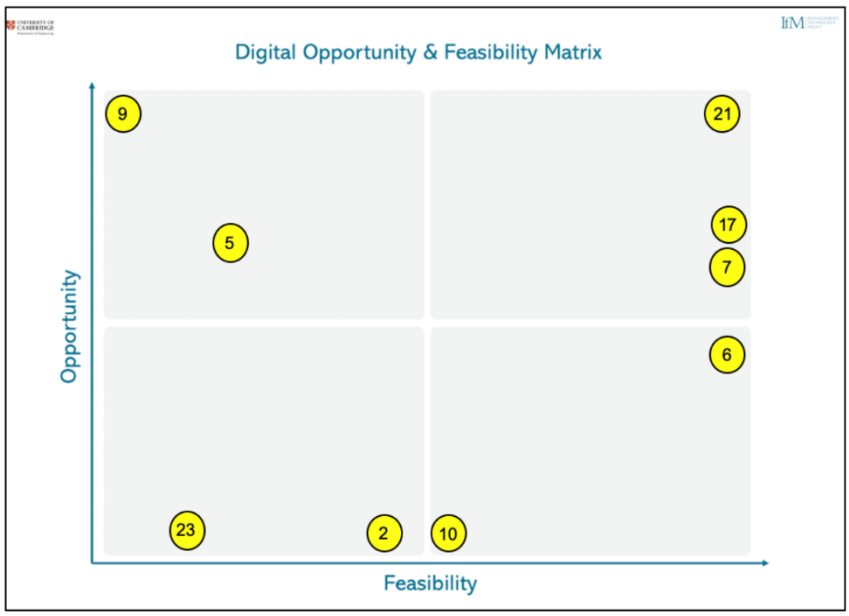

Figure 6.10*: Opportunity and feasibility matrix for pilot study 2*

Prototype

The objective of the Prototype phase was to create the first draft of the DT roadmap. The first activity took the five prioritized initiatives and mapped them to the middle layer of the

roadmap. Following that, an MVP scope was outlined for each digital initiative. Finally, the bottom layer of the roadmap was completed by estimating the required resources in terms of the finance, people, and technology required to deliver the digital initiatives. The first draft of the DT roadmap is shown in Figure 6.11.

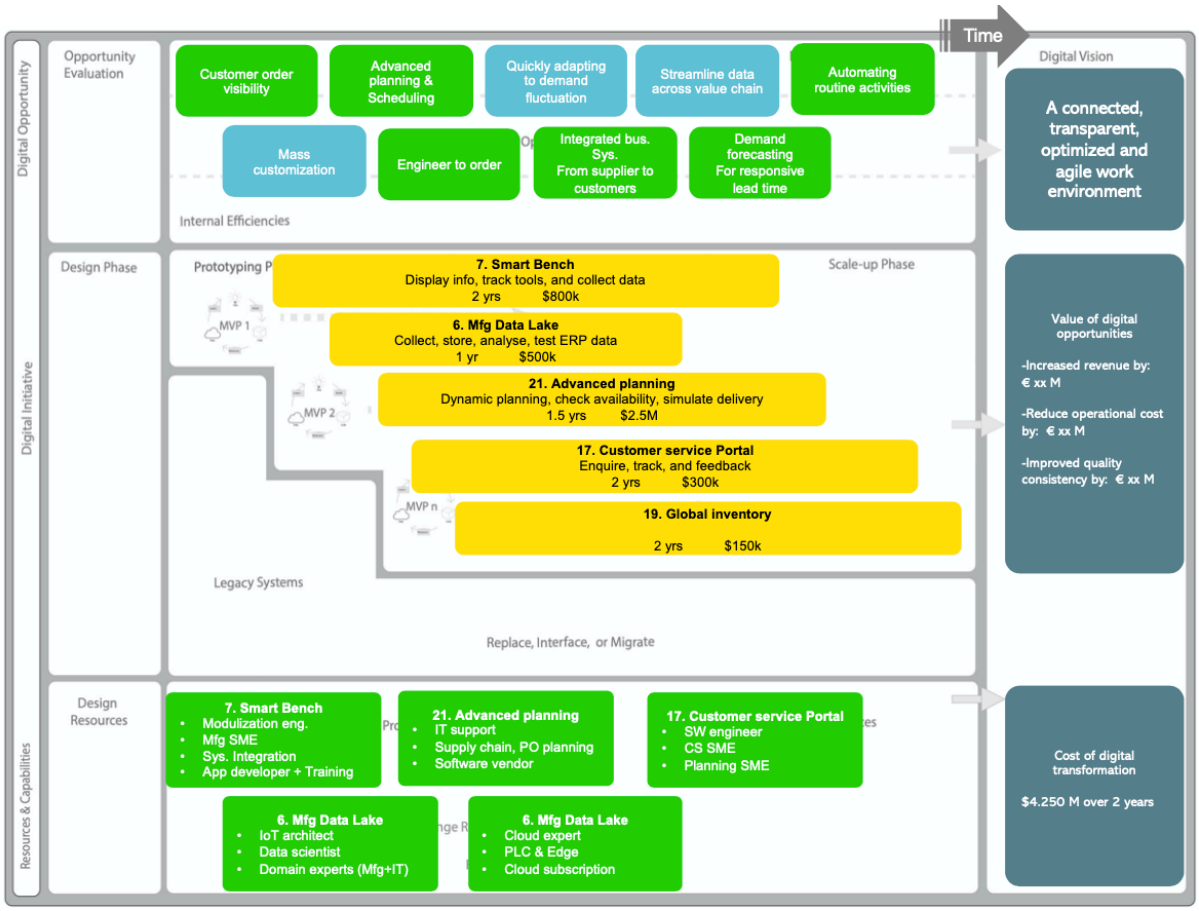

Figure 6.11: *First draft of pilot study 2 DT roadmap*

Validate

Validation did not happen during the workshop as the required decision makers were not present on site. However, the workshop outcomes were presented to the workshop sponsor along with senior management few days later.

6.6.4 Framework Evaluation

The framework evaluation of pilot study 2 covered feasibility, usability and utility as shown in table 6.16. There were minor changes to the roadmapping process from pilot study 1, which resulted in relatively similar outcomes. However, due to a few differences in Company 2 business context, the results showed that the workshop activities were slightly less efficient for

this pilot project. The main differences between Companies 1 and 2 were that the organization was significantly larger, there were twice as many participants, and the digital maturity was slightly more developed. Nonetheless, the workshop was successfully completed, and the main outcomes were produced. This demonstrated that the workshop is feasible. Some activities were not completed, but that did not inhibit the success of the workshop. However, some changes are required to improve the process for usability.

Usability was demonstrated to be marginally less effective than in pilot study 1. This can be inferred from multiple data points. First, the workshop survey demonstrated lower scores than the previous pilot. The results are listed in Table 6.17. The team rated the clarity of the workshop objectives as 3.5 out of 5. This clearly indicates that there is room to improve the explanation of the workshop and the objectives of the activities. Specifically, some activities involved multiple tasks being assigned to participants at once. A better approach could be to break down long activities into sets of tasks to improve usability. Moreover, given that the DT topic is new to many team members, the preparation and workshop introduction could be explained more carefully and workshop introduction to clarify the workshop objectives. Participants rated meeting the objectives as 3.7 out of 5. This demonstrates that although the big picture was not clear enough, productive progress was made.

Table 6.16: *Evaluation of pilot study 2 outcomes*

Criteria	Evaluation	Evidence
Feasibility	Feasible	The workshop was successfully completed, and all plan components were created
Usability	Usable—could benefit from moderate improvements to some activities	Clarity of workshop objectives: 3.5 Ability to meet workshop objectives: 3.7
Utility	Useful—could benefit from clarifying next steps and digital journey beyond the MVP	Post-workshop interview: Workshop outcomes were perceived as vital starting point

The retrospective, as shown in Table 6.18, provided a more qualitative understanding of the usability. Participants had a strong preference for doing activities in groups or pairs. The main principle behind individual tasks is to avoid overriding of individuals' ideas. However, the team found that more ideas were generated through group activities and tasks progressed faster. Therefore, some activities can be done in pairs in following the pilot studies. The participants also suggested that more time be allocated to some activities. However, this would not have

been possible for the pilot as it is a timeboxed exercise that is meant to provide an overview of the full-scale activity. In contrast, other participants saw timeboxing activities as an efficient way to progress with tasks, and hands-on activities were found to be engaging and productive. Participants also encouraged the use of other activities that went well, such as the exploration of trends and drivers, scoping MVPs, and having discussions with a cross-functional team.

Table 6.17: *Pilot study 2 feedback survey results*

No.	Clarity of objectives	Meeting the objectives	Utility of outcomes	Confidence in roadmap
1	2	3	3	3
2	3	3	3	3
3	3	3	3	3
4	3	3	3	3
5	3	3	3	3
6	3	3	4	3
7	3	4	4	3
8	3	4	4	3
9	4	4	4	4
10	4	4	4	4
11	4	4	4	4
12	4	4	4	4
13	4	4	4	4
14	4	5	4	4
15	5	5	5	4
Mean	3.5	3.7	3.7	3.5

In terms of utility, the participants rated the utility of outcomes as 3.7 out of 5 and the confidence in the roadmap was 3.5 out of 5. A possible interpretation of this is that the outcomes were perceived as useful but that the roadmap was not yet in usable shape. The follow-up interview also revealed detailed insights into the perceived utility of the outcomes. The workshop outcomes were perceived to be useful for multiple reasons. First, the cross-functional collaboration enhanced the participants' understanding of DT opportunities. Second, the speed of moving from an objective to a first-draft DT roadmap was perceived as fast and productive progress. Third, creating tangible and actionable steps through MVPs was also found to be useful in clarifying next steps.

Table 6.18: *Pilot study 2 workshop retrospective feedback*

Start	Stop	Continue
• Quantitative scoring of opportunities • Provide more time for scoping digital concepts • Provide more examples of activities digital expertise • Clarify the bigger picture and agenda • More team discussions • More group exercises • Reiteration on outcomes of each phase	• Individual activities to allow discussions • Repetitive ideation activities • Value chain activity	• Tangible MVPs • Iterative process • Engaging workshop activities • Timeboxed activities • Practical exercises • Brainstorming and sketching • Exploration of trends and drivers • Cross-functional discussion

Other points were raised that could improve the utility of the agile DT roadmapping framework. The team found that three out of the five digital concepts were not new to them. Therefore, the lead participant perceived the framework as better suited to departments that are early in their DT journey. It was also suggested that the framework is being considered to kick off DT planning at a less digitally mature site of their organization. Additionally, it was suggested that some of the activities, such as the "Digital Trends Tweets" activity, could be repurposed and integrated into the organization's own process for strategy visioning. Finally, the lead participant expressed concern that there was no explanation of what happens between the completion of MVP1 and the long-term digital vision. Funding initiatives require estimates of the resources, effort, and results to be added to any business case. This can be resolved by introducing topic roadmaps for each of the five digital initiatives.

The lead participant also reported some tangible pieces of evidence on utility. First, the team presented the workshop outcomes to the digital factory steering committee, which is chaired by the workshop sponsor, the Vice President of Manufacturing. The outcomes were positively received and encouraged further progress. Moreover, it was suggested that key DT members be trained on running and facilitating the framework so that it can be used internally to start new DTs at other sites. Second, scoping MVPs with tangible hypotheses for desirability, feasibility, and viability allowed for more focused and faster than usual progress. Third, three digital initiatives had been revised and started by the time the interview was conducted two

months after completion of the workshop. The remaining two initiatives were planned to follow soon. Finally, after this short workshop, the team was aware of what was required next to complete and improve the DT plan; this was inferred from the details of comments on aspects that were missing or needed further refinement. This can be considered as evidence of the iterative learning process.

6.6.5 Specifying Learning

As was the case in pilot study 1, learnings came from tested, observed, and inferred knowledge points. There were some findings that persisted in this pilot study. For instance, participants found themselves lacking in knowledge on digital technologies and were not accustomed to agile practices. Moreover, implementation of MVPs was rapid but also sequential, as resources needed to be aligned.

Table 6.19: *Learnings from pilot study 2*

Tested	Observed	Inferred
• MVPs were directly linked to DBS • MVPs enabled accelerated progress • Powerful cross-functional discussions	• Limited knowledge of digital technologies and applications • Limited agile practice • Data and analytics are fundamental components • Alignment with business strategy requires time • Initiatives kicked off sequentially • Digital capabilities are interdependent	• MVP feedback provides insight into DBS

There were also some critical observations. The team found completing the redesign of the value chain to be challenging. In hindsight, this may have been because not enough details were provided on the digital concepts to be mapped into a process. Moreover, only one MVP was planned, so the full picture is missing. Therefore, it would be premature to conduct the value chain activity that provides a detailed blueprint of the future digital enterprise. Therefore, the focus needs to be diverted to the design of the selected digital concepts. The goal of the framework was to provide sufficient focus on the DBS to allow for tangible experimentation and reliable validation. A few changes have been made to this premise. As DT is a response to

the most pressing trends and drivers, captured in the "Digital Trends Tweets," the workshop should be guided to focus on the most suitable digital concepts that are perceived to carry sufficient response. A summary of learnings is presented in Table 6.19 and actions taken to refine the process are presented in Table 6.20.

Table 6.20: *Actions taken to calibrate the framework*

No.	Learnings	Actions
1	Some activities were found complex and difficult to follow	Break activities down into tasks with clear instructions. A slide has been dedicated to explaining each task
2	Participants preferred to complete tasks in groups as discussions were found insightful	Provide the option of completing tasks in pairs if needed
3	The team was unable to complete the value chain activity as the details of the digital solutions were not clarified	Remove the activity from the process; suggest completing it in the follow-up iteration as the vision becomes clearer. It was found not suitable to redesign the value chain before validating the hypothesis and choosing final mode of implementation
4	The team noticed that the workshop was too divergent, which limited the deep dive into the selected areas of focus and MVPs	Focus the workshop on the top five factors identified by the "Digital Trends Tweets". Vote on the top five ideas to be pursued in detail to eliminate the need for prioritization using opportunity and feasibility analysis
5	The lead participant was worried about the gap between the MVP and the digital vision	Add an activity for topic roadmapping to investigate the evolution of each MVP during the Decide phase
6	Participants had limited exposure to agile concepts and practices	Emphasize the nature of the workshop to manage expectations and participant selection

6.7 Pilot Study 3

6.7.1 Overview

The third pilot study was done in collaboration with an industrial equipment manufacturer. It was recently spun off as an independent subsidiary of the mother company. It is considered one of the market leaders in the field, employing 14,000 professionals. The organization is considered financially healthy with $4.4 billion in revenue and a 20.1% operating margin. The organizational strategy is geared toward higher product automation, productivity, and DT to cope with the experienced growth and customer demand. This study was initiated by the

Research and Development (R&D) department of one of its eight divisions. Each division is designed around a product group. This workshop was focused on creating a DT plan for the hydraulic equipment product group.

6.7.2 Pre-Workshop Preparation

The workshop preparation was led by the R&D manager. The first activity was to complete the workshop brief. A summary of the document can be found in Table 6.21. The sponsor of the workshop was the VP of R&D. The sponsor's goal was to consolidate the requirements for DT from participating functions to form the foundation for the DT strategy as well as to learn more about DT roadmapping. There were 12 participants representing six departments, forming a cross-functional team. The workshop challenge was focused on becoming the market leader for digital products by 2024. The expected deliverable for the workshop was the first-draft DT roadmap for the core products.

Table 6.21: *Summary of pilot study 3 brief*

Section	Summary
Workshop sponsor	VP of R&D
Sponsor's goals	• Foundation for a strong strategy • Contribution from all functions • Learning about new roadmapping approach
Workshop challenge	Design a digital transformation roadmap, including technology development and digital business models, focusing on customer experience with two future milestones: **2022:** Next generation of connected hardware **2024:** Market leader for "digital products" in industry
Deliverables	An overall digital transformation roadmap (5-year time horizon) that is understood and supported by all relevant functions
Current state of DT	Multiple individual digital initiatives are being planned but no implementation yet
Participating functions	• R&D (3 participants) • Marketing (2 participants) • Aftermarket (2 participants) • Sales (2 participants) • Production (2 participants) • IT (1 participants)

The second workshop preparation activity was identifying the relevant trends and drivers. Based on the feedback from previous pilot studies, this workshop gave greater attention to more comprehensively identifying the trends and drivers. After three iterations, the team consolidated a list of 40 trends and drivers. There was a clear direction toward improving the performance, productivity, and connectivity of industrial products for a better customer experience. This formed a rich input to the workshop.

6.7.3 The Workshop

The workshop took place over two consecutive days at the main manufacturing sites in Cologne. There were six stages, each with one or more activities. The first stage was an introduction, which was followed by the five stages of the design sprint. The introduction covered a summary of the workshop brief, background on DT, and the agenda for the two days. A snapshot of the workshop is presented in Figure 6.12 and a summary of the outcomes of each workshop stage is presented in Figure 6.13.

Figure 6.12: *Snapshot of pilot study 3 workshop*

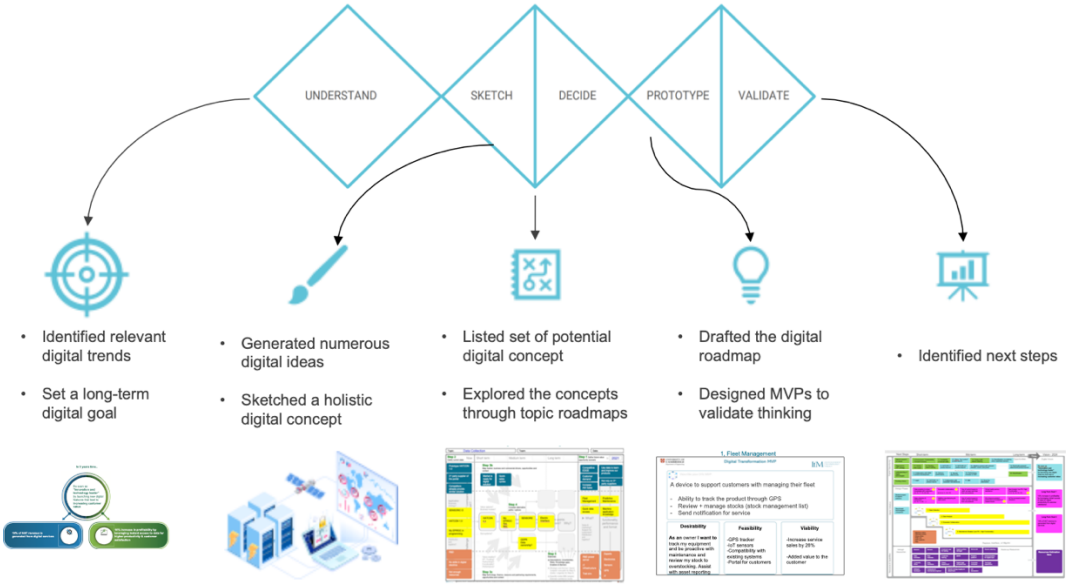

Figure 6.13: *Illustrative summary of pilot study 3 workshop*

Understand

The main objective of the Understand phase was to understand the digital opportunities for the hydraulic product group. While the objective of this phase remained the same as in previous pilot studies, the activities were slightly modified by removing the value chain mapping exercise. Therefore, there were four activities, as summarized in Table 6.22.

Table 6.22: *Summary of the Understand phase from workshop 3*

Activity	Objective	Outcomes
1. Digital Trends Tweets	Reframe trends and drivers in a concise and company-specific way	Four prioritized trends and drivers: • Digital customer experience • Productivity optimization • Digital business models • Digital services
2. Start at the End	Articulate the vision in an unconstrained way	Be seen as an innovation and technology leader by launching new digital features that lead to increasing customer value
3. How Might We	Frame trends and drivers as specific digital opportunities	Eight prioritized opportunities grouped into two clusters: • Digital customer experience and services • Digital business models
4. Map Digital Opportunities	Populate the top layer of the roadmap with digital opportunities	Eight opportunities mapped to the top layer

The first activity was “Digital Trends Tweets,” where the trends and drivers were reviewed, prioritized, and grouped. Five tweets were created, focusing on product tracking, productivity analytics, and business model innovation. Data were a core component of the five digital tweets. The second activity was “Start at the End,” where the team agreed on the long-term goal. This included leveraging digital capabilities to offer higher value to the customer. The objective was to yield increased profitability as well as new revenue sources from digital services. The third activity was “How Might We,” which converted the trends and drivers into specific digital opportunities. Five customer experience opportunities and three business model digital opportunities were identified. Finally, the team mapped the digital opportunities to the roadmap. This completed the Understand phase and prepared the team for brainstorming.

Sketch

The objective of the Sketch phase is to generate ideas that target identified digital opportunities. There were four activities in this phase as summarized in Table 6.23. The main update to this phase was that all activities were specific to the generated ideas from the “How Might We” activity. Five opportunities were selected, brainstormed, and refined, as shown in Figure 6.14. There were four activities in this phase. The first activity was voting to select the top five digital opportunities for brainstorming. The second activity lightning demo which gave the team exposure to few digital initiatives that were relevant to the organization to learn from. The third and fourth activities were iterative refinements of the brainstormed sketches. There were only four digital concepts as one team member was unable to continue participating.

Table 6.23: *Summary of the Sketch phase from workshop 3*

Activity	Objective	Outcomes
1. Dot Voting	Select digital opportunities for brainstorming solutions	Top five digital concepts were selected: • Big data platform • Data analytics • Product integration • Mechatronic equipment • AI for productivity
2. Lightning Demos	Explore relevant digital solutions	Five digital initiatives from various companies
3. Doodle Sketch	Express initial digital ideas	Five individual rough sketches for DT
4. Solution Sketch	A detailed digital solution sketch	Four detailed digital solution sketches

Decide

The Decide phase has been repurposed based on prior feedback that no visibility was given beyond the MVP. Moreover, to ensure flow across activities, the opportunities were selected at the beginning of the Sketch phase. The Decide phase therefore had two activities that focused on selecting the features for each digital concept and were laid out in a topic roadmap. The first activity was solution features, where the team listed, prioritized, and selected the three most critical features. In the second activity, the team created a topic roadmap that detailed the development journey of the digital concept. The outcomes of this phase were four topic roadmaps with prioritized set of features. An example topic roadmap can be found in Figure 6.15.

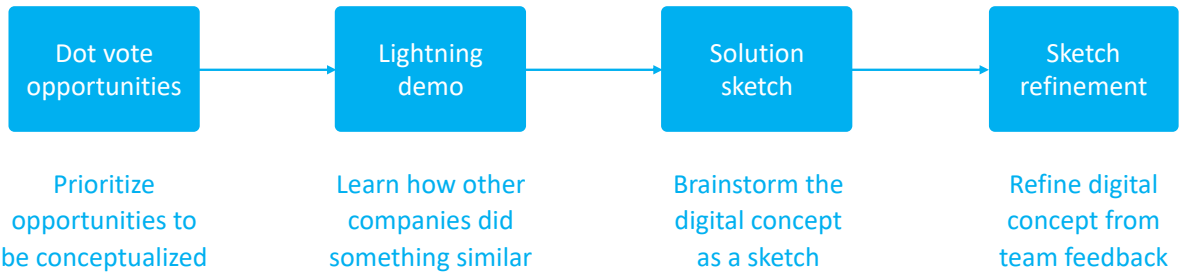

Figure 6.14: *Update to Sketch phase activities*

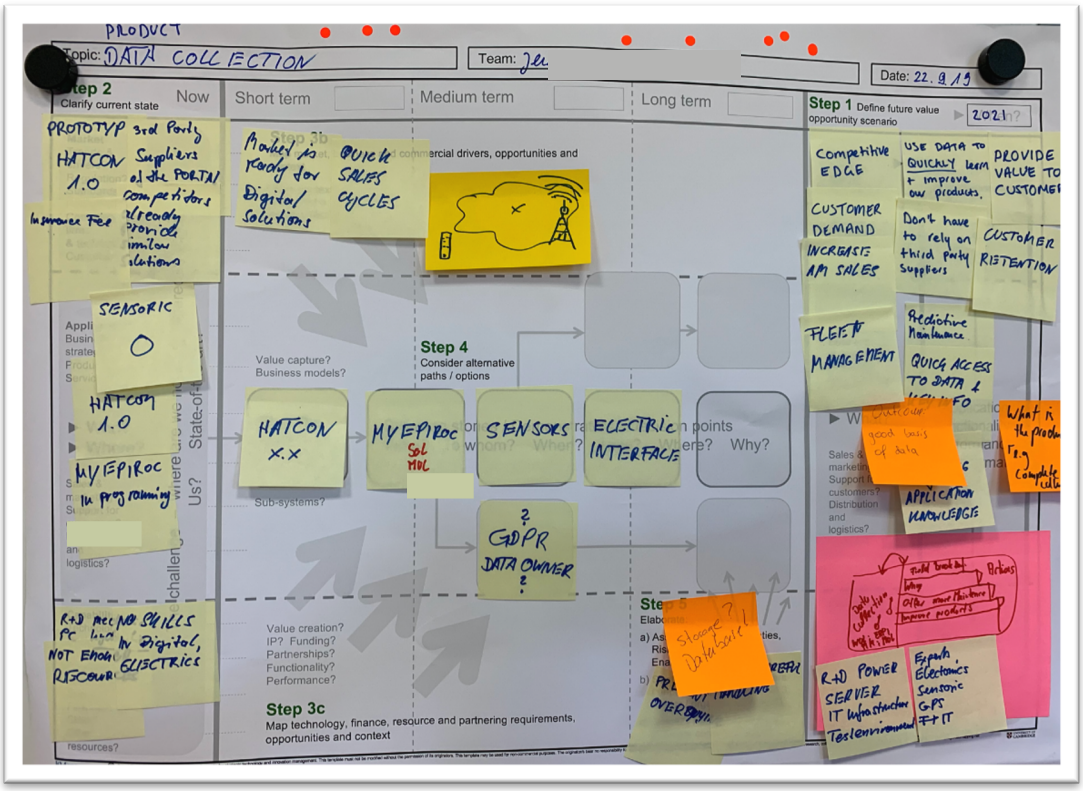

Figure 6.15: *Topic roadmap example*

Prototype

The objective of the Prototype phase remained the same as for the previous two pilot studies: to prototype a first draft of the DT roadmap. The Prototype phase had no significant changes except for dedicating a specific activity for gap identification that contributed to the clarification of next steps. The first activity was "MVPing," where an MVP scope with hypotheses was defined for each digital concept. The second activity was mapping the selected digital concepts on the middle layer of the roadmap. The third activity was mapping the required resources to the bottom layer of the roadmap. The final activity was gap identification, where missing information was marked on the roadmap for further investigation. The roadmap can be found in Figure 6.16.

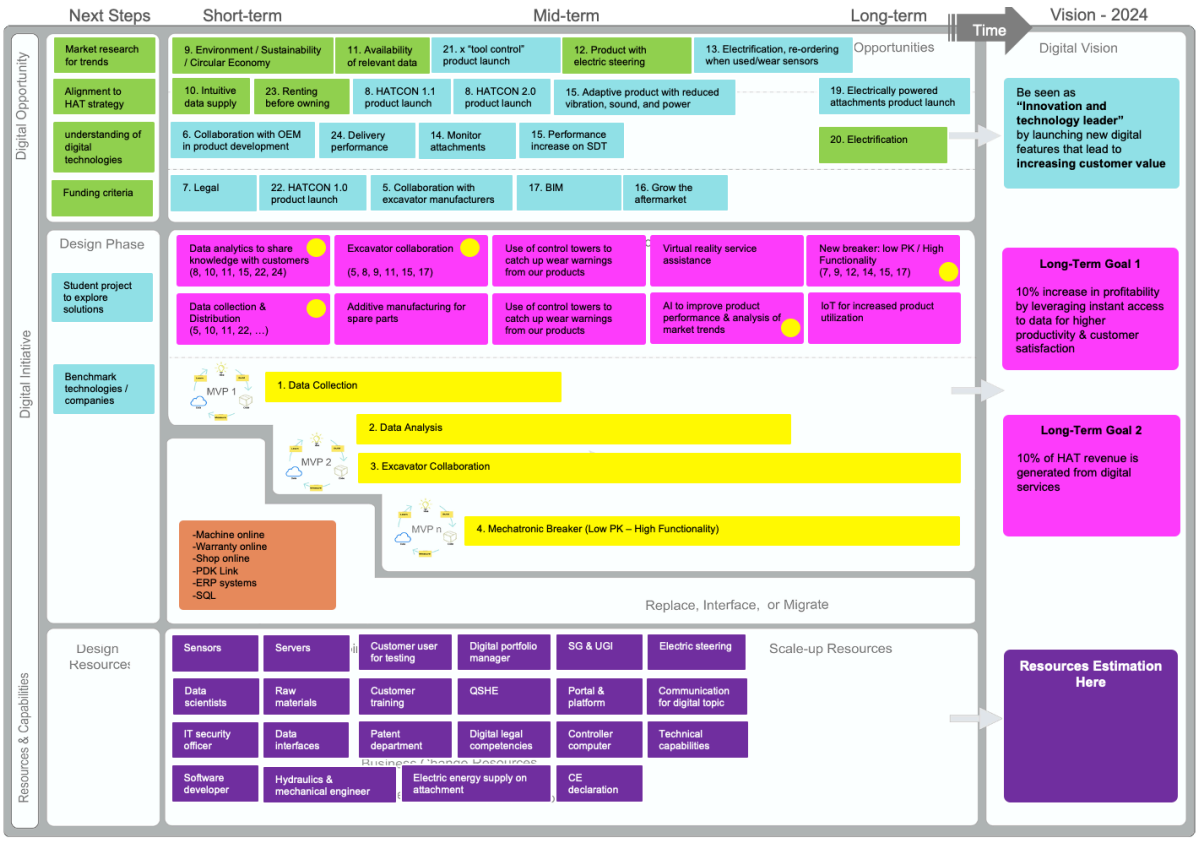

Figure 6.16: *First draft of pilot study 3 DT roadmap*

Validate

The sponsor was a participant in the workshop, so it was possible to play back the outcomes of the workshop for feedback. The feedback was positive, and further refinement of the outcomes was required. Moreover, a next steps action plan was created, which included tasks,

owners, and delivery dates. This left the team at a point where a first-draft DT plan was created, along with clear next steps to refine it.

6.7.4 Framework Evaluation

Moderate changes were made to the workshop preparation and activities from pilot study 2, which led to slightly improved results in pilot study 3. A few activities were eliminated. The main changes were that the Understand and Sketch activities were more streamlined. A summary of the pilot study evaluation can be found in Table 6.24. All workshop activities were successfully completed, and all planning components were created as evident from the pilot report. Therefore, this pilot study can be considered feasible.

Table 6.24: *Evaluation of pilot study 3 outcomes*

Criteria	Evaluation	Evidence
Feasibility	Feasible	The workshop was successfully completed, and all plan components were created
Usability	Usable—could benefit from moderate improvements to some activities	Clarity of workshop objectives: 4.0 Ability to meet workshop objectives: 4.0
Utility	Useful—could benefit from clarifying next steps and digital journey beyond the MVP	Post-workshop interview: Workshop outcomes were perceived as vital starting point

Table 6.25: *Pilot study 3 feedback survey results*

No.	Clarity of objectives	Meeting objectives	Utility to DT planning	Confidence in roadmap
1	2	3	3	3
2	3	3	3	3
3	3	3	3	3
4	4	4	3	3
5	4	4	3	3
6	4	4	3	3
7	4	4	4	3
8	4	4	4	3
9	4	4	4	4
10	5	5	4	4
11	5	5	4	4
12	5	5	5	4
Mean	3.9	4.0	3.6	3.3

There were also a few suggestions of "things to start" as shown in Table 6.26. One suggestion was to use color coding for Post-it Notes to help people understand patterns. For instance, green Post-it Notes could be used for ideas, while yellow could be used for questions. The same idea could also be applied to size, where smaller Post-it Notes could be labeled with larger ones for clustering purposes. A participant also requested more information on the research background as well as digital technologies. Team members with less knowledge of digital technologies found it slightly more challenging to contribute. Although a webinar was held before the workshop to present the research background, it is apparent that it did not provide enough information. Providing summarized reading materials to participants can help overcome this challenge. It is also possible to invite a digital expert as a supporting participant. Other comments were about time—participants were for and against having time-boxed activities. However, a core principle of this iterative approach is that "getting started is more important than being right", because having an incomplete draft is more effective for reflecting on the things that are missing or need to be improved. Finally, participants had some positive comments on being able to have a hands-on workshop, learn about design sprints, and leave with tangible outcomes.

Utility in this case also performed better than the previous pilot studies, although the survey results in Table 6.25 were 3 out of 5 for both utility and confidence in roadmap outcomes. The lead participant explained during the interview that this was due to participants lacking sufficient knowledge on DT to be able to maximize the utilization of the outcomes. The interview demonstrated that the workshop goals were achieved. The outcomes raised participants' awareness of the potential of DT for the organization while also increasing their appreciation for the size and scope of the effort needed to drive the DT. Since the workshop, participants have organically formed a DT network and continued collaboration.

In terms of agility, the team found that having a precise scope with MVPs had multiple benefits. The team managed to be focused and had clarity on the next steps. Having a tangible scope shaped some quick wins and encouraged divisional management support. Furthermore, the team experienced accelerated progress thanks to the concise scope of MVPs. This was demonstrated by kicking off three MVPs, with the fourth to follow soon after. This practice of hypothesis testing through business experiments is also being transferred to other projects. The lead participant also stated that similar workshops have been planned to develop a DT roadmap

for each digital initiative. These outcomes provide sufficient evidence for the framework's utility. Therefore, the workshop outcomes are perceived to have had fundamental value.

6.7.5 Specifying Learning

The learnings from this pilot study identified more strengths than areas for improvement. Moreover, the suggested improvements are considered secondary and targeted toward further enhancing the usability of the framework. In contrast, the strengths shed the light on the utility of incorporating agility. Most importantly, the scope of the MVP can dictate the extent of validation. An MVP can be seen as an opportunity either for testing hypotheses or achieving a quick win. Nonetheless, an MVP scope can be viewed as a spectrum that can vary based on the needs of a given situation. Moreover, streamlining the process to dive deeper into the digital concepts enabled smoother progress and more reliable outcomes. Finally, most of the learning points from previous pilot studies were also found in this study. A summary of learnings by category can be found in Table 6.27.

Table 6.26: *Pilot study 3 workshop retrospective feedback*

Start	Stop	Continue
• Follow standard color code for Post-it Notes • More time and details should be given to each task • Better way to cluster ideas • More time for idea clustering • Extended introduction to research background • More technical explanation of digital technologies • Stronger emphasis on the overall purpose of digital transformation	• Digital Trends Tweets • Random use of Post-it Note colors and sizes • Difficult to see how things come together till the end	• Great to have MVPs as an outcome • Design sprint approach to roadmapping • All in all is good • Time-constrained activities • Hands-on atmosphere

Table 6.27: Learnings from pilot study 3

Tested	Observed	Inferred
• MVPs were directly linked to DBS • MVPs enabled accelerated progress • Powerful cross-functional discussions	• Limited knowledge of digital • Limited agile practice • Data and analytics are fundamental components • Alignment with business strategy requires time • Initiatives kicked off sequentially • Dependencies between digital capabilities • MVP scope can be directed to optimize learning or optimize for quick win	• MVP feedback provides insight into DBS

6.8 Findings

This section provides a cross-case analysis of the three pilot studies to synthesize the findings. Findings from the three pilot studies came from testing and observations. The first source of learning came from testing the application of agility by piloting the framework. Evidence was collected on the feasibility, usability, and utility of the framework. The second source of findings was through observing the use, perception, and value of the framework to participants, which was documented and reviewed using the reflective log. There were 21 findings grouped under feasibility, usability, utility, and observations. Each finding strand is discussed in this section. The findings from all three pilot studies are consolidated in Table 6.28.

The framework evaluation provided evidence of its suitability for DT planning. While three pilot studies are not enough to validate the framework, depth was intentionally prioritized over breadth. Moreover, the framework was adapted from proven frameworks and tools such as the planning process from the exploratory case study, agile methodology, roadmapping, and design sprints. Furthermore, participants from pilot studies 2 and 3 intend to reuse the framework as they found it effective. It was also evident that while areas of improvement remain, none

inhibited the attainment of the major desired outcomes of the framework. However, framework validation is recommended as an opportunity for further research in section 6.10.

6.8.1 Feasibility

Feasibility was assessed through two points: completing the workshops and achieving the desired outcomes. The workshop was successfully completed in each pilot study. It was also possible to deliver the outcomes of creating a first-draft roadmap that integrated the three core DT plan components. Agility could be incorporated by scoping an MVP for each digital initiative. This also included hypotheses to be validated for each digital initiative. Therefore, using the design sprint process for roadmapping an agile DT roadmap demonstrated feasibility across three different cases.

6.8.2 Usability

Usability is a relatively subjective measure but a critical one, nonetheless. It can also cover a spectrum with a minimum usable threshold, requiring it to be measured on a discrete scale. The criteria for assessing usability of the workshop's activities were: (1) ability to understand the objective; (2) ability to achieve the objective; (3) perception about ease of use. The aggregated results of the three surveys can be found in Appendix C4. Criteria 1 and 2 were assessed on a 5-point Likert scale using the workshop feedback survey; criterion 3 was assessed qualitatively through retrospective sessions. The scores were 4, 3 and 3 for pilots 1, 2 and 3, respectively. Given that this scale is discrete, the criterion of understanding the objective is considered "acceptable." This can indicate that the workshop objectives require further elaboration. It can also be partially attributed to the teams' limited exposure to and experience in design thinking and agile-based workshops. The ability to meet the workshop objectives scored 4 out of 5 for all pilot studies. Therefore, the second criterion can be considered "Good." This indicates that participants were only able to understand the workshop objectives in hindsight. The final point was assessed based on the retrospective feedback and the researcher's intervention as a facilitator to help with the completion of activities. The first two pilot studies required moderate intervention. It was necessary to intervene multiple times to guide and re-explain some of the activities. However, those interventions were not major and were limited to guidance rather than participation. The third pilot study required minimal intervention. Pilot study 3 was considered the smoothest of the three. This was mostly attributed to streamlining the activities by reducing the divergence of topics and diving deeper into the prioritized digital

concepts. Therefore, the proposed framework is considered usable as it stands. However, there is clearly room to improve its usability to make it more accessible to practitioners.

6.8.3 Utility

Utility was the most critical point to evaluate as it holds the answer to this research question. There were eight findings that can be clustered into perception of utility and evidence of progress. Perception of participants was measured using the workshop survey to evaluate the utility of the outcomes as well as confidence in the outcomes. The scores for the utility of the outcomes of pilot studies 1, 2, and 3 were 4, 4, and 3, respectively. This indicates that the outcomes were considered mostly useful. The scores for confidence in the outcomes were 4, 3, and 3, respectively. This indicates that participants were moderately confident in the outcomes. Although the scores can be improved, they are reasonable for a first-draft roadmap. Feedback was also received on the perception of the workshop sponsor. In all cases, there was positive feedback and teams were encouraged to continue their efforts. However, there was no critical evaluation of the outcomes by the sponsor or senior stakeholders, because teams were hesitant to present details while the work was in progress. The follow-up interview with lead participants reaffirmed the utility of the outcomes. This was also evident from all pilot studies progressing with the refinement and implementation of the DT roadmap.

Evidence of utility was focused specifically on incorporating agility. Scoping an MVP for each digital initiative enabled the pilot teams to have clear next steps. This is due to MVPs having specific scope to validate the digital initiative. The second piece of evidence is that all the pilot companies managed to start the execution of MVPs within two months of the workshop. The number of MVPs kicked off at the time of the interview was 1, 2, and 4 for Companies 1, 2, and 3, respectively. All lead participants perceived this as accelerated progress and attributed it to the concise scope of MVPs offering quick wins. In the case of Company 3, having quick wins was perceived to incentivize the support of the managers across different divisions. Finally, Companies 2 and 3 intend to reuse the workshop and some of its tools for refining the DT roadmap, as well as transferring the tools to other domains, such as new product development of non-digital products.

6.8.4 Observed Findings

The framework observations led to various insights. There were eight findings that could be clustered into four groups: digital skills, foundational technologies, strategy scope, and strategy

execution. First, in terms of digital skills, most participants had a limited understanding of digital technologies, their applications, and available commercial solutions. Moreover, agile practices were also considered new to most participants. This was observed equally across all pilot studies.

Second, a set of technologies was observed to be foundational for each digital initiative across all the pilot cases. The first technology is data platforms, which includes the management of data in a form that makes it accessible for various applications. All data technologies are reliant on a data platform to offer data in a clean, structured, and usable format. The second technology is data analytics. While applications took various shapes and forms, including statistics, mathematical optimization, and machine learning, it was an essential component to almost all digital initiatives across all pilot studies.

The third observation was related to the digital strategy scope. There was some variation across pilot studies between developing new digital initiatives and refining existing ideas. All digital initiatives in pilot study 1 were new. However, in pilot studies 2 and 3 there was a combination of developing new ideas and refining existing ones. This can potentially be attributed to the progress made with the DT journey prior to the workshop. Nonetheless, these findings have demonstrated that the workshop was suitable for both cases. Setting the MVP scope was also observed to vary. In pilot study 3, participants were focused on creating quick wins over learning. This demonstrated that the scope of an MVP can cover a spectrum based on uncertainty. Quick wins require less uncertainty, which, in return, will generate less learning. On the other hand, focusing on learning will involve a high level of uncertainty and therefore less confidence in delivering a quick win. The ideal scope of an MVP would be one that validates hypotheses while creating tangible results. Figure 6.17 illustrates the concept of the MVP scope spectrum.

Fourth, it was noticed that the teams from Companies 1 and 3 required the digital strategy to be aligned with the current strategy, the scope to be refined, and the resources to be dedicated, before they were able to kick off digital initiatives. Moreover, not all initiatives were started at once. All pilot studies prioritized a few digital initiatives due to limited resources and expertise. It was also noticed that starting with an MVP enabled relaxed funding, as the budget for scaling up the digital initiative was only required once the hypothesis had been validated.

Finally, across all pilot studies, the participants formed a network and continued to collaborate on DT with a bottom-up approach.

Table 6.28: *Cross-case findings*

Findings		Pilot 1	Pilot 2	Pilot 3	Scale
Feasibility	It was possible to rapidly prototype a DT strategic plan using the design sprint approach	✓	✓	✓	Yes/No
	It was possible to use roadmapping as an integrator of the DT strategic plan	✓	✓	✓	Yes/No
Usability	Participants were able to understand the objective of the workshop	4	3.5	3.9	5-point Likert scale
	Participants were able to follow the workshop activities and achieve their objectives	4.3	3.7	4	5-point Likert scale
	Participants perceived the framework's process and tools as easy to use and follow	Medium	Medium	High	L, M, H
Utility	Participants perceived the workshop's outcomes to be of utility to the DT journey of the organization	4.3	3.7	3.6	5-point Likert scale
	Participants had confidence in the effectiveness of the DT strategic plan	3.5	3.5	3.3	5-point Likert scale
	The workshop outcomes met the sponsor's expectations	✓	✓	✓	Yes/No
	The lead participant perceived the workshop's outcomes as useful	✓	✓	✓	Yes/No
	Scoping MVPs enabled clear next steps	✓	✓	✓	Yes/No
	Focusing on prioritized MVPs enabled accelerated progress	✓	✓	✓	Yes/No
	Scoping MVPs for quick win enabled management buy-in	-	-	✓	Yes/No
	Team intend to reuse the framework or its main tools	-	✓	✓	Yes/No
Observations	Participants were able to generate new ideas rather than refining existing ones	High	Low	Medium	L, M, H
	Participants were able to form a network that continued after the workshop	✓	✓	✓	Yes/No
	Participants had limited knowledge of digital technologies, their applications, and solution providers	✓	✓	✓	Yes/No
	Participants were new to agile practices	✓	✓	✓	Yes/No
	Internal alignment was required before MVPs could be started	✓		✓	Yes/No
	Not all MVPs were started at once. Some were prioritized based on other constraints	✓	✓	✓	Yes/No
	Data platforms and analytics were foundational to all digital initiatives	✓	✓	✓	Yes/No
	MVP scope can range from learning-focused to "quick win"-focused	✓	✓	✓	Yes/No

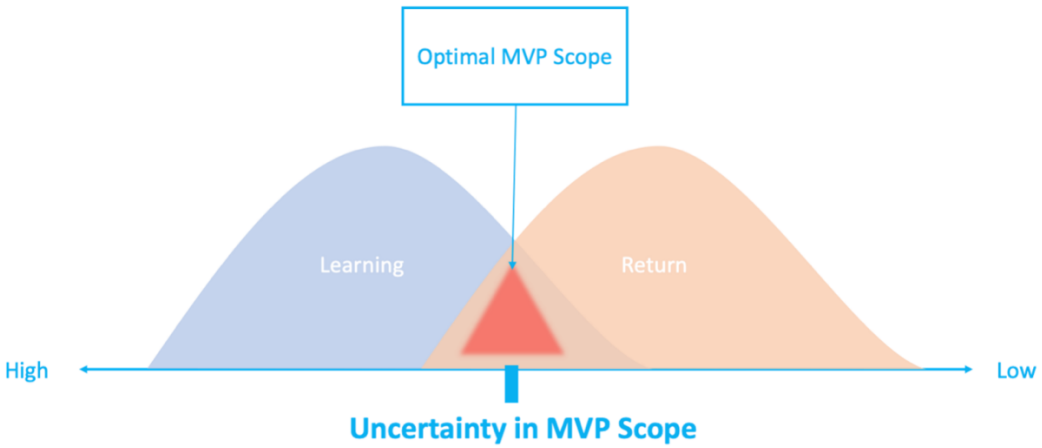

Figure 6.17: *Conceptual MVP scope spectrum*

6.9 Discussion

The findings in this chapter have covered the formulation of a DT roadmap with a specific focus on the utility of incorporating agility. This section discusses findings against that from Chapter 4, evaluates findings in light of existing digital strategy formulation literature, addressing the value of incorporating agility to systematically clarify uncertainty, the implications of findings on the emergent strategy, and a refined agile DT roadmapping framework.

The exploratory case study in Chapter 4 highlighted the role of the trends and drivers in shaping digital strategy, the importance of considering interdependencies between digital capabilities, and the importance of incorporating agility in DT roadmaps. The findings from the three pilot studies enriched these findings by providing deeper evidence on how they are unpacked in digital strategy formulation process. Across all pilot studies trends and drivers were instrumental in clearly stating the impact and opportunity of the digital economy to the organization. This allowed for setting DT initiatives that can potentially act as an adequate strategic response to the identified trends and drivers. Moreover, responding to the trends and drivers requires building the required digital capabilities and their interdependencies. For example, it was found throughout all the pilot studies that delivering the desired digital customer experience was dependent on digitalizing a set of operational processes. Finally, incorporating agility in the DT roadmap and setting MVPs enabled faster pace towards implementation. In turn, this allowed for evaluating the adequacy of the formulated digital strategy in acting as a strategic response to the identified trends and drivers. Therefore,

incorporating agility can enable calibrating the digital strategy early in the process to validate the fulfillment of interdependencies between digital capabilities and reduce the risk of failure as identified in Chapter 4.

A strategy can take various forms based on where it falls on the deliberate–emergent continuum (Mintzberg and Waters, 1985). The existing literature identified that digital strategy formulation is an ongoing process. This has been attributed to the dynamics of the digital economy (Warner and Wäger, 2019), incorporating learning by doing as a feedback loop (Chanias *et al.*, 2019), and managing the complexity of execution (Yeow *et al.*, 2018). In all cases, evidence-based learning from implementation led to validation and renewal of the digital strategy. Therefore, it is important to provide a structure to this ongoing process. Mintzberg and Waters (1985) refer to this approach as "the process strategy" where the process is standardized but the outcomes are at the discretion of the actors, leading to a deliberately emergent strategy. Nonetheless, it is important to proactively connect the process with the stimulants of the emergent strategy to have a closed feedback loop. The findings from this chapter demonstrate that explicitly acknowledging uncertainty is a critical step for validation, which was accomplished by scoping MVPs. Moreover, formulating actions under uncertainty as hypotheses to be validated through business experiments provided structure to this process. With this understanding, it is possible to extrapolate a link between uncertainty in digital strategy and the validation of hypotheses as shown in Figure 6.18. This demonstrates an iterative cycle between strategy formulation and validation through experimenting with hypotheses. This iterative process resembles the search for an adequate response to DT.

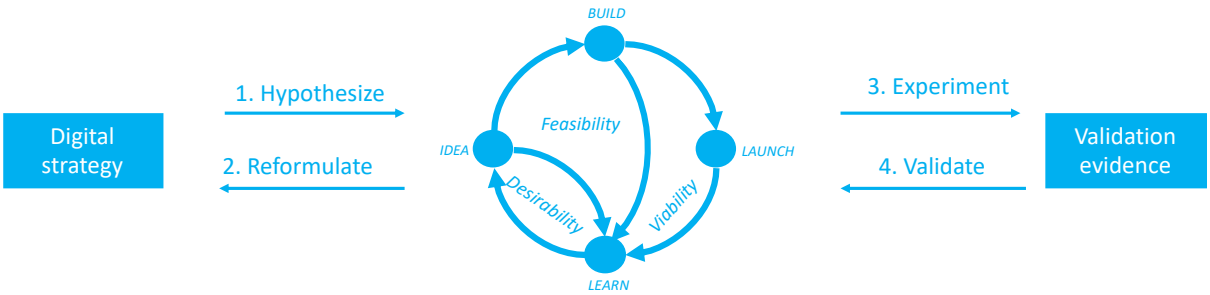

Figure 6.18: *Validation of digital strategy hypotheses*

Digital strategy formulation is known to be a lengthy process. Its duration has been reported as 6 months (chapter 4), 12 months (Yeow *et al.*, 2018), and up to 16 months (Chanias *et al.*, 2019). This is time that was spend purely on formulation without any implementation.

However, episodes of digital strategy formulation continued throughout implementation. This chapter's findings demonstrated that it was possible to prototype a first draft of the DT roadmap and start implementation with the goal of validation in parallel. Therefore, the proposed approach to strategy formulation can reduce the overhead of a long planning process. Taking an agile approach is more logical in hindsight given that the digital strategy is highly emergent (Chanias *et al.*, 2019), and many parts of the original plan will be unrealized.

Given the emergent nature of digital strategy, this is a proactive way to incorporate validated hypotheses back into the DT roadmap. Moreover, such an approach enables faster progress thanks to the focused nature of MVPs. This in turn can accelerate the realization of the emergent digital strategy through multiple iterative episodes of experimentation. Figures 6.19 and 6.20 provide a contrast between static and agile views of the emergent digital strategy.

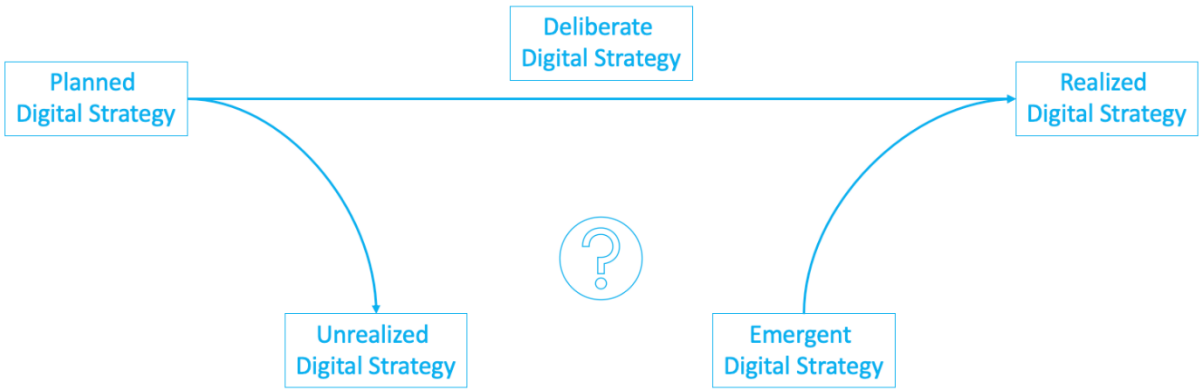

Figure 6.19: *The emergence of the digital strategy (Source: (Chanias and Hess, 2016))*

The discussion thus far suggests that there is a continuous iteration between digital strategy formulation and validation. Digital strategy formulation involves both understanding the trends and drivers and formulating a digital strategy as a strategic response. Digital strategy validation involves running a business experiment as well as collecting evidence for validation. This validation will in turn enhance the understanding of the trends and drivers while also triggering another episode of digital strategy formulation. This approach integrates the lean startup approach (Ries, 2017) into the digital cycle of strategy formulation episodes (Chanias *et al.*, 2019). The first iteration builds the initial understanding, while subsequent iterations improve understanding. At the center of this cycle is the DT roadmap integrating various components of the DT strategic plan. As with any hypothesis-testing experiment, the results will lead to preserving, pivoting, or re-experimenting with various components of that plan (Van Der Pijl

et al., 2016). This concept is illustrated in Figure 6.21 as a refinement of the agile DT roadmapping framework.

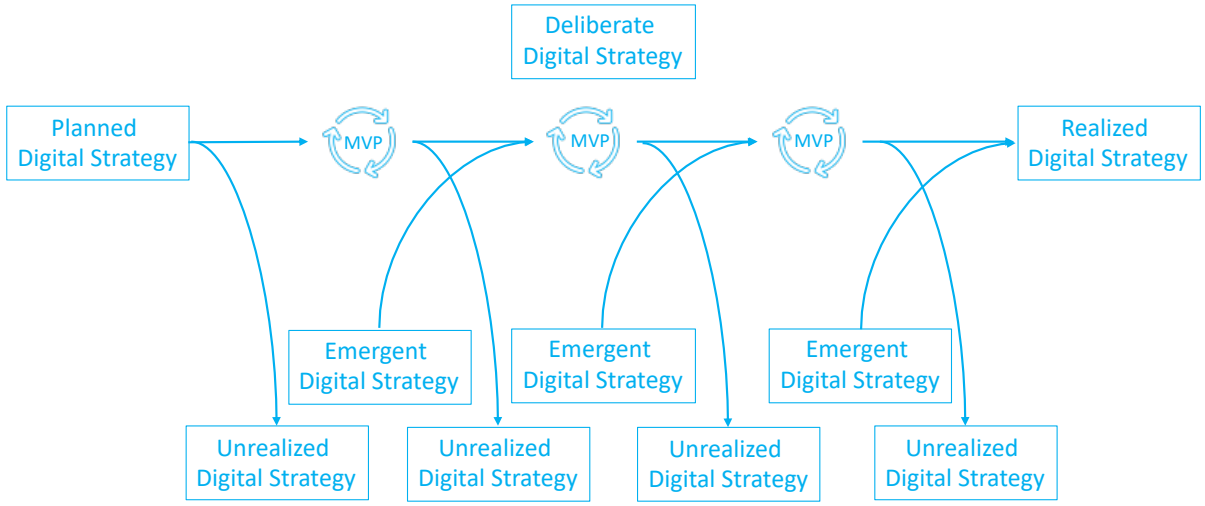

Figure 6.20: *Agile approach to the emergent digital strategy*

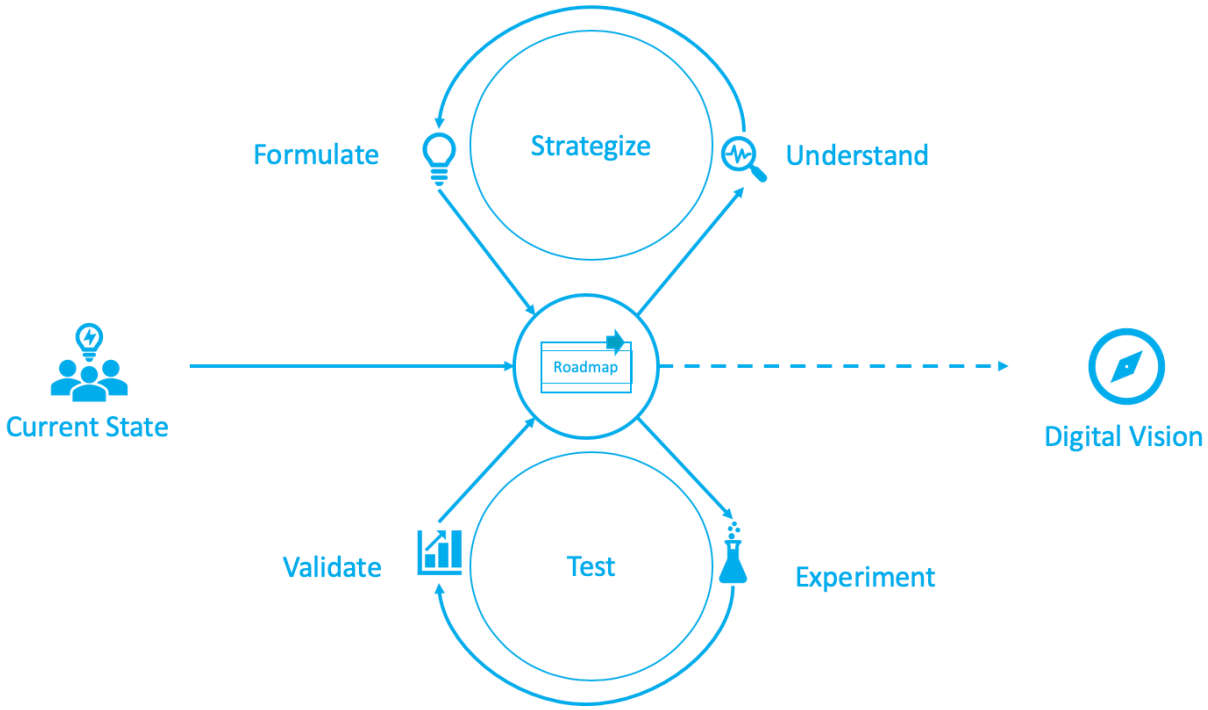

Figure 6.21: *Agile DT roadmapping framework v2.0*

The theory on digital strategy has been guided by the emergent strategy and dynamic capabilities. The realized strategy has been predominantly emergent as a result of the inherent uncertainty. Leveraging business experiments to validate uncertainty can accelerate the realization of the emergent strategy. This can be done episodically, forming a recurring and

growing link between the emergent and realized strategy. In terms of dynamic capabilities, agility can aid the evaluation of the sensed digital opportunities and validate that it was seized. This feedback loop can strengthen the iterative nature of dynamic capabilities.

6.9.1 Practical Implications

The pilot studies in this chapter have provided practitioners with a better understanding of leveraging roadmapping for DT on multiple fronts. First, a roadmap architecture was proposed to integrate the various components of a DT strategic plan and provide a holistic view. Second, a rapid and iterative process for roadmapping has been proposed. This process gave practitioners common and accessible tools and processes, such as the design sprint, the lean startup, and roadmapping. Finally, incorporating agility into the digital strategy formulation enables faster, more focused, and evidence-based progress. However, it is important to realize that the offered framework is not a rigid procedure but a baseline to be customized for the domain of application.

The practical implications of this chapter also highlighted that practitioners should take into considerations the required knowledge and skills to effectively manage digital strategy formulation process. It was identified in the pilot studies that DT is driven by business functions rather than DT and innovation teams. Therefore, Managers should focus on equipping team members that are responsible for DT with the necessary knowledge and skills. Knowledge on digital technologies, their maturity, and potential applications is paramount to enabling both a productive digital strategy formulation process as well as in making digital investment decision. Rapid experimentation and development skills were also found to be critical. This includes agile practices, design thinking and design sprints, roadmapping, data analysis, and building MVPs. Such skills can enable practitioners to manage digital strategy formulation processes more effectively.

6.9.2 Limitations and Future Research

The studies presented in this chapter had some limitations. First, testing and evaluation of the framework were only done using pilot studies. With more time, it would be possible to test the framework on a larger scale. Moreover, carrying out longitudinal case studies can provide a better understanding of the role of agility in DT. Given that the proposed framework requires DT knowledge and skills, longitudinal case studies would allow for identifying how the results of the process improve in relation to the development of team members. Furthermore, thus far,

the pilot studies included a single formulation workshop. Tracking digital strategy formulation workshops episodically can allow for more effective calibration of the process.

Second, change management in its various form has social dynamics implications which were not investigated sufficiently. Specifically, participants were hesitant to present incomplete work to management and stakeholders. From the outset this is counterproductive to the view of failing fast to succeed sooner. Therefore, future research can investigate the way that these social dynamics unfold in practice. One way to accomplish this is by carrying out interviews with DT teams and their management as they plan and implement DT initiatives. Such findings can indicate ways to align the process to the social dynamics in a way that fosters productive collaboration.

Finally, future research can investigate the causal relationship between the digital strategy validation constructs and the emergent digital strategy. Despite these caveats, this research provided a novel insight into the utility of incorporating agility to enhance the success of DT through practical framework.

6.10 Chapter Summary

Chapter 6 investigated the suitability of agile DT roadmapping to aid digital strategy formulation. This was accomplished by carrying out a series of pilot studies as action research. Conducting such research allowed for calibrating the framework process while testing the theoretical proposition. The results were presented at the pilot level as well as at the cross-case level, and showed that agile DT roadmapping can accelerate the validation of the DT strategic plan and consequently accelerate the realization of the emergent digital strategy. The discussion synthesized the findings in light of the current literature, and the framework was refined as version 2.0. As digital strategy formulation is a search process, a deliberate strategy is needed as a baseline. Chapter 7 investigates the digital strategy archetypes that are implemented by Fortune 500 companies.

7. Digital Strategy Exploration

7.1 Introduction

Chapter 6 showed that the iterative formulation and validation of digital strategy accelerates the realization of the emergent strategy. This requires an intended strategy as a starting point. Chapter 7 investigates the content of digital strategy in terms of digital and transformation capabilities. This exploration focuses on Fortune's Global 500 companies, as they form one of the most critical components of the global economy. The data have been collected from publicly available information including financial performance and earnings calls. Qualitative data on companies' digital activities has been quantified using natural language processing (NLP). Statistical analysis has also been performed to understand companies' approach to DT. Section 7.2 describes the research design used for this chapter while sections 7.3 and 7.4 cover the data collection and analysis, respectively. The results in section 7.5 demonstrate different strategy archetypes and their focus in various sectors. The chapter ends with a discussion in section 7.6 and a summary in section 7.7.

7.2 Research Design

Investigating the digital strategy archetypes as implemented by organizations required the use of various unstructured data sources. Moreover, the breadth of the data sample—Fortune 500 companies—lends itself to quantitative analysis. Therefore, data science as a research method was chosen to answer the research question. This is done by adapting the data science research method proposed by Rizk and Elragal (2020) as illustrated in Figure 7.1.

RQ-3: *What are the main digital strategy archetypes that may guide the formulation process?*

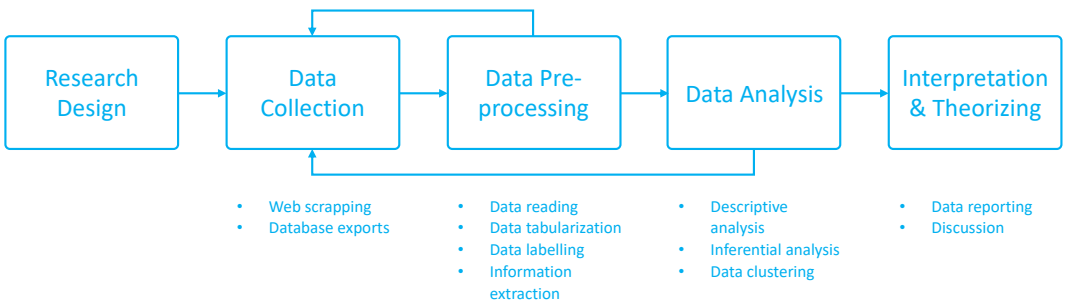

Figure 7.1: *Data science-based research method*

Data science has been used in management research for theory investigation, theory testing, contextual elaboration, and theory building (Rizk and Elragal, 2020). In this chapter, data

science techniques are used for contextual elaboration on the DBS archetypes that large companies implement. Therefore, it is important to conceptualize the desired outcome before jumping into data analysis that may not address the research question (Rizk and Elragal, 2020). This is laid out in research objective 3:

RO-3: *Identify the main digital strategy archetypes that may guide the formulation process*

The expected result from this analysis is the identification of DT-related activities that collectively form the pursued DBS of a given company. In this chapter, the DBS is characterized as an organization's efforts to build digital capabilities, transformation capabilities, and the use of digital technologies. The selected digital capabilities are digital products, digital customer experience, digital operations, and digital business models, as identified in Section 2.5.1. Transformation capabilities have 12 components as outlined in Table 2.7. The transformation capabilities can be grouped into two clusters, DT enablers and DT practices. DT enablers comprise all the measures a company has in place to enable the DT, such as digital strategy, technological infrastructure, and governance. DT practices refers to all the activities required to execute the digital strategy, such as agile practices, data-driven decision making, and digital innovation. Eleven digital technologies were identified in section 2.5.3. With 4 digital capabilities, 2 transformation capabilities, and 11 digital technologies; this collectively forms 17 aspects related to the DBS. The definition of each digital and transformation capability can be found in Table 7.3.

It is not enough to only identify DT-related activities, as context is needed. Therefore, it is necessary to measure the progress made on a given digital activity. Existing research on digital maturity uses a quantitative approach to conduct a comparative analysis for benchmarking against industry peers (Gurbaxani and Dunkle, 2019). However, it lacks the ability to track progress over time (Thordsen *et al.*, 2020). Thordsen *et al.* (2020) conducted a systematic literature review of digital maturity models and found that they lack consistency. Therefore, the authors recommended to use practitioners' outlets given the practical nature of maturity assessment tools. EY and Microsoft (2019) conducted a global research on AI maturity with 399 companies across Africa, Middle East, and Europe. This study showed five levels of maturity including None, Planning, Piloting, Released, and Advanced. This framework has been adapted to measure digital maturity as it enables measuring digital transformation progress in a discrete and consistent way. This is done by measuring the maturity based on four

stages: planned, piloted, released, and pioneered. Released and pioneered can be seen as two parallel paths of digital innovation. *Released* refers to implementation using commercially available solutions such as an Enterprise Resource Planning (ERP) system. *Pioneered* refers to delivering a unique solution that is considered original, such as a high-performing microprocessor or a new algorithm. The definition of each maturity level can be found in Table 7.4.

7.3 Data Collection

Data were collected using multiple sources, techniques, and preprocessing stages. The target was to collate a dataset that includes information on Global 500 companies, their digital activities, and their financial results for five years (2015–2019 inclusive). The year 2015 was selected as a starting point as it is the year that DT research started to exponentially increase as shown in Figure 2.1. Moreover, five years is considered an appropriate time frame to start realizing results from DT (Gupta, 2018). A summary of the collected datasets is outlined in Table 7.1. The collection process for each of the three datasets is explained in the following paragraphs of this section.

Table 7.1: *Summary of data collection*

Dataset	Objective	Content	Source	Quantity
Global 500 list	A list of the top 500 companies based on revenue	Company name Ranking Sector Location	Fortune.com	500
Global 500 financial data	Financial ratios of the 500 companies 2015–2019	Company name Return on equity % Return on capital % Net profit margin % EBITA[2] % Company ticker code	Capital IQ database	473
Quarterly earnings calls	Transcripts of the conference calls for companies' earnings	Call transcript	Capital IQ database	304 companies 4,911 transcripts

[2] EBITA: Earnings Before Interest, Taxes, and Amortization

The Global 500 companies list was collected from Fortune.com (2019). The list of companies changes marginally from year to year. Therefore, companies that appeared on the 2018 list were selected as the 500 companies for analysis. These data were saved in a table, which was used as the master table to be enriched with earnings calls and financial performance reports for each company.

Collecting information on companies' digital activities required the selection of a data source that is official, reliable, and that presents data in a consistent format across companies. Therefore, company earnings calls were selected, based on the evaluation conducted in section 3.4.7. Earnings calls are public conferences held by publicly traded companies to share their financial results, initiatives, and strategies, including DT. Earnings call transcripts were obtained from the S&P Capital IQ database. This database provides financial information on US and international companies. It was possible to download earnings calls for 304 companies out of the 500. Earnings calls missing from the database are likely due to companies not being publicly traded. The total number of downloaded transcripts was 4,911. There were slight variations in the number of downloaded transcripts per company because companies can hold earnings calls annually, twice a year or quarterly.

Financial data were used to supplement the findings. Companies vary in size, use of non-financial assets, and profitability. Therefore, it was decided that the focus would be on financial ratios to reduce the effect of such variation. The selected ratios are return on capital, return on equity, net profit margin, and earnings before interest, taxes and amortization (EBITA). These data were also downloaded from S&P Capital IQ as a Microsoft Excel file. Financial data were obtained for 473 companies out of the 500; financial data from the remaining 27 companies were missing from the database.

Data preprocessing took significant effort and happened over multiple stages. To scale the data analysis and modeling, both the earnings calls and financial data had to be structured and integrated in a single table. Earnings calls were available in PDF and converting it into editable files required the use of the programming language Python. The outcome was a table where each row included the company name, company ticker, call date, and transcript content. This was then saved as a comma-separated values (.csv) file. The financial ratios were available as an Excel file, where each company's financial information was listed in a separate tab. Using Python, it was possible to automate the extraction and consolidation of each financial year of

a company as a row in a table. Data from the three sources were then joined into a single table with 4,911 rows and 25 columns.

7.4 Data Analysis

The data analysis was conducted in four stages—data preprocessing, descriptive analysis, inferential statistics, and clustering analysis—using Python 3.6. The data visualization was created using Tableau 2019.3. Each stage is described in this section.

7.4.1 Data Preprocessing

The data preprocessing stage used NLP techniques with the aim of extracting relevant information from all the transcripts. The objective of the data preprocessing stage was to identify occurrences of the 17 DT topics, and their respective maturity, from the transcript text. There were four data preprocessing stages as illustrated in Figure 7.2.

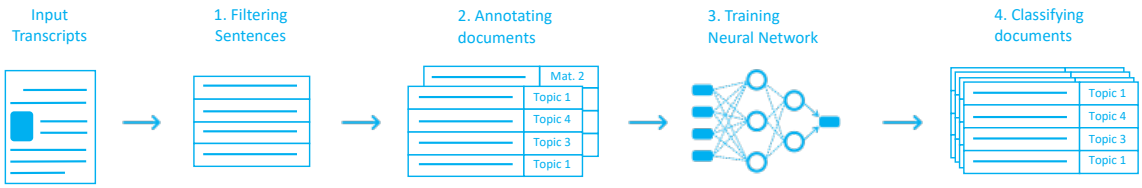

Figure 7.2: *Data preprocessing steps*

Machine learning models tend to work well with short to medium-length documents (Beltagy *et al.*, 2020). Therefore, sentence-level analysis was deemed appropriate. Performing sentence-level splitting resulted in approximately 3.2 million sentences. A large portion of the transcript contained non-DT-related topics. Therefore, the dataset was filtered for relevant sentences. A list of 275 keywords covering the 17 DT-related topics was used to search for relevant sentences. The list of keyword terms covered digital capabilities, transformation capabilities, and digital technologies, and can be found in Appendix D1. This filtering process resulted in 46,277 relevant sentences showing that around 1.46% of earning calls discussions were related to digital. To maintain sufficient context, the preceding and following sentences were also added. Each block of text containing three sentences is referred to as a document.

Text mining can be performed using supervised or unsupervised machine learning techniques. Text classification was used for this task, which falls under supervised learning.

This is where a model is shown a set of examples from which to infer an approximation function between the input and output (Murphy, 2012). This required examples to be manually labeled for use as a training dataset. Two text classification models were needed: a topic identification model and a maturity classification model. In this case, *Topics* refer to the 17 aspects under digital capabilities, transformation capabilities, and digital technologies. Multi-label text classification was chosen because the occurrence of topics in a document is not mutually exclusive. *Maturity* refers to the progress made with a given aspect, including (1) planned, (2) piloting, (3) released, and (4) pioneered on a discrete scale (EY and Microsoft, 2019). Multi-class text classification was used, since maturity runs on a discrete scale. A total of 1,300 examples were manually labeled for each task, and used for training the text classification models. A data annotation tool, Prodigy, was used, which provides an interactive user interface for labelling examples (Figure 7.3).

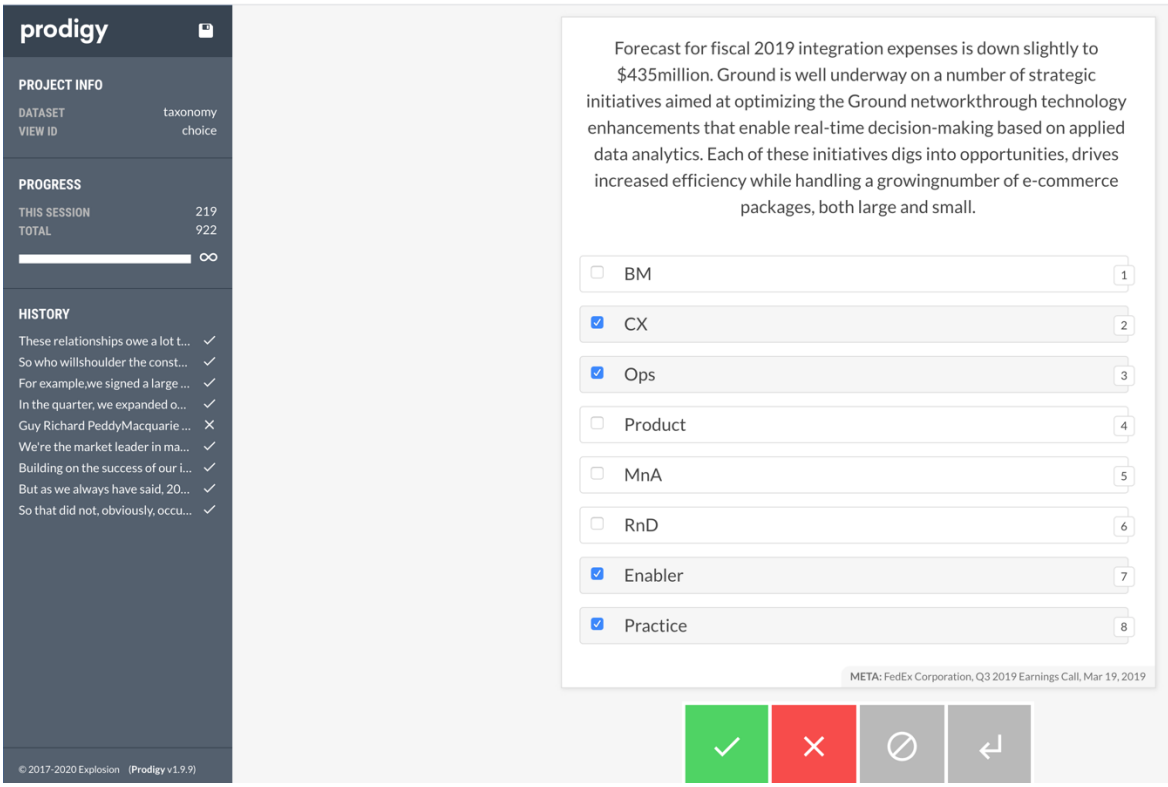

Figure 7.3: *Snapshot of the data annotation tool interface*

Given that a contextual understanding of the analyzed text is required, it was essential to use deep learning-based algorithms rather than rule-based or keyword frequency count approaches. Machine learning models tend to improve their accuracy as the number of training examples increases. To reduce the need for extensive data annotation, transfer learning technique can be used. This is where a neural network is trained on a large corpus that can then

be transferred to other NLP tasks (Howard and Ruder, 2018). This allows the neural network to build a representation of the language structure before learning a specific task. Howard and Ruder (2018) trained a recurrent neural network on Wikipedia data and managed to outperform state-of-the-art techniques by an 18–24% improvement in accuracy. They also achieved a 100-fold reduction in training dataset size when using transfer learning. These transferrable language models continued improving in performance and sophistication. For this task, the RoBERTa-base language model was used, which is an optimized version BERT (Liu *et al.*, 2019). BERT is also a language model; the abbreviation stands for bidirectional encoder representations from transformers (Kenton *et al.*, 2019). As this was a newly curated dataset, it was not possible to assess the models' performance against a benchmark result. Therefore, the models' performance was compared against that of several machine learning models to measure the gain in performance when compared to linear models. The labeled data were split 80% for training, 10% for validation, and 10% for testing. RoBERTa-base performed best on F1-weighted score[3] as shown in Table 7.2. Compared to the linear naïve Bayes–support vector machine model, the F1-score was 20.4% higher for topic identification and 19.2% higher for maturity classification.

Table 7.2: *Text classification experiment results*

Model	Aspect			Maturity			
	Precision	Recall	F1-weighted	Precision	Recall	F1-weighted	MAE[4]
RoBERTa-base	**68.9**	**67.5**	**67.4**	**59.1**	**58.2**	**58.2**	**0.516**
BERT-base	65.5	63.3	62.0	56.8	56.0	55.7	0.563
LSTM+GloVe	66.4	60.2	62.5	51.3	50.9	50.6	0.624
NB SVM	52.1	46.0	47.0	49.0	51.3	49.0	0.802

The model performance could benefit from further improvement as discussed in section 7.6.5. However, this has limited impact on the validity of findings for the following reasons:

- The difference between precision and recall scores is insignificant which demonstrates the consistency of both the aspect and maturity models performance
- The maturity model runs on a discrete scale from 1 to 4. The mean absolute error score shows that the error in model prediction is on average 0.516 classes away from the correct

[3] F1-score = 2 × (precision × recall) / (precision + recall)

[4] Mean Absolute Error, $MAE = \frac{1}{n}\sum_{i=1}^{n} |y_i - \hat{y}_i|$

maturity class. Therefore, given the subject nature of natural language and the potential overlap between classes the model is considered slightly deviated rather than wrong

- The models are applied uniformly to all companies and the results were aggregated. Therefore, the model deviation has limited impact on the comparative analysis of companies' digital activities

Table 7.3: *Definitions of digital and transformation capabilities*

Aspect	Definitions	Count	Percentage
Digital Product	A significantly new way of creating and capturing business value that is embodied in or enabled by digital technologies	17,936	28.99%
Digital Operations	The technology and business capabilities that ensure the efficiency, scalability, reliability, quality and predictability of core operations	5,107	8.25%
Digital Customer Experience	To create a seamless, omnichannel experience that makes it easy for customers to order, inquire, pay and receive support in a consistent way from any channel at any time	3,399	5.49%
Digital Business Model	Enhancing product value through digital features usually requires integrating a combination of products, services and data	1,105	1.79%
DT Enablers	Measures that a company have in place to facilitate the DT	11,035	17.84%
DT Practices	Activities that a company performs to facilitate the DT	2,245	3.63%
AI	Only the explicit mention of digital technologies using commercial or technical terms was used in labelling and inference. Therefore, no definition was needed for this task.	2,897	4.68%
Cloud computing		3,931	6.35%
IoT		1,565	2.53%
VR		290	0.47%
AR		223	0.36%
Robotics		1,509	2.44%
Analytics		2,916	4.71%
Mobile		6,502	10.51%
Social Networks		773	1.25%
3D printing		26	0.04%
Blockchain		413	0.67%

The difficulty of the task and the time gain in automating the task is considered an advantage. Moreover, the qualitative evaluation of the output showed reasonable performance based on the training dataset size, in which errors were commonly attributed to vaguely expressed digital activities. Using the described text classification approach, 61,872 topic occurrences were detected in 27,198 documents from 295 companies. The maturity model gave a score between 1 and 4 for each of those documents. This shows that 58.7% of the filtered dataset referred to a specific digital strategy-related activity by the company. The counts and distributions for each label are shown in Tables 7.3 and 7.4.

Table 7.4: *Definitions of DT maturity levels*

Label	Definition	Count	Percentage
Planned	Digital initiative is being or has been planned	4,286	15.7%
Piloting	Digital initiative is being developed or piloted	9,443	34.7%
Released	Digital initiative has been launched and is actively contributing to the business	12,115	44.5%
Pioneered	Digital initiative is being pioneered and making significant business impact	1,354	4.9%

To aggregate results from the documents to the company level, several transformation steps were performed. First, the topics of each document were transformed to binary vectors by applying One-Hot encoding where each mentioned topic out of 17 was “1” and the remaining topics were “0”. Second, each vector of a document was multiplied by its respective maturity class (1–4). Differentiating companies that simultaneously exhibit multiple maturity levels of a topic in the same year is important. This demonstrates higher dynamic capabilities in managing the digital strategy implementation. Taking a weighted average was penalizing companies for simultaneous maturity levels. Therefore, the maturity of a topic is treated as a checklist, in which the score is calculated by summing each identified maturity class within the same year for a given aspect. The mean scores across the five years was then calculated, which resulted in a maturity score between 0 and 10 for each topic. As a result, the dataset was a matrix of *295 companies* × *18 features* (17 topics + mean maturity score) related to the digital strategy. An example of the transformation process is shown in table 7.5

7.4.2 Analysis of results

The data analysis was conducted over three stages. The first data analysis stage was descriptive in nature. The objective was to provide an overview of the collected dataset and explore some of its characteristics. This analysis covers the description of the Global 500 list, the companies' financial performance, and the main digital strategy-related features. The second analysis stage was inferential. The aim of this analysis was to evaluate relationships across different features and various segments. This analysis was applied at the company and sector levels. Specifically, this stage allowed the dependencies between digital and transformation capabilities, and their relation to financial performance, to be investigated. The third stage of analysis focused on clustering companies into different segments. This was done over two steps. First, companies were clustered based on their features. Second, the average values across all features were calculated for each cluster. This provided a summary of the main digital strategy archetypes and their characteristics.

Table 7.5: Example of the data transformation to aggregate DT maturity scores on a company level

Step	Step Description	Before Transformation	After Transformation
1	Classification of topic and maturity in a document	*"We are putting most of our efforts right now -- continue to --into our robotics program. We think it's been a great addition to our fulfillment capacity."*	**Topics:** [robotics, operations] **Maturity:** [3]
2	Convert topic classification to binary vectors by using One-hot encoding	**Topics:** [robotics, operations] **Maturity:** [3]	**Topics:** [0, 0, 1, 0, 1, 0,…..] **Maturity:** [3]
3	Multiply the maturity class by each identified topic in the document	**Topics:** [0, 0, 1, 0, 1, 0,…..] **Maturity:** [3]	**Topics_Maturity:** [0, 0, 3, 0, 3, 0,…..]
4	Sum of each unique maturity class for a given topic in the same year	**Topics_Maturity 2019:** [0, 0, 3, 0, 3, 4,…..] [0, 0, 4, 0, 0, 4,…..] [0, 0, 2, 0, 1, 4,…..] [3, 0, 1, 0, 4, 4,…..]	**Topics_Maturity 2019:** [3, 0, 10, 0, 8, 4,…..]
5	Take the average topic maturity across the five years	**Topics_Maturity 2015 - 2019:** [3, 0, 3, 0, 1, 4,…..] [3, 0, 6, 0, 1, 4,…..] [3, 0, 7, 0, 6, 4,…..] [3, 0, 6, 0, 8, 4,…..] [3, 0, 10, 0, 8, 4,…..]	**Topics_Maturity Score:** [3, 0, 6.4, 0, 4.8, 4,…..]

7.5 Results

7.5.1 Descriptive Analysis

Global 500 companies are a critical segment of the global economy. They are the world's top 500 companies in terms of annual revenue. These 500 companies span 20 sectors, with financials, energy, and technology taking the lead in terms of presence. Figure 7.4 shows a bar chart of the number of companies in each sector. The sampled companies also have a wide geographical stretch, covering all continents except Africa. Most of the companies are in the US, followed by China and then Europe. Figure 7.5 provides a map of where each company's headquarters are located. The bubble size represents revenue in millions of dollars and the colors represent the sectors, as shown in the legend. The financial performance of Global 500 companies is not always profitable, despite high revenue being reported. The revenue ranges between $24.7 billion and $514.4 billion, with an average of $65.3 billion. However, net profit margin ranged between −38.8% and 46.5%, with a mean of 6.4%.

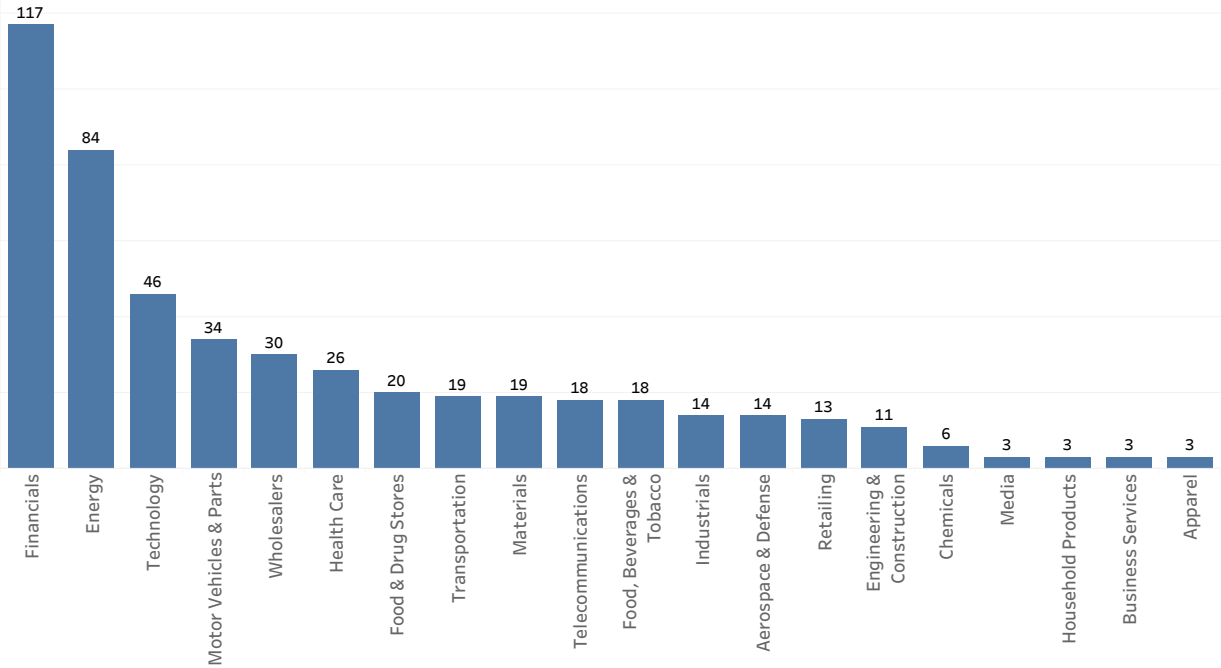

Figure 7.4: *Number of companies per sector*

The identified topics show an uneven distribution (Figure 7.6). The digital capabilities are skewed toward digital products (65% of the overall activities), while digital business models are the least mentioned, at around 4%. Digital customer experience and digital operations are mentioned 18% and 12% of the time, respectively. Transformation capabilities have only two topics, distributed as 83% for DT enablers and 16% for DT practices. The focus on digital technologies is also unevenly distributed. The use of analytics is the highest among digital

technologies. Nonetheless, a focus on AI, mobile, cloud computing, and IoT is also visible. In contrast, Blockchain, AR, VR, and 3D printing are not yet mainstream.

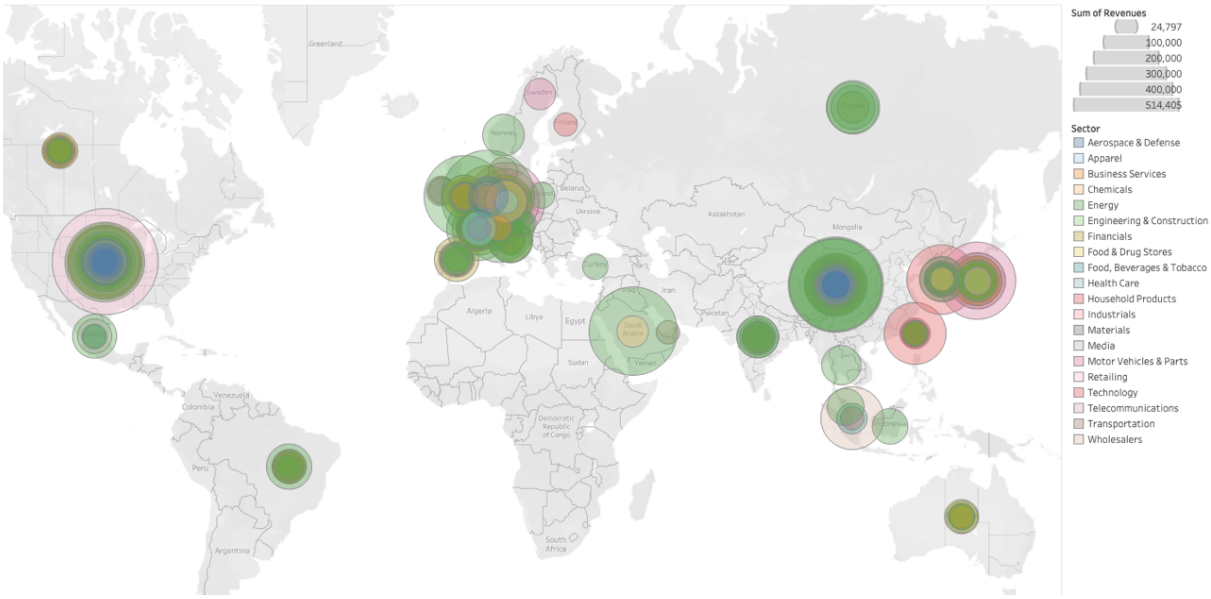

Figure 7.5: *Geographical distribution of the Global 500 companies*

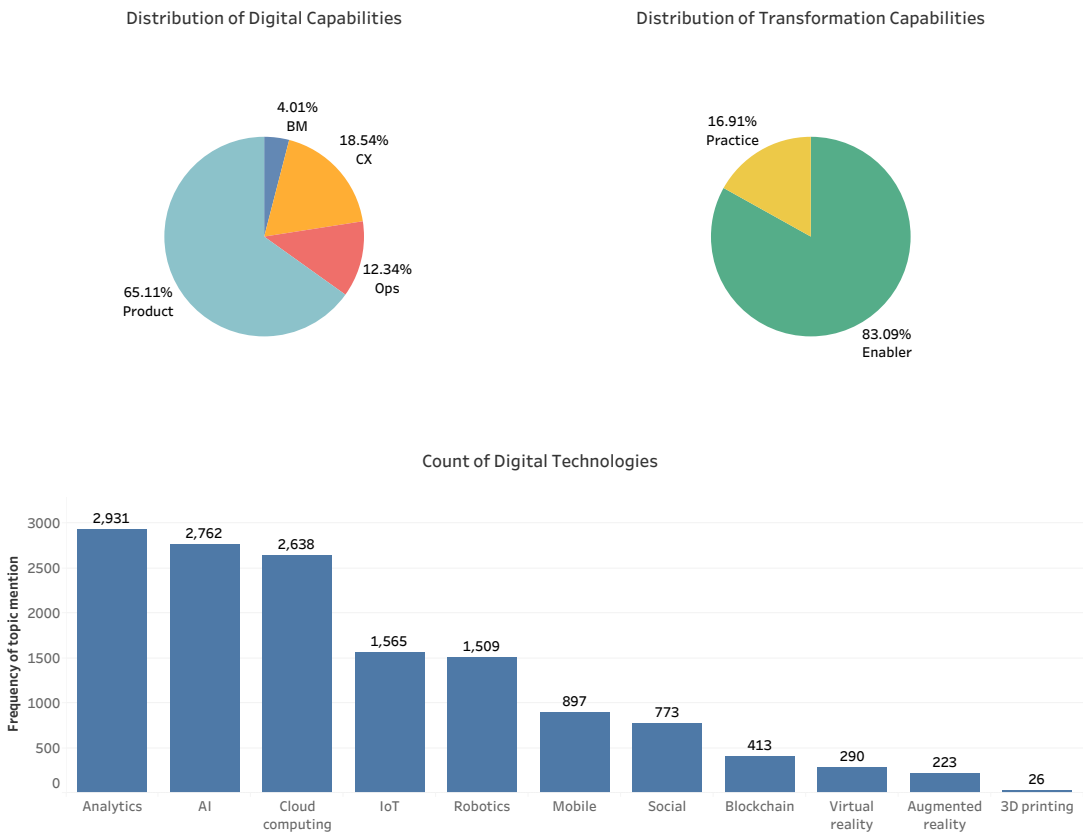

Figure 7.6: *Summary of topics distribution and count*

The efforts toward DT capabilities and technologies varies in focus and maturity across sectors. To investigate this further, the data were aggregated by calculating the mean for each sector. Figure 7.7 provides a heatmap matrix of digital maturity, with DT capabilities on the *x* axis and sectors on the *y* axis. The majority of sectors focus most strongly on DT enablers and digital products. The technology sector has the highest maturity across all sectors, followed by apparel, household products, and telecommunications. The least mature are industrial sectors, such as food and beverage, chemicals, and energy. Some sectors have high maturity distributed across multiple capabilities while others are more focused. This can be influenced by the number of companies in a given sector where companies are focused on different areas.

Sector	Business Model	Customer Experience	Product	Operations	Enabler	Practice	Maturity
Aerospace & Defense	0.6	0.5	5.3	2.3	3.5	2.2	5.7
Apparel	1.9	7.3	6.8	2.4	5.7	4.0	7.6
Business Services	1.1	2.6	3.7	1.6	4.6	1.2	5.4
Chemicals	0.3	0.7	2.1	1.0	1.9	0.4	3.6
Energy	0.6	0.4	1.4	2.2	2.7	0.8	3.5
Engineering & Construction	0.7	1.1	4.2	1.3	3.2	0.5	5.2
Financials	0.9	3.1	2.8	1.9	3.5	1.3	4.9
Food & Drug Stores	1.1	3.6	1.7	2.2	3.0	1.0	4.6
Food, Beverages & Tobacco	0.8	1.6	0.9	1.7	2.9	0.7	3.5
Health Care	0.6	1.9	3.2	1.1	2.6	1.8	4.4
Household Products	2.8	7.4	4.0	4.6	5.2	4.8	7.6
Industrials	1.5	1.4	5.0	3.2	4.8	2.9	5.5
Materials	1.5	0.6	1.4	2.4	3.4	1.2	3.8
Media	0.0	5.9	6.4	0.0	1.7	0.0	6.4
Motor Vehicles & Parts	1.0	0.9	3.7	2.0	3.6	1.7	5.0
Retailing	0.9	4.2	3.2	2.2	3.4	1.4	5.2
Technology	1.4	3.9	7.8	1.4	5.1	3.7	8.0
Telecommunications	0.8	4.1	7.0	2.1	4.2	1.3	7.1
Transportation	0.4	1.7	2.1	2.5	3.1	1.0	4.2
Wholesalers	0.9	1.6	4.0	1.6	3.4	1.4	5.4

***Figure** 7.7: Sector-level heatmap of topic maturity*

7.5.2 Inferential Analysis

In this section, relationships between the digital strategy topics are investigated. A correlation matrix was plotted using Pearson's correlation coefficient (Figure 7.8). The correlation matrix was used to identify highly correlated topics for deeper investigation. The highest correlation is between digital products and digital maturity where $r = 0.91$. This means that companies with high digital product maturity tend to enjoy high overall digital maturity and vice versa. Correlations of digital capabilities vary from low to high. The highest correlations are between products and customer experience $(r = 0.59)$ and between operations and business models $(r = 0.46)$. In transformation capability, the correlation between practice and enablers is also high, $(r = 0.74)$. The average score of digital capabilities and transformation capabilities also has a high correlation score $(r = 0.8)$. In terms of digital

technologies, analytics is highly correlated with multiple technologies including AI, cloud computing, and mobile.

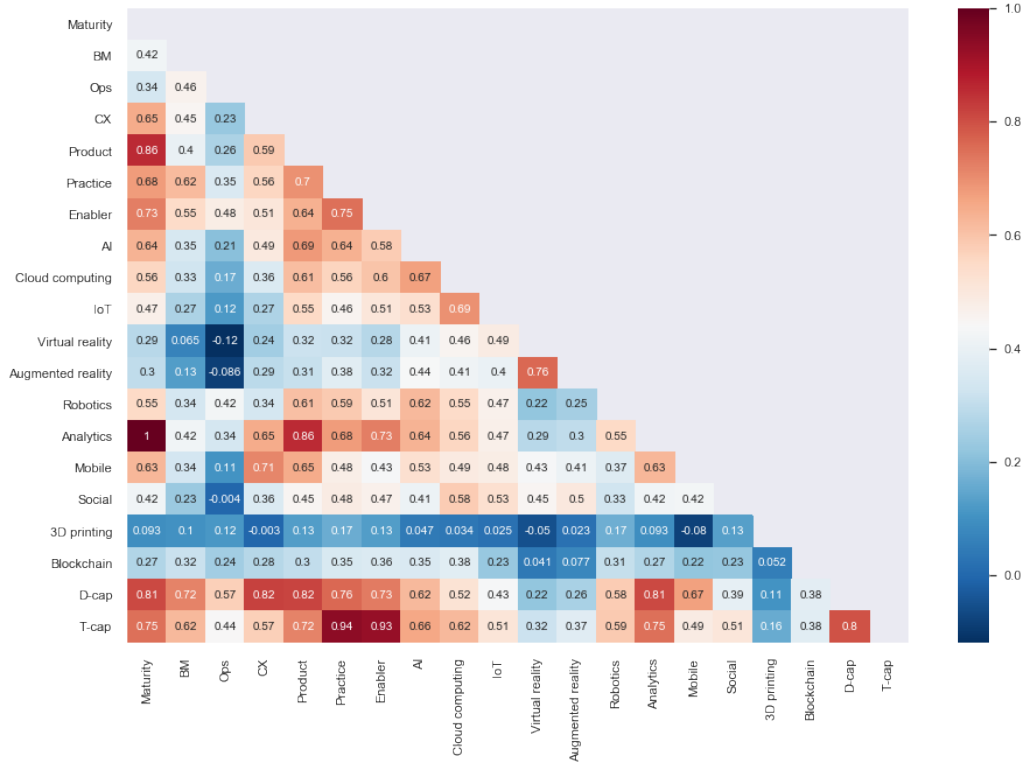

Figure 7.8: *correlation matrix of topics across companies (r= Pearson correlation coefficient)*

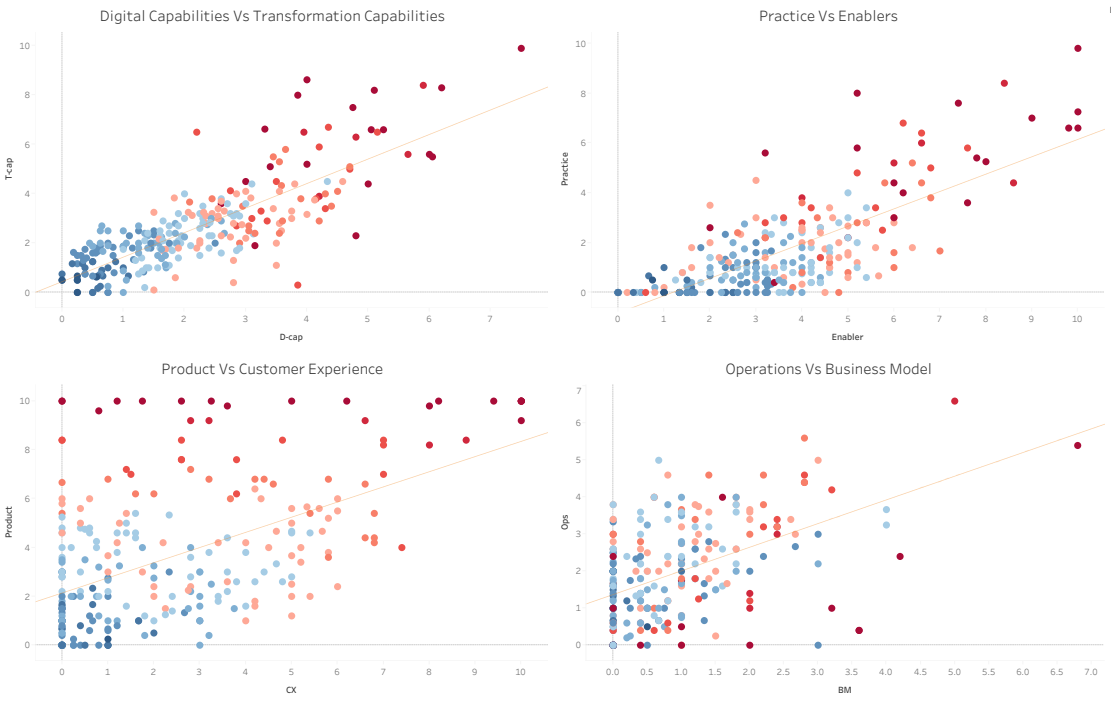

Figure 7.9: *Scatter plots of correlated DT parameters*

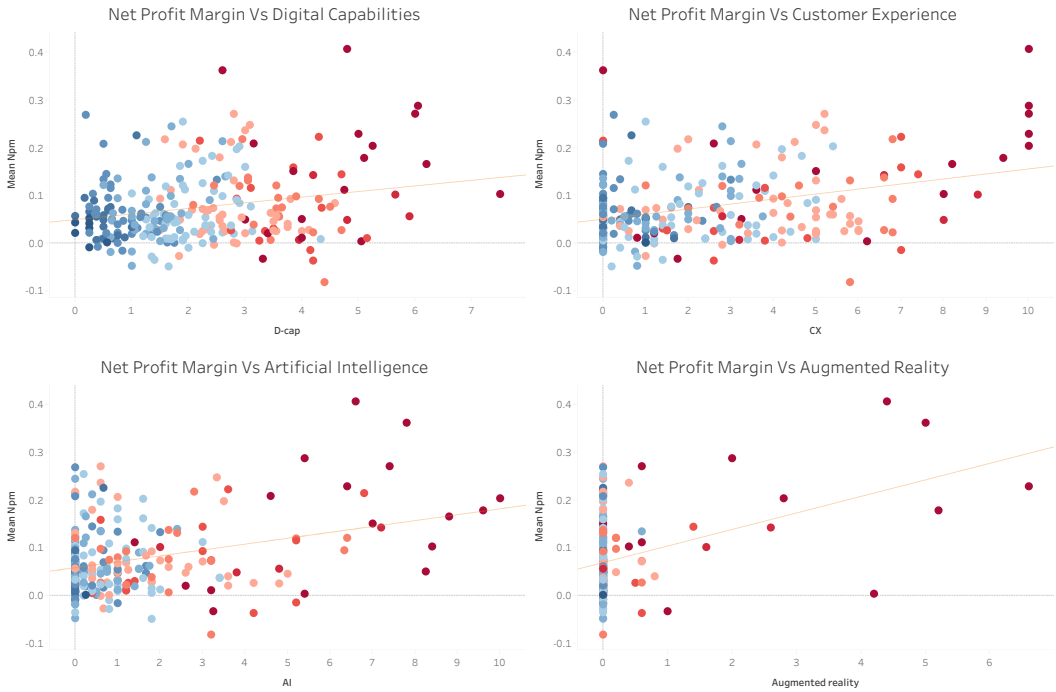

Figure 7.10: *Scatter plots of DT parameters against net profit margin*

Table 7.6: *Pearson's correlation coefficients of DT topics*

Parameters	*r*	*p*-value	Figure
Digital capabilities, Transformation capabilities	0.80	$1.04\ e^{-58}$	7.9
Practice, Enablers	0.74	$1.78\ e^{-46}$	7.9
Product, Customer experience	0.53	$3.02\ e^{-20}$	7.9
Operations, Business model	0.46	$5.13\ e^{-17}$	7.9
Net profit margin, Digital capabilities	0.22	0.0002	7.10
Net profit margin, Customer experience	0.35	$7.10\ e^{-09}$	7.10
Net profit margin, Artificial intelligence	0.33	$5.13\ e^{-08}$	7.10
Net profit margin, Augmented reality	0.36	$2.23\ e^{-09}$	7.10

Correlation can be influenced by outliers in the data. Therefore, calculating the probability value, *p*, and visualizing the correlation using scatter plots can provide further insights into the robustness of a correlation coefficient value. Table 7.6 presents statistically significant correlation coefficients and *p*-values across topics and against net profit margin. Digital capabilities and transformation capabilities show high and robust correlation. Digital capabilities also demonstrate moderate and statistically significant correlations between them. In contrast, DT parameters, while statistically significant, showed moderate to weak correlations against financial performance. However, upon visualizing the correlation it was

evident that the correlation coefficient was influenced by a few outliers. Therefore, correlation with financial performance cannot be taken as a linear relationship.

7.5.3 Clustering Analysis

Companies adopt various digital strategies based on industry, digital maturity, and scope, as shown in Figure 7.7. This section explores the various digital strategy archetypes adopted by companies. To do this, the k-mean clustering algorithm was used. K-mean clustering is an unsupervised machine learning technique used to identify inherent patterns in the data. The letter *k* in k-mean refers to the number of neighboring data points used to determine the cluster that a data point belongs to. k-means clustering assumes that the data distribution is of an equal mean and variance, therefore, the data were standardized by following three steps:

1. Topics with greater than 60% zero values were removed to maintain a dense feature representation. This resulted in using 12 out of the 18 features
2. Log transformation and MinMax scaling was applied to obtain a score between 0 and 1for each of the 12 features
3. A dimensionality reduction technique was used (t-distributed stochastic neighbor embedding [t-SNE][5])

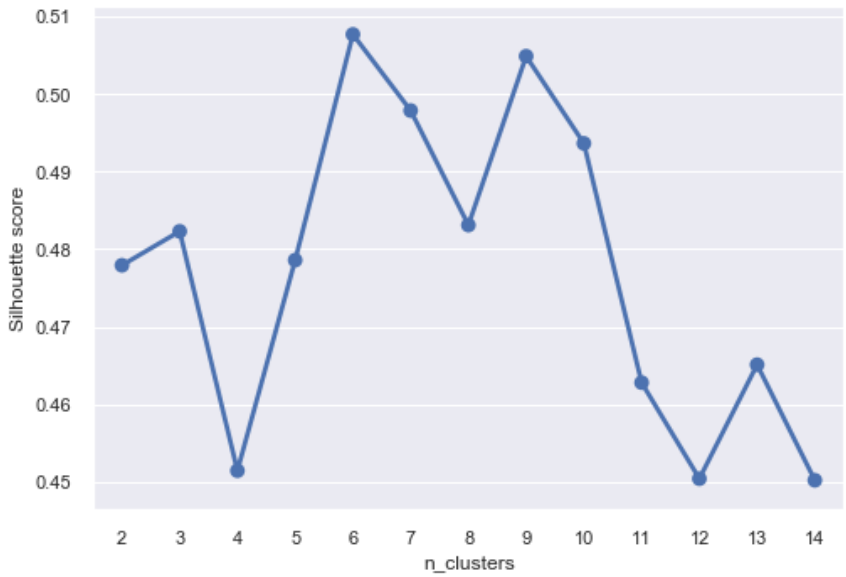

Figure 7.11: *Silhouette score for optimal cluster identification of the digital strategy*

[5] t-SNE hyperparameters were set as (*n* dimensions = 2, random state = 42, perplexity = 10, learning rate = 200, iterations = 1000)

The number of clusters must be specified for the clustering algorithm. In this case, a silhouette score was calculated to identify the optimal number of clusters. Figure 7.11 shows two peaks for silhouette score at *n_clusters = 6* and *n_clusters = 9*. This demonstrates that the data are hierarchical and can be clustered in multiple ways. The clustering analysis took multiple iterations to get the appropriate data transformation and algorithm hyperparameters tuning. After visually inspecting the clusters, it was evident that *n_clusters = 10* provided a meaningful representation of the data. The t-SNE values were then used to plot the companies in a scatter plot, as shown in Figure 7.12. Datapoints that are close to each other mean that they share a similar DBS. Visually inspecting the plot shows that companies with similar business activities are often placed next to each other. This was achieved without any information on the company name, sector or profit margin, which demonstrates reasonable reliability in the clustering outcomes.

The next step was to investigate the characteristics of each cluster. First, the average maturity, average profit margin, company count, and sector count was calculated for each cluster as shown in Figure 7.13. Digital maturity ranged from 3.4 to 9.7, whereas net profit margin ranged from 3.7% to 14.9%. The number of companies per cluster was 11–39 and the number of sectors was 8–12. A few observations can be made on the clusters. For instance, cluster 1 has the highest number of companies, is the least mature, and has a low profit margin. In contrast, cluster 2 has very high digital maturity, a very high profit margin, and a low number of companies.

A deeper investigation was carried out to understand the DBS of each cluster. This was done by calculating the mean value of the 12 selected features for each cluster. This analysis demonstrated that there were four distinct approaches to DBS and two clusters with very limited digital efforts. Table 7.7 provides a summary description for each digital strategy archetype based on the features' values and the characteristics of its companies. Figure 7.14 provides a visualization of the main four DBS archetypes. Each of the four DBS archetypes are discussed in the following paragraphs of this section.

The most distinct DBS comes from cluster 2, which occupies the top right section of the cluster map in Figure 7.12. The companies in cluster 2 are focused on digital products, demonstrate high transformation capabilities, and enjoy high competence across various digital technologies. Those companies are pioneering digital technologies and offering them as digital

products. Some examples are Microsoft, offering AI as a service; SAP, selling cloud computing services; and ABB, selling robotics. This cluster also follows the product-as-a-service business model. Therefore, this DBS is referred to as Tech Pioneers.

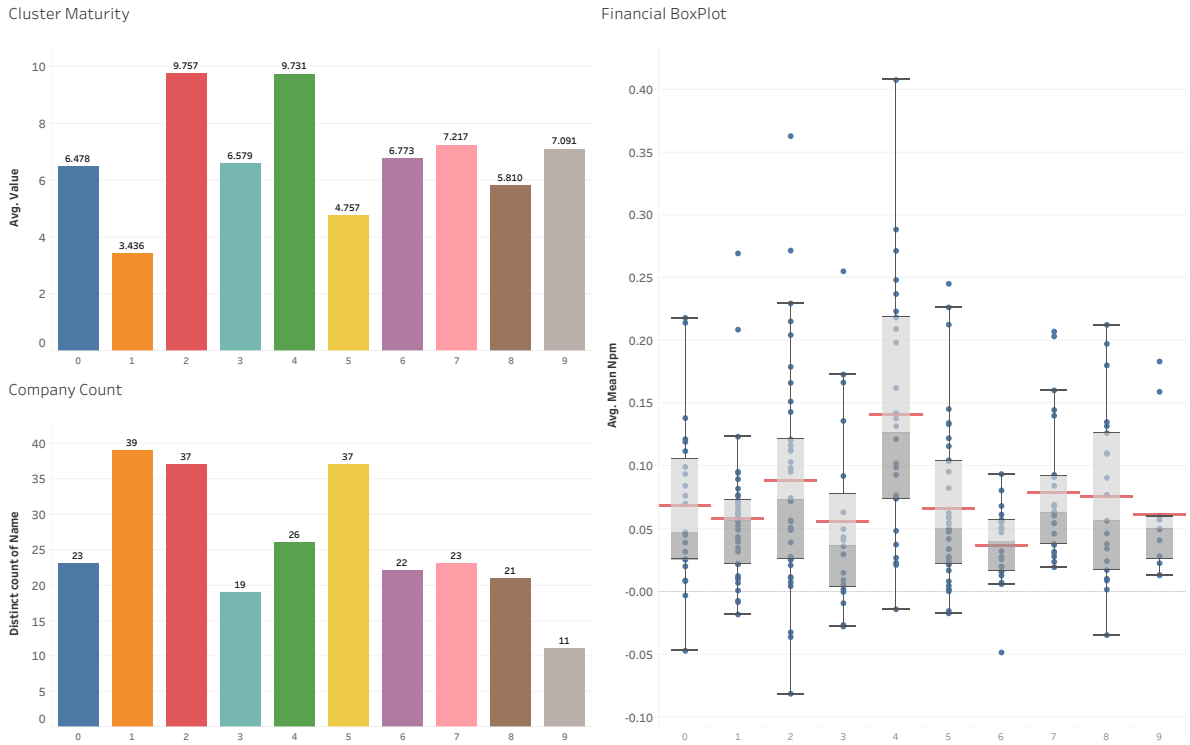

Figure 7.12: *Summary of cluster features' values*

Another distinct DBS is demonstrated by cluster 4. This cluster has the highest digital customer experience maturity and a very high digital product maturity. Their focus on digital technologies shows explicit focus on analytics and mobile. Compared to clusters 2, cluster 4 is placing a higher focus on the customer experience and prioritizing strategy choices accordingly. Some examples in this cluster are Facebook, aiming to redefine the social experience on mobile and through virtual reality; Amazon.com, redefining the retail experience with Amazon Alexa; and Medtronic, pioneering digital healthcare products. Therefore, the DBS of cluster 4 is referred to as Digital Experience.

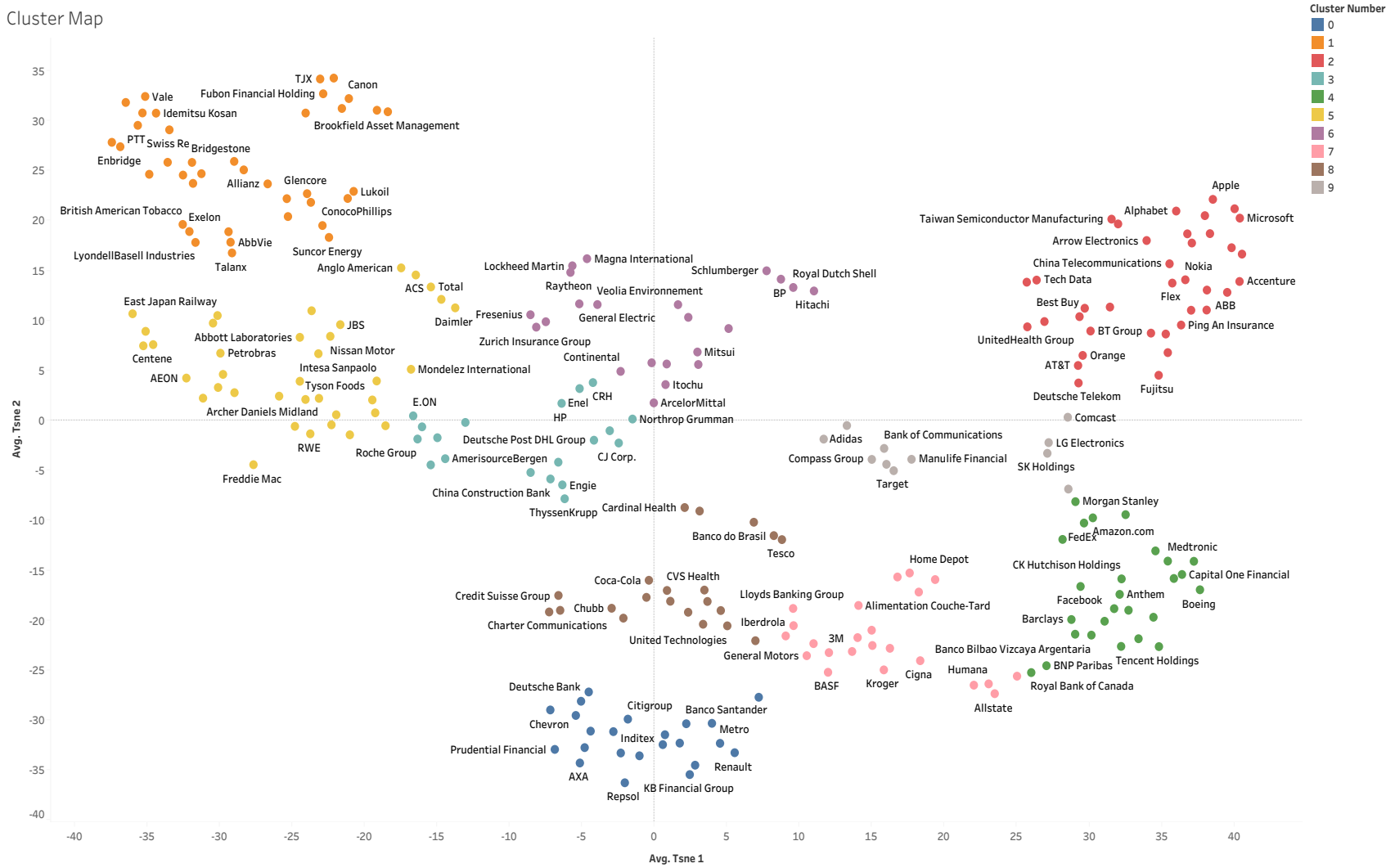

Figure 7.13: *Cluster map of the digital strategy of 295 companies from the Global 500. Color coding of datapoints represents the cluster that a company belongs to as outlined by the figure legend*

Table 7.7: *Digital business strategy archetype descriptions*

DBS archetype	Clusters	Description
Brick & Mobile	0, 7, 8, 9	Mobile and customer experience focused strategy to convert services to digital channels
Laggards	1	Limited digital efforts across the board
Tech Pioneers	2	Pioneers of various digital solutions with dominant focus on technology
Industry 4.0	3, 6	Industrial and manufacturing companies that are focused on digitizing and automating the supply chain
Digital Experience	4	Digital native companies that are redefining customer experience in the digital economy
Explorers	5	Early and balanced experimentation of digital capabilities

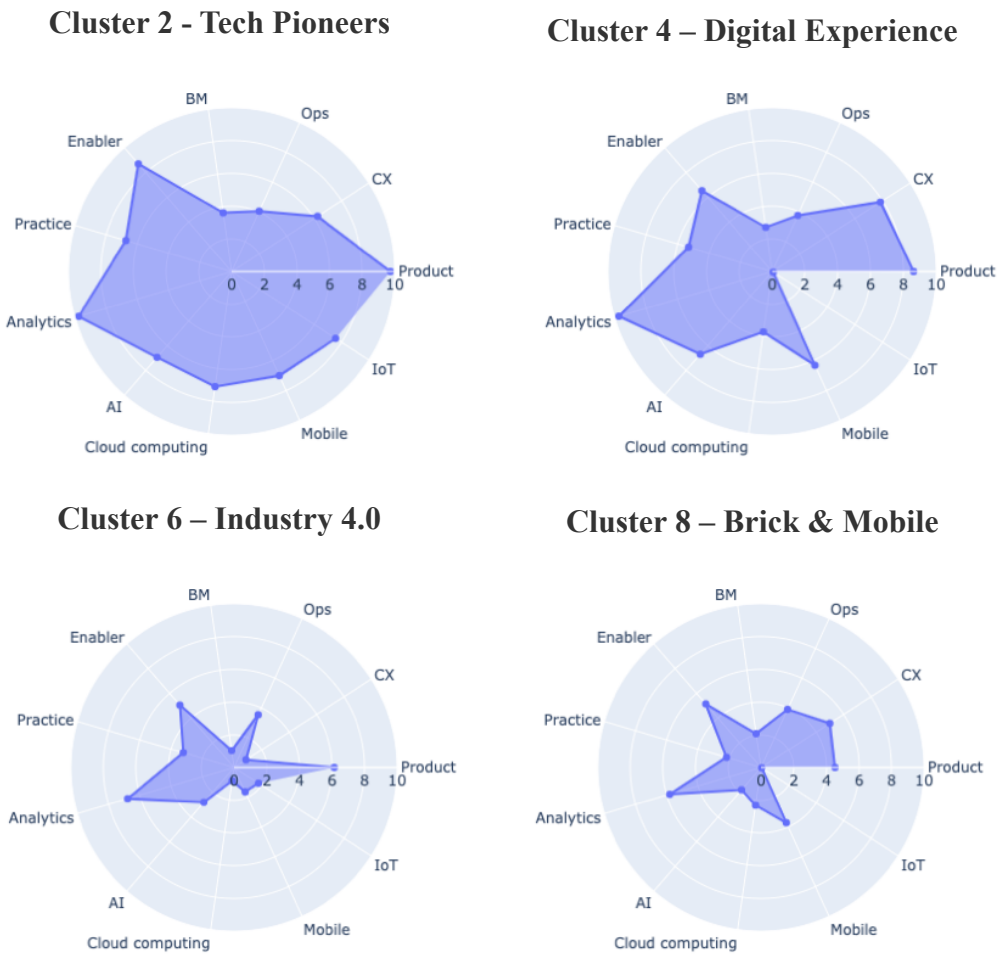

Figure 7.14: *Radar chart presenting the features values of the Four main DBS archetypes*

Clusters 3 and 6 share a similar approach to DBS. Companies in both clusters are predominantly related to industrials and manufacturing. They have an above-average digital

maturity score and split their focus between operations and product. Moreover, technology choice is focused mostly on analytics to drive efficiency. A moderate focus on AI and IoT is also evident to support the digital product experience. Some examples in this sector are General Electric, focusing on the industrial internet; and Thyssenkrupp, focusing on Industry 4.0 strategy. Therefore, the DBS of clusters 3 and 6 is referred to as Industry 4.0.

Cluster 0 shares a popular strategy with clusters 7, 8, and 9. Companies in these clusters are of average maturity with a relatively balanced focus on all digital capabilities. In terms of technology, they have above-average focus on mobile and analytics to go along with their customer experience. Most companies in these clusters are brick-and-mortar companies that aim to transform their value proposition toward digital channels. Examples in this sector are Barclays bank, striving for mobile banking; and Walmart, expanding their e-commerce presence. Therefore, this DBS is referred to as Brick & Mobile.

Clusters 1 and 5 have significantly less digital effort. This can be extrapolated from the cluster map where they are at opposite ends to clusters 2 and 4. Cluster 5 has a modest and balanced effort across all digital capabilities. However, the data are not sufficient to judge whether they are lagging behind or if they are focused on continuously piloting new ideas. Nonetheless, the maturity of all capabilities is low, demonstrating limited tangible progress beyond experimentation. Cluster 1 has the lowest effort across all parameters.

7.6 Discussion

7.6.1 Discussion of Findings

The results in this chapter have explored the DT activities of the Global 500 companies. Earnings calls make up a rich dataset that attracts both industry and academic research (Lewis and Young, 2019). These data are mostly used for finance and investment research, such as predicting stock prices (Keith and Stent, 2019), but this research also demonstrates that they are a useful source of information on companies' digital activities. Previous DT-related NLP research used annual reports (Pramanik *et al.*, 2019) and company descriptions from Crunchbase.com (Riasanow *et al.*, 2020). Although these NLP-based studies revealed insights into companies' digital strategies, they were exploratory in nature with limited quantitative evaluation of digital strategy components.

It was evident from the results that companies tend to focus on digital capabilities that are critical to their core business; retailers focus on the customer experience while manufacturers focus on operations. But DT also provides companies with the flexibility to go beyond traditional industry boundaries. For instance, although Apple and Amazon.com are both technology companies, they have distinct DBSs: Apple pioneers digital products, whereas Amazon.com strives for a seamless experience. This is in line with the findings of Sebastian *et al.* (2017).

The core business of a company was also found to drive specific digital technology focus. For instance, banks have a clear focus on mobile and analytics to drive mobile banking and credit scoring. An analysis of annual reports from large North American banks showed similar findings (Pramanik *et al.*, 2019). Moreover, a clustering analysis of companies' descriptions showed similar clusters, such as technology products, industrial solutions, and digital banking (Riasanow *et al.*, 2020). Another interesting phenomenon that was observed is the movement of companies toward a more mature cluster. For instance, the DBS of companies like ABB and Siemens is more comparable to that of technology companies than to that of other manufacturing companies. Therefore, they can be referred to as digital migrants.

Dependency between DT capabilities is a less well studied area. The most prevalent correlation is between digital and transformation capabilities. Existing literature shows that organizational readiness—in terms of resources, strategy, and IT, among other factors—has a positive effect on digital innovation diffusion (Lokuge *et al.*, 2019). Moreover, the success of DBS is also mediated by organizational agility (Murawski *et al.*, 2018). While those are plausible findings that strengthen the present results, it is also possible to have a bidirectional relationship; for example, higher digital capabilities can improve organizational agility and other transformation capabilities, leading to a virtuous cycle. Therefore, both capabilities should have parallel focus.

Digital products and digital customer experience are also significantly correlated. This implies the importance of customer experience mastery for customer-facing digital products. While this finding sounds reasonable in hindsight, the correlation between digital operations and digital business models was less obvious. Research shows that digital business model innovation toward servitization for manufacturing has several implications on operations (Paiola and Gebauer, 2020). For instance, offering equipment as a service requires a strong

digital operations backbone to execute such a business model. This concept is also referred to as digital servitization (Coreynen *et al.*, 2020). The importance of the operational backbone for seamless execution of digital business models was also argued by Sebastian *et al.* (2017).

The existing literature portrays DBS formulation as a set of exclusive options between product, service, and platform (Bharadwaj *et al.*, 2013; Sia *et al.*, 2016; Sebastian *et al.*, 2017). Others have also considered the importance of operational efficiency (Westerman *et al.*, 2014; Tekic and Koroteev, 2019). However, the implementation of DBS was demonstrated here to be more fluid than argued in the literature; for example, industrial companies turn to DT to improve their sustainability goals, operational safety, agility, and efficiency (Ghobakhloo, 2020). The present analysis identified four distinct DBS archetypes: Tech Pioneers, Digital Experience, Brick & Mobile, and Industry 4.0. Each of these strategies included all the digital capabilities to varying degrees. Moreover, each strategy reflected variations in the choices of digital technologies. Furthermore, a common theme was that companies always focused more strongly on core business areas and value proposition.

Returning to the research question of this chapter (RQ-3), there are four distinct digital strategy archetypes that companies implement: product led, customer experience led, service led, and efficiency led. All strategies are guided by a focus on a specific digital capability, but not exclusively. This is because of the dependencies between the capabilities that enable the successful deployment of the strategy. The choice of digital strategy archetypes also mostly reflected the core business and the industry that companies operate in. However, there were a few exceptions, such as digital migrants. This understanding of digital strategy archetypes can provide guidance in formulating the deliberate digital strategy by selecting the archetype that is closer to the core business and taking into consideration the interdependencies of the capabilities.

7.6.2 Cross-chapter Discussion

The findings from this chapter allow for a cross-sectional synthesis with previous chapters to strengthen the validity of the overall research findings. This is done reciprocally to include the comparison of digital and transformation capabilities as well as complementing the agile DT roadmapping framework.

A clear theme emerged from chapters 4 and 6 on the dependencies across digital and transformation capabilities. In both chapters, data analytics was identified as a core foundational technology that enabled various digital capabilities. The correlation matrix in Figure 7.8 shows that analytics is highly correlated with digital capabilities. This reinforces the notion that analytics is a foundation technology for DT. Moreover, it was identified that incorporating agility can play a critical role in accelerating the realization of the digital strategy. This was demonstrated by the highly positive correlation between DT practices and digital capabilities. Therefore, this indicates that incorporating agility is critical for enhancing the maturity of digital capabilities.

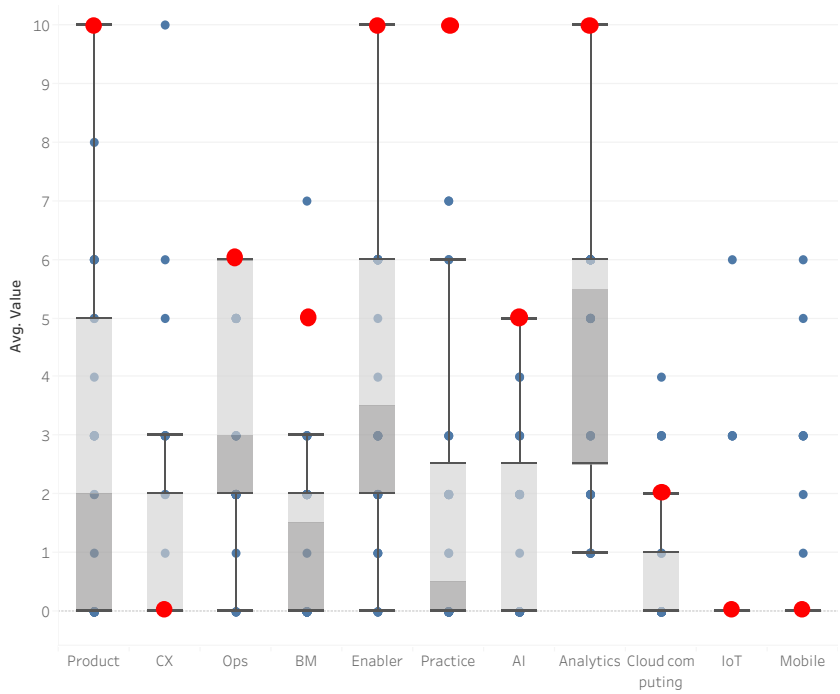

Figure 7.15: *Box plot of the maturity range of DBS in the energy sector; red dots represent Company 2 maturity*

The digital strategy formulation framework developed in chapter 6 can guide the selection of a suitable digital strategy. This can be done by identifying the relevant trends and drivers to be matched with a digital strategy that can offer a sufficient strategic response.

It is also possible to conceptualize the value of the followed methodology to enhance the formulation of the digital strategy. As shown in chapter 4, identifying trends and drivers is critical to formulating an appropriate strategic response. The DBS analysis method demonstrated in this chapter can be used to provide an overview of the competitive landscape in terms of DBS. This can be done at the cluster or sector level. For instance, Figure 7.15 shows

the range of the DBS maturity in the energy sector, which can be used as a benchmark for pilot study Company 2 as it happens to be in the sample. The figure shows that the company has strong digital product and operations but is significantly behind in terms of customer experience. Moreover, IoT and mobile technologies are critical for the energy sector but not leveraged by Company 2. Such information can be used as an input into the agile DT roadmapping workshop so that relevant stakeholders can evaluate its significance.

7.6.3 Practical Implications

The findings in this chapter have several practical implications. First, the identified DBS archetypes can be used by managers and decision makers as a baseline for DBS formulation. Those strategies would then require experimentation and calibration to fit the strategic priorities of their companies. Second, dependencies across digital and transformation capabilities were identified to enable the execution of the desired business and operating models. Third, the analytical model designed in this chapter can be used for continuously assessing or benchmarking the progress of the digital journey against that of its industry peers. Such a benchmark can shed light on ways to further enhance DBS implementation.

7.6.4 Theoretical Implications

The theory on DBS focused on the evolution of the emergent strategy. However, a deliberate strategy is required as a baseline. This chapter elaborated DBS archetypes that can be considered deliberate. Moreover, the correlation between digital and transformation capabilities demonstrated the importance of dynamic capabilities in supporting the realization of the emergent DBS. This means that digital maturity can be mediated by the dynamic capabilities of an organization.

7.6.5 Limitations and Further Research

Time and effort constraints placed some limitations on the study. First, deep learning models are data hungry and would have benefited from further data collection to enhance the accuracy of the model and increase the sample size. To reduce the data labelling effort, active learning can be used where labeled examples are provided to the model for documents with low prediction confidence. Second, supplementing earnings calls with other data sources, such as social media, news, and patent data, would have provided deeper insights into companies' digital activities. Third, 17 topics were used, but these could be broken down to enable a fine-grained investigation of the digital strategy. Nevertheless, this research is the first to use state-

of-the-art NLP models to investigate the digital strategy, and its contribution to the field provides a foundational step for future research.

7.7 Chapter Summary

This chapter investigated the DBS archetypes of the Global 500 companies. Data were collected from publicly available information including financial results and earnings call transcripts. Machine learning and statistical analysis were employed to extract insights from the data. The results revealed four distinct DBS archetypes that transcended multiple sectors. The discussion evaluated how the results can complement the digital strategy formulation.

8. CONCLUSION

8.1 Reseach Recap

The research presented in this thesis investigates the digital strategy formulation in terms of content and context. The motivation for this stems from the limited success of organizations in leveraging DT to improve business performance. Investigating the literature highlighted the lack of applied understanding of digital strategy formulation. This was reflected in the research aim:

To develop tools and insights that enhance the understanding and practice of digital strategy formulation within companies.

The actions taken to achieve the aim of this research are outlined by the research objectives:

- **RO-1:** Identify key process activities and outcomes required for formulating a digital strategy

- **RO-2:** Develop an applied framework to aid the iterative formulation and validation of digital strategy

- **RO-3:** Identify main digital strategy archetypes that may guide the formulation process

The research aim and objectives were designed to answer the overarching research question:

How may digital strategy be effectively formulated and validated?

To operationalize the investigation of the main research question, it was broken down into the following sub-questions:

- **RQ-1:** What are key process activities and outcomes required for formulating a digital strategy?

- **RQ-2:** How may digital strategy benefit from being iteratively formulated and validated?

- **RQ-3:** What are the main digital strategy archetypes that may guide the formulation process?

Research question 1 is addressed by the exploratory case study in chapter 4. The results identified the key activities and outcomes of the digital strategy formulation process. The activities were to *discover* the trends and drivers for DT, *define* the digital vision and scope, *design* the future digital enterprise, and *consolidate* the content into a DT roadmap. The outcomes of the process were the identification of trends and drivers, the design of a digital vision, and the formulation of a DBS and a DTS. Moreover, roadmaps were identified to act as integrators of DT strategic planning outcomes.

Research question 2 is addressed in chapters 5 and 6. In chapter 5, a conceptual framework was designed that incorporates the agile roadmapping concept to aid the iterative formulation and validation of the digital strategy. In chapter 6, the framework was tested and calibrated iteratively in a series of three pilot studies. This allowed the collection of data on the utility of agile roadmapping. The results demonstrated three tangible benefits. First, following an iterative process allows for rapid experimentation with hypotheses to continuously validate the strategy by taking an evidence-based approach. Second, a minimum viable digital strategy can reduce the planning overheads and distribute the effort of planning to work in parallel with implementation. Finally, taking such an approach allows for expanding the organizational understanding of the relevant trends and drivers to formulate an adequate strategic response. Such an approach can consequently accelerate the realization of the emergent digital strategy.

Research question 3 is addressed through multiple chapters but was the sole focus of chapter 7. The study investigated digital strategy of 295 of Fortune's Global 500 companies. The results identified four distinct digital strategy archetypes: product led, experience led, service led, and efficiency led. Moreover, the dependencies between digital and transformation capabilities was identified. These findings can guide the formulation process by choosing a deliberate digital strategy that forms an adequate strategic response to the trends and drivers.

8.2 Contribution to Knowledge

This PhD research contributes to the body of knowledge on DT on multiple fronts, practically, theoretically, and methodologically. Each contribution is outlined in this section.

8.2.1 Contribution to Practice

There are three practical contributions delivered by this research. First, a framework for agile DT roadmapping was developed. This framework can be used by practitioners as a reference to pragmatically formulate the digital strategy and validate its adequacy as a strategic response. Moreover, the framework significantly reduces the time needed between planning and execution by working on both in parallel based on a minimum viable digital strategy. The customization of the design sprints process and the proposed tools for digital strategy provide new additions to roadmapping practice and practitioners.

The second contribution to practice is the identification of four digital strategy archetypes. The identified archetypes provide practitioners with a deliberate strategy that can be used as a baseline for digital strategy formulation. The calibration and validation of the identified strategies can be done by leveraging the proposed agile DT roadmapping framework. Moreover, the uncovered dependencies across DT capabilities highlight areas of consideration to aid successful implementation of the digital strategy.

The third contribution to practice is the measurement of the digital strategy maturity across 17 topics. This can be used by practitioners in two ways. First, companies can leverage such an approach to expand their understanding of the competitive landscape. Second, the same approach can be used for benchmarking the progress and maturity of a company's DT journey against its peers. This can yield a comparison by which to identify the strengths and areas of improvement in DT.

8.2.2 Contribution to Theory

This research has expanded the understanding of dynamic capabilities (Teece *et al.*, 1997) and the emergent strategy theory (Mintzberg and Waters, 1985) from the DT perspective. Dynamic capabilities in the context of DT require digital sensing, digital seizing, and digital transforming (Warner and Wäger, 2019). However, the literature remained unclear on how dynamic capabilities unfold in the DT of organizations (Vial, 2019). It was identified in Chapter 4 that digital sensing requires an explicit focus on DT trends and drivers. Digital seizing, therefore, requires the formulation of an adequate strategic response to capitalize on the identified trends and drivers. The proposed framework provides a feedback loop by following the chain of evidence between strategizing and testing to guide the dynamic

capabilities. This minimum viable digital strategy approach complements the iterative nature of dynamic capabilities in sensing, seizing, and transforming DT opportunities.

Digital transformation strategy was previously found to be predominantly emergent as a result of uncertainty (Chanias and Hess, 2016). Moreover, strategizing activities are the source of uncovering the emergent strategy (Chanias *et al.*, 2019). However, strategizing activities are unstructured and conducted on an as needed basis. The findings of the present research demonstrated that incorporating agility into digital strategy formulation can accelerate the realization of the emergent strategy. This is done by using the intended digital strategy as a hypothesis to be validated. The episodic testing of the intended strategy provides earlier opportunities for the emergent strategy to start emerging and replace the unrealized components of the intended strategy. This continuous and episodic iteration between strategizing and testing can form a growing link between the emergent and realized digital strategy as presented in section 6.9.2.

8.2.3 Methodological Contribution

Text mining and data science, more broadly, are increasing in popularity as a research method for technology and innovation management research. To the best of the researcher's knowledge, this is the first study that makes use of state-of-the-art NLP techniques to investigate the digital strategy. A novel methodology has been developed to measure the digital activities of companies by analyzing earnings call transcripts. The use of deep learning and pre-trained language models allowed the topic and maturity to be identified based on the contextual meaning of a sentence rather than the appearance of certain keywords. This method enables technology and innovation management researchers to broaden their research approach and leverage publicly available data to uncover new insights on DT.

8.3 Limitations and Further Research

This research had several limitations that should be addressed in future studies. The first limitation was investigating the digital strategy formulation process using a single case study, although this was done intentionally to investigate the topic in depth. Given that the key components of the digital strategy formulation have been identified, future studies can survey a wide range of companies to identify the various approaches adopted for digital strategy

formulation. Moreover, selecting a sample with different digital maturity levels can provide further insights into strategic options and constraints.

Second, the proposed framework is preliminary and can benefit from additional testing, calibration, and validation. While the utility of the framework was demonstrated, it can be standardized further. Moreover, carrying out longitudinal action research can provide deeper insights into the causal relationship between incorporating agility and DT success.

Third, it was only possible to find earnings call transcripts for 304 out of the 500 companies. Going beyond this to analyze a larger sample of companies would strengthen the validity of the results. Moreover, increasing the size of the training dataset can also improve the accuracy of the machine learning models. Furthermore, increasing the variety of data sources to include news, patent data, social media data, and annual reports would result in an expanded understanding of companies' digital activities.

Fourth, digital transformation is an emergent body of knowledge. Successful digital transformation requires further investigation. Specifically, the causal relationship between digital activities and improvement in business performance. Such findings can be instrumental to improving the success rate of DT and can enhance the return on investment.

8.4 Concluding Remarks

This thesis was designed to address one of the main challenges that faces organizational innovation, which is that no plan survives the first contact with reality. This challenge is a function of the inherent uncertainty in innovation and is more prevalent in the DT context due to its emerging nature. Therefore, continuous adaptation is the most reliable way known for innovation success. Adaptation requires learning from others as well as learning by doing. The contribution of this research addressed both approaches to learning. Learning from the DT of others was done by leveraging deep learning to uncover the digital strategy archetypes of companies, whereas the agile DT roadmapping framework focused on learning by doing. Notwithstanding some limitations, the results of this research enhance the understanding and practice of digital strategy formulation. An inspiring future state of this research would be to develop AI systems that are capable of augmenting technology and innovation professionals' productivity and co-creating business success. In the end, as the statistician George Box once

said, “All models are wrong but some of them are useful.” It is hoped that the models developed in this research can be among the useful ones and have a positive impact on humanity.

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APPENDICES

Appendix A1: Digital Transformation Definitions Analysis

The table shows the analysis of 20 DT definitions and its categorization by scope, means, and outcomes. This analysis led to the DT definition used in this research.

Definition of DT	Source reference	Scope	Means	Outcomes
The use of technology to radically improve the performance or reach of enterprises.	Westerman *et al.* (2011), Westerman *et al.* (2014), Karagiannaki *et al.* (2017)	Enterprise-wide	Digital technologies	Performance improvement
The use of new digital technologies (social media, mobile, analytics or embedded devices) to enable major business improvements (such as enhancing customer experience, streamlining operations or creating new business models).	Fitzgerald *et al*. (2014), Liere-Netheler *et al*. (2018)	CX[6] Ops BM	Digital technologies Social Mobile Analytics Embedded devices	Business improvement
DT involves leveraging digital technologies to enable major business improvements, such as enhancing customer experience or creating new business models.	Piccinini *et al*. (2015b)	CX BM	Digital technologies	Not Specified
Use of digital technologies to radically improve the company's performance.	Bekkhus (2016)	Digital technologies	Digital technologies	Performance improvement
DT encompasses both process digitization with a focus on efficiency, and digital innovation with a focus on enhancing existing physical products with digital capabilities.	Berghaus and Back (2016)	Process Product	Digital technologies	Efficiency Innovation

[6] CX: Customer Experience, BM: Business Model, Ops: Operational Processes

Definition of DT	Source reference	Scope	Means	Outcomes
The profound and accelerating transformation of business activities, processes, competencies, and models to fully leverage the changes and opportunities brought by digital technologies and their impact across society in a strategic and prioritized way.	Demirkan *et al*. (2016)	Process Ops Competencies	Digital technologies	Not Specified
DT encompasses the digitization of sales and communication channels, which provide novel ways to interact and engage with customers, and the digitization of a firm's offerings (products and services), which replace or augment physical offerings. DT also describes the triggering of tactical or strategic business moves by data-driven insights and the launch of digital business models that allow new ways to capture value.	Haffke *et al*. (2016)	Sales CX Products Services	Digital technologies	New value
DT is concerned with the changes digital technologies can bring about in a company's business model, which result in changed products or organizational structures or in the automation of processes. These changes can be observed in the rising demand for Internet-based media, which has led to changes of entire business models (for example in the music industry).	Hess *et al*. (2016)	BM Products Structure Process	Internet	Not Specified
Use of new digital technologies, such as social media, mobile, analytics or embedded devices, in order to enable major business improvements like enhancing customer experience, streamlining operations or creating new business models.	Horlacher *et al*. (2016), Singh and Hess (2017)	CX Ops BM	Digital technologies	Business improvement

Definition of DT	Source reference	Scope	Means	Outcomes
Changes and transformations that are driven and built on a foundation of digital technologies. Within an enterprise, DT is defined as an organizational shift to big data, analytics, cloud, mobile and social media platforms. Whereas organizations are constantly transforming and evolving in response to changing business landscape, DT are the changes built on the foundation of digital technologies, ushering unique changes in business operations, business processes and value creation.	Nwankpa and Roumani (2016)	Ops Process BM	Digital technologies Big data Analytics Cloud Mobile Social media platforms	Performance improvement
Extended use of advanced IT, such as analytics, mobile computing, social media, or smart embedded devices, and the improved use of traditional technologies, such as enterprise resource planning, to enable major business improvements.	Chanias (2017)	Enterprise-wide	Digital technologies	Business improvement
The changes digital technologies can bring about in a company's business model, which result in changed products or organizational structures or automation of processes.	Clohessy *et al*. (2017)	BM Products Structure Process	Digital technologies	Not Specified
Adopting business processes and practices to help the organization compete effectively in an increasingly digital world.	Kane (2017), Kane *et al*. (2017)	Business processes	Not Specified	Competitiveness
An evolutionary process that leverages digital capabilities and technologies to enable business models, operational processes and customer experiences to create value.	Morakanyane *et al*. (2017)	CX Ops BM	Digital technologies	Value creation

Definition of DT	Source reference	Scope	Means	Outcomes
Fundamental alterations in existing and the creation of new business models [...] in response to the diffusion of digital technologies such as cloud computing, mobile Internet, social media, and big data.	Remane *et al*. (2017)	BM	Digital technologies Cloud computing Mobile internet Social media Big data	Value creation
The use of new digital technologies that enables major business improvements and influences all aspects of customers' lives.	Reis *et al.* (2018)	CX	Digital technologies	Business improvement
Changes in ways of working, roles, and business offerings caused by adoption of digital technologies in an organization, or in the operational environment of the organization.	Parviainen *et al.* (2017)	Structure BM Ops	Digital technologies	None
Achieved when the digital usages which have been developed enable innovation and creativity and stimulate significant change within the professional or knowledge domain.	Martin (2008)	Not Specified	Digital technologies	Innovation Change
The process of organizational or societal changes driven by innovations and developments of ICT. DT includes the ability to adopt technologies rapidly and affects social as well as technical elements of business models, processes, products, and the organizational structure.	Bockshecker *et al.* (2018)	Innovation BM Process Products Structure	ICT	Not Specified
A process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies.	Vial (2019)	Enterprise-wide	Digital technologies Information Computing Communication Connectivity	Improvement

Appendix B1: Exploratory Case Study Interview Questions

- Can you tell me about your role within the digital transformation initiative?
- How did the digital transformation initiative start?
- What is the vision for this program and the group?
- Can you tell me how the team planned for digital transformation? The planning activities.
- What were the outcomes of the planning process?
- What are the phases of the whole program? Can you take me through them?
- What happens during each MVP?
- What will happen between MVPs, “Inspect & Adapt”?
- When do you move from experimentation/prototyping to decision making and implementation?
- How would you move the business from legacy to digital, the transition?
- How do you ensure that what you develop now will be relevant once you launch in 2020?
- What challenges have you faced so far, or do you expect to face in the future?
- Knowing what you know now, how would you have done things differently, if you would change anything?
- Are there any relevant comments you would like to share?

Appendix B2: PESTLE Analysis Sample

Trends (Technology 1/2)

What is the trend?	Examples (Stats / Actors)	Impact on Digital Strategy
1. Big Data – Analytics Analytics enabled by Big Data have become must have for modern companies These capabilities enable dynamic pricing, which will be a major component of how airlines will improve their in-flight shopping experience	• Laser spectrum analysis	
2. Internet of Things (IoT) IoT will have experienced rapid growth by 20.8 — 2030bn connected devices by 2020 and 1 trillion connected sensors by 2030 Impact on IoT on global economy projected to be $ 6.2 trillion by 2025 IoT will disrupt traditional supply chain models, allowing automated control of external environment and automated decision-making	• Tag-free luggage • Optical identity of bags • Ticket free travel	• How to reduce cost by tracking assets in real-time?
3. Blockchain The airlines rely on multiple actors and touchpoints. From booking to arrival, players include online travel platforms, government agencies, airlines, card providers, airports and more. Each actor collects, stores and often shares operational information. Complex data reconciliation takes place behind the scenes at every touchpoint of every traveler's trip. Blockchain technology can enhance reconciliation and data sharing	• Bitcoin, Fintec, Loyyal • Fast-track existing processes: e.g. Check-in free • There will be no need to pass through any gate and see people	
4. Artificial Intelligence (AI) Being focused on predictive capability, Artificial Intelligence can help airlines organizations better understand and plan for the future, e.g. provide a service to match consumer demand	• Assisted self service: lemonade learns driving patterns and bases insurance on this • Cognitive - ML, algorithms, neural network Robotics - Automation mechanism • Speech and voice recognition, haptics, eye tracking interfaces, gesture recognition, wearables • Situational Awareness - Decision science + Augmented humanity	• How to improve AI capabilities while maintaining the "human touch"?
5. APIs APIs could enable airlines to take back control of their distribution. Airlines reliance on GDS to decrease as airlines will seek platforms to actively and nimbly retail their products with the same control, flexibility and detail as any other online retailer	• Ebay's increase in revenue by releasing APIs Expedia gets 90% of revenue from APIs • 3rd party retailers to decrease: by 45%, 2021 of bookings from digital direct channels. Mobile is expected to surge, from 1.7% in 2016 to more than 7% by 2021	
6. Seamless Payment experience Airlines will put greater focus on payment (e.g. locally, frictionless payments) as new payment methods grows in some market (e.g. mobile money or installment payment) and new payment providers emerge	• M-Pesa • Alipay • PayPal	• How do we serve customers who don't have traditional bank accounts?
7. Post Mobile World By 2021 mobile will no longer be "a" channel, it will be "the" channel passengers, travel agents and others use to connect with airlines		• What will be the preferred way of communication on mobile? Voice, text or digital?
8. Full Retailing Platforms PSS to become Full Retailing Platforms incorporating artificial intelligence applications, inventory module, scheduling, dynamic pricing + End of "fare buckets"		• Could ICE becomes the platform/bridge to the "other side" (partnerships)?

Appendix C1: Workshop Scoping Template

DIGITAL DESIGN SPRINT

Sprint Brief Outline

- Background materials, market research, trends and drivers
- Sponsor's vision, goals, and expectations
- Sprint challenge statement
- Deliverables

BACKGROUND:

- ……..……
- ……..……
- ……..……
- ……..……

What are the main trends and drivers shaping your industry?
Here are few points to consider:

- *Summarize existing market research and potential opportunities*
- *Identify changes in customer needs*
- *How can digital technologies influence your industry value chain?*

Example: The petroleum analytics market is growing by 30% YoY. Offering Software as a Service can capture this segment.

SPONSOR GOALS:

……..……

What are the sponsor's expectations from the sprint and the digital transformation of the company?
Here are 4 questions that can guide the conversation:

- *What are our current strengths?*
- *What is our vision/aims for the future?*
- *How can digital transformation help us get there?*
- *What is a good outcome of the 2-day digital design sprint?*

SPRINT CHALLENGE:

Design X's digital transformation strategy, focusing on ____, with year XXXX as a milestone? ……..……

What is the challenge that you want to solve in the sprint?
Here are 4 things that make a great challenge:
- The challenge is something real that the team needs to deliver
- It's stated in a way that sounds inspiring – something to solve for
- It's clear and concise

- It includes a time frame (next quarter? 3 years from now?)

Example: Redesign the future of self-driving cars as a service, focusing on two future milestones: 2014 and 2016.

DELIVERABLES:

……..…….

What do you want the team to create during the sprint? Example: user journey flows for X and Y. Vision video… Website prototype… Strategy Roadmap.

- List all the business functions that should be included in the roadmap

- Aim for the highest quality deliverables possible. Digital polished work, videos, interactive prototypes… win over sketches.

- List all platforms that we need to design for (web, mobile, tablet) / (physical product + website) / (environment)

Stakeholders:

High Influence & Low Interest	*High Influence & High Interest*
Low Influence & Low Interest	*Low Influence & High Interest*

LOGISTICS:

Who: ……

When: ……

Where: ……

Sprint Master: ……

APPROVERS & RESOURCES:

Stakeholders: ……

Who needs to sign off on the project so it can launch? We want to include this person's view in the sprint so we can plan a path to launch that's fast and smooth.

WIP: Stakeholders

For short-term sprints: Assignment development team, if any: ……..……

It's recommended that you start a design sprint by having assigned development resources to carry the work after the sprint. This is easier in the case of short-term focused sprints.

For long-term / vision sprints: Plan to secure resources:*[7]

……..……

Vision sprints take a long-term view of planning. In order to succeed, your team needs to have a plan of approvals for how to integrate the sprint within the organizational roadmap.

PROJECT TIMELINE:

1. Current state of the digital transformation

What's been created already? What is in progress? If this is a new project with no history, just say so. If this is a 4-year project with lots of history, summarize.

2. Roadblocks

What stands in your way?

3. Early wins, if any.

Has our team already demonstrated any wins or learnings in digital?

4. Estimated launch plan

When is the projected launch for the piece we are designing? What is this likely to be at launch – a website, campaign, service, physical product, transformation programme… Make sure to list that in the challenge statement as well.

SPRINT SCHEDULE - 2 Days

To be confirmed

[7] Don't have to be considered at this stage.

Appendix C2: Workshop Feedback Survey

This survey was given to participants at the end of the workshop to collect feedback.

1	How clear were objectives of this workshop?				
	1 – Very Poor	2 – Poor	3 – Acceptable	4 – Good	5 – Very Good
2	How well did the workshop activities help in meeting the objectives?				
	1 – Very Poor	2 – Poor	3 – Acceptable	4 – Good	5 – Very Good
3	How useful are the workshop outcomes to planning your digital transformation?				
	1 – Very Poor	2 – Poor	3 – Acceptable	4 – Good	5 – Very Good
4	How confident are you with the effectiveness of the developed roadmap?				
	1 – Very Poor	2 – Poor	3 – Acceptable	4 – Good	5 – Very Good

Appendix C3: Workshop Follow-up Interview Questions

1. Can you share your experience of the workshop?

2. Have you had any progress with the digital transformation journey? Can you elaborate on that?

3. Did you present it to stakeholders? Did it meet expectations? Was it approved or modified? What is your impression of this?

4. Did you start working on the MVPs? What are the challenges you faced? What was easy?

5. How would you improve the roadmapping workshop for better MVP?

6. Are there things that were left out? What would you like to include?

7. Were there things that aren't useful? What would you like to change?

8. Have your vision and goals changed? Why? How?

9. Have your initiatives changed? Why? How?

10. How confident are you about your current plan?

11. Overall, how effective was the workshop for the digital journey? What would you do differently?

Appendix C4: Aggregated results of the three survey questions

No	Clarity of objectives	Ability of meeting objectives	Utility to roadmap	Confidence in roadmap
1	3	4	4	3
2	4	4	4	3
3	4	4	4	3
4	4	4	4	4
5	4	5	5	4
6	5	5	5	4
7	4	4	4	4
8	2	3	3	3
9	3	3	3	3
10	3	3	3	3
11	3	3	3	3
12	3	3	3	3
13	3	3	4	3
14	3	4	4	3
15	3	4	4	3
16	4	4	4	4
17	4	4	4	4
18	4	4	4	4
19	4	4	4	4
20	4	4	4	4
21	4	5	4	4
22	5	5	5	4
23	2	3	3	3
24	3	3	3	3
25	3	3	3	3
26	4	4	3	3
27	4	4	3	3
28	4	4	3	3
29	4	4	4	3
30	4	4	4	3
31	4	4	4	4
32	5	5	4	4
33	5	5	4	4
34	5	5	5	4
Mean	3.7	4.0	3.8	3.4

Appendix D1: List of relevant terms

Topic group	Topic	Keywords	Count
Digital capabilities	Digital product	smart product*, connected product*, software as a service, Saas, platform as a service, Paas, platform, product as a service	8
Digital capabilities	Digital customer experience	digital experience, customer experience, \bCX\b, user experience, \bUX\b, user journey, customer journey, digital engagement, customer engagement, personalization, personalisation, digital marketing, recommendation, market place, marketplace, e-commerce platform, digital service, digital services, e-service, online chat, chatbot, \bapp\b, digital channel, omnichannel	24
Digital capabilities	Digital operations	process automation, process mining, process analytics, process optimization, efficiency, cost saving, cost reduction, reduce cost, reducing cost, automation, predictive maintenance, ERP, supply chain, logistics, operations	15
Digital capabilities	Digital business model	business model, new market, new segment, monetization, Saas, software as a service, on-demand, product as a service, value proposition, freemium, subscription, marketplace, ad-revenue, ads, peer-to-peer, two-sided, double-sided	17
Transformation capabilities	Enablers	digital strategy, digital business strategy, digital transformation strategy, governance, prioritisation, prioritization, digital vision, digital leadership, leadership support, leadership buy-in, communication, digital goals, data scientist, data analyst, machine learning engineer, developer, coder, programmer, chief digital officer, CDO, head of digital transformation, head of digital, product manager, product owner, cross-functional, scrum master, agile coach, innovation manager, data lake, data warehouse, middle ware, enterprise architecture, digital tools, digital workplace, digital integration, chat, video call, CRM, ERP, service oriented architecture, \bSOA\b	40
Transformation capabilities	Practices	Agile, scrum, MVP, minimum viable product, sprint, design thinking, business experiment, DevOps, \bepic\b, feature, user story, product owner, product manager, collaboration, cross functional, cross-functional, A/B testing, exploratory data analysis, data analysis, decision support system, dashboard, hypothesis testing, experimental design, product metrics, user metrics, usage metrics, click through rate, conversion rate, click stream, digital marketing, customer segmentation, risk modelling, simulation, decision analytics, decision support system, project management, digital skills, digital leadership, transformation, data analysis, social media	62

Topic group	Topic	Keywords	Count
		management, social listening, user research, UX research, UX design, UI design, programming, coding, lean startup, experimentation, incubator, accelerator, innovation lab, digital lab, digital transformation, open innovation, design thinking, design sprint, digitalization, digitalisation, digitization, digital technolog[a-z]*	
Digital technology	AI	\bAI\b, artificial intelligence, NLP, natural language processing, natural language understanding, NLU, natural language generation, NLG, speech recognition, sentiment analysis, speech to text, text to speech, deep learning, machine learning, \bML\b, neural network, generative adversarial network, GANs, supervised learning, reinforcement learning, semi-supervised learning, active learning, self-supervised learning, transfer learning, back propagation, tensorflow, pytorch, Watson machine learning, AI as a service, azure ML, AutoML, autonomous vehicles, computer vision, image recognition, pattern recognition, cognitive computing, predictive analytics, predictive maintenance, algorithmic trading, clustering, dimensionality reduction, t-sne, \bPCA\b, principal component analysis, chatbot, \bbot\b, RPA, robotic process automation, matrix factorization, collaborative filtering, recommender system, recommendation engine, graph mining, graph theory, cortana, alexa, google assistant, virtual assistant, intelligent assistant	60
Digital technology	Cloud computing	cloud computing, cloud native, cloudless, distributed cloud, distributed computing, clustered computing, hybrid cloud, platform as a service, edge computing, cloud api, google cloud, azure cloud, AWS cloud, software as a service, cloud applications, GPU, HPC management, cloud storage, elasticity, elastic computing, the cloud, data platform	23
Digital technology	IoT	internet of things, \bIoT\b, industrial internet, \bIIoT\b, embedded device, embedded sensor, digital twin, digital thread, building information modelling, BIM, connected device, connected sensor, IoE, internet of everything, smart machines, connected machines, wearable, cyber physical systems, machine to machine, connected factory, model based definition	21
Digital technology	Virtual reality	\bVR\b, virtual reality, immersive technologies, mixed reality	4
Digital technology	Augmented reality	\bAR\b, augmented reality, immersive technologies, mixed reality	4

Topic group	Topic	Keywords	Count
Digital technology	Robotics	robots, humanoid, drone, drones, smart robots, smart warehouse, smart spaces, Lidar, computer vision, UAV, autonomous vehicles, swarm robots, industrial robot, robotics, automation	15
Digital technology	Analytics	analytics, business intelligence, optimization, data analysis, data science, descriptive statistics, predictive, inference, inferential, customer segmentation, correlation, data visualization, data storytelling, text analytics, data lake, data warehouse, big data, network mining, network analysis	26
Digital technology	Mobile	smart phone, mobile application, mobile platform, mobile technology, \bapp\b	7
Digital technology	Social	social media, social network, content marketing, networking	4
Digital technology	3D printing	3D print[a-z]*, additive manufacturing, 3D scan, material jetting, stereolithography, bioprint, bioprinted organ, fused deposition modeling, digital light processing, selective laser sintering, selective laser melting, laminated object manufacturing, digital beam melting	13
Digital technology	Blockchain	blockchain, distributed ledger, decentralized, smart contracts, cryptocurrency, \bICO\b, initial coin offering, asset tokenization	8