Quantifying the Value of Digital Innovation in a Manufacturing Company

Master's thesis in Product Development

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Abstract

The industrial landscape for *GKN Aerospace* has changed drastically and is anticipated to experience more disruptive changes in the future. To remain competitive, the current view of products needs to be re-innovated as well as finding new ways to compete in the forthcoming digital era. By taking an explorative approach, the conditions, in the context of digitalisation, for GKN Aerospace are studied and examined externally. Understanding the concept of value is imperative to grasp the full potential of digital innovation, this includes both the traditional monetary value and the intangible value such as company reputation, customer perception, brand, and employee satisfaction. This study thus explores the notion of value and digital maturity in the context of digital innovation.

The internal application and utilisation of advanced technologies are the most common employment of digital innovation and are driven by a desire to increase the competitiveness and business resilience of the company. This employment of digital innovation is mostly reactive in its nature, revolved around the economical benefits, and occurs in proximity to the current core business. This essentially implies that the current business is improved and the company does what is already being done, but better; the organisation can e.g. increase operational performance, efficiency, and reduce costs. The findings suggest that organisations should shift the approach to a proactive stance in order to develop fundamental digital capabilities to (i) identify and capitalise on opportunities to create, deliver and capture value, and (ii) identify and mitigate potential threats and exogenous changes that may disrupt the industry in the future. Such, the current product offerings and current way of working should continuously be re-innovated, as the effects of "doing nothing" will result in a declining state where the current core business becomes obsolete.

Keywords: Digitalisation, Digital transformation, Digital Innovation, Digital maturity, Value, Manufacturing, Business Innovation, Business resilience, Strategy, Servitisation

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Introduction

GKN Aerospace is a leading component manufacturer within the aerospace industry, and act as both tier 1 supplier and direct OEMs within the value chain. This position entails that the company is being distanced from the end customer, resulting in barriers to extend the employment of digitalisation to capture more value. Additionally, the aerospace domain is unique as it is a slow-moving industry with high entry barriers and high requirements due to flight safety. Such, the urgency for change has not been as prevalent as other more fast-moving industries where the product cycles and entry barriers are lower. While digital innovation has a strong connection and history in the company, there has been a resurgence of attention for digitalisation as the industry will need to be re-innovated to survive disruptive changes in the future. Thereby the need for an explorative study covering the value of digital innovation and the path forward has emerged.

To successfully capture the full potential of digital innovations, it is fundamental to understand the concept of value. It includes both the traditional monetary value and, the often overlooked, intangible values. This study thus explore the notion of value and digital maturity in the context of digital innovation; the quantification of value implies a broader perspective of value and is not limited to the traditional monetary numerals.

In the most recent history, the global economy experienced an upswing as a result of the diffusion of *information and communication* technologies (ICT); this period may be described as an information revolution where the society went through systematic *computerisation* (Perez, 2009). Combined with the development of more advanced digital innovations, an amalgamation of these technologies has the potential to cross the physical and digital paradigm (European Union, 2020). According to a study carried out for the European Commission the digitalisation of society is one of the greatest challenges of *our time* and has been regarded as a top priority for investments (European Union, 2020). The same study concludes that this digital transformation is still in its early stages, implying that investments are likely to increase in the future.

Digitalisation is within the manufacturing domain seen as *the fourth industrial revolution* (Bärring, Johansson, & Stahre, 2020), and are often referred to as *Industry 4.0* introduced by Professor Wolfgang Wahlster (RICAIP, 2020; Lydon, 2014). The wide establishment of digitalisation has led to dominant actors losing their competitiveness when being late to adopt the digital transformation. This phenomenon has not yet been noted within the manufacturing domain (Björkdahl, 2020). Though, the digital transformation of the manufacturing domain is perceived to be essential to remain competitive in the future and thus can not be ignored (Bärring et al., 2020; Björkdahl, 2020).

The term was first introduced by Robert Wachal back in 1971 to initiate a public dialogue concerning the social impacts and implication with the wide *computerisation* and "*digitalisation of society*" (Wachal, 1971; Brennen & Kreiss, 2010). Within the industry, the efforts of implementing digitalisation focuses on the extended utilisation and integration of digital technologies. Regarding this Björkdahl (2020) notes that "*digitalization involves the increased use of digital technologies and their integration and cross-fertilization in the firm's products and inbound and outbound activities*". He moreover defines digitalisation as:

> *...digitalization can be seen as increased generation, analysis, and use of data in order, on one hand, to increase the firm's internal efficiency, and on the other hand to grow the firm by adding value for customers (Björkdahl, 2020)*

This definition of digitalisation represent a clear description and can be found in varied forms throughout the literature. However, this perspective alone excludes much of the potential value of digitalisation which goes beyond the traditional economic benefits that are created and captured. To accommodate this, the definition proposed by Björkdahl (2020) is complemented with a *corporate culture aspect* which includes the intangible values of digitalisation. Volvo Group (2021) includes this aspect and notes: *"digitalisation means that digital technologies alter the way in which people and processes interact"*. Associated with this is the integration of data in every part of the organisation and ultimately becoming fully data-driven. As the afore-proposed definition of digitalisation suggests, data is a fundamental part of digital innovation.

In a broad view, digitalisation can be seen as a necessary bridge and a catalyst for a digital transformation in which the industry standards and current business models are fundamentally altered. This transition into the digital era of the industry will require companies to innovate and re-imagine their traditional products and services, where new value can be created and captured with the combination of physical and digital assets (Govindarajan & Immelt, 2019). *Digital maturity* describes the "*...organization's ability to create value through digital...*" and constitutes a key determinant for success when launching a digital transformation (*Digital Maturity*, 2021). Kane, Palmer, Phillips, Kiron, and Buckley (2017) studied the topic and defines digital maturity as:

> *Maturity goes far beyond simply implementing new technology by aligning the company's strategy, workforce, culture, technology, and structure to meet the digital expectations of customers, employees, and partners. Digital maturity is, therefore, a continuous and ongoing process of adaptation to a changing digital landscape (Kane et al., 2017).*

The diffusion of digitalisation within industries will introduce new opportunities to create and capture value, and enable companies *to compete in new ways* (Iansiti & Lakhani, 2014). This transformation can have a disruptive effect on the whole industry, and companies that are ill-prepared to adapt to the new norm may find themselves in a declining position. Understanding the purpose and value of digitalisation can enable companies to prepare for a wide digital transformation, and to quickly capitalize on emerging opportunities.

1.1 Background

The outbreak of COVID-19 and the initial stages of the pandemic resulted in a historically large contraction of the commercial aerospace sector (PricewaterhouseCoopers, 2020). Air travel nearly experienced a complete shutdown around the world which caused the majority of airlines to cancel orders. This had drastic economical effects on the sector that already lags other industries when it comes to creating value through digitalisation. Considering the current situation, digital transformation is a vital source for creating and capturing new value within the aerospace industry. Considering the effects of the outbreak, companies are recognising the fragility of the aerospace industry with regards to unpredictable disruptive changes within the market landscape. Thus the search for new revenue streams and business models are carried out to increase long term business resilience. Thereby has the COVID-19 outbreak speed up the digital development within the aerospace industry.

The way that manufacturing firms are doing business is shifting (Isaksson, C. Larsson, & Öhrwall Rönnbäck, 2009). Increased customer value, and a more stable cash flow management has become two of the main business argument for both customers and suppliers. This shift has caused manufacturers during the last decade to refine their offering towards *function* rather than *product*, which impacts the way products are developed and realised. These solutions that provide a function to meet customer needs are referred to as *Product-Service Systems* (PSS) and raise engaging opportunities for the manufacturing firms.

A company's capabilities to create and deliver innovative PSS solutions reveals vital challenges for the organisation, typically requiring a closer collaboration between customer and supplier. One challenge related to customer involvement in the co-creation of innovative PSS solutions is to identify a business model that the customer finds valuable and protects the company's interest and *intellectual property* (IP) (Wallin, Parida,

& Isaksson, 2015). Building on the manufacturer's expertise about both the product and technology the PSS offerings can reduce costs, increase revenue and provide an elevated status among customers as a problem-solver and solution-provider (Isaksson et al., 2009).

An identified challenge is to quantify the potential value that these digital innovations may have for the organisation, and how this can be realised. Considering that the manufacturing company mainly develops and produces physical products, their organisation is not adapted to handle digital innovations. In addition, there exists a knowledge vacancy for how they should approach this transformation of incorporating digital innovations in their organisation and services in their offering.

1.1.1 GKN Aerospace

The study is conducted for the unit *Analytics and Digital Innovation* at the *Department of Strategy and Business Innovation* in the company *GKN Aerospace*, which today is a leading component manufacturer in the aerospace industry. Their technology goal is to deliver the best technology today and develop the innovative technologies of tomorrow (*GKN Aerospace Technology | GKN Aerospace*, 2021). The study thus supports their investigation of future prospects of delivering system-based solutions that can incorporate both physical and digital elements. That is, how the creation and offering of digital services, exploitation of data and information related to their product and process know-how can strengthen their traditional hardware sales.

By measuring the internal processes in the manufacturing industry, valuable data can be gathered and analysed through advanced analytics. This can be translated into information, by processing the data, that can be applied to increase the internal efficiency and quality (Bärring et al., 2020; Björkdahl, 2020). Furthermore may this newly gathered information contribute to an increase knowledge for value adding improvements that enables the firm to grow its business (Björkdahl, 2020). This constant stream of data-based knowledge can be a great asset for the firm. It allows; (i) the machine-operators to monitor the ongoing process and detect abnormalities in production, (ii) the technicians to schedule maintenance more effectively, and (iii) decisions to be made based on *facts* rather than intuition, including both centralised and decentralised decision-making. The aforementioned items represent the core functions of a developed *machine connectivity platform* in the manufacturing company, GKN Aerospace, and they now wish to explore what would be required to transform and externalise innovations such as this, that have existed for some time within the company, to products and services.

Today the business climate is changing fast where the adoption and exploitation of digital technologies play one of the leading roles (Zangiacomi, Pessot, Fornasiero, Bertetti, & Sacco, 2020). The *Industrial Internet of Things* (IIoT) has opened up new possibilities to increase efficiency in operations and engineering (Maple, 2017). It also puts additional requirements on speed and innovation to keep up with the customers' needs and to stay

competitive. In 2020 a global pandemic changed the conditions for how many companies operate. The game plan for the aerospace landscape has changed drastically (Dalstam & Grima, 2021). Do emerging technologies require manufacturers to rethink what a product is?

1.2 Aim and research questions

The aim is to develop proposals of the next steps for *GKN Aerospace* if they wish to continue with digitalisation by introducing new digital products and services to their portfolio in the future. To support this, the three following general research questions are analysed and applied to the specific context of the aerospace company:

- **R**$_1$ What are the driving forces for digitalisation in manufacturing companies?
- **R**$_2$ How can the value of a digital innovation be created, delivered and captured?
- **R**$_3$ How does digital maturity affect the traditional view on products and how they create value?

1.2.1 Limitations

The study regards the manufacturing domain, specifically the aerospace industry with unique features concerning the market landscape and business environment. While the information gathering is not limited by this, the evaluation of its relevancy is influenced. The information gathering is limited by time, thus thorough scrutiny over the entire topic is not possible. Also, the study is limited to one specific company, GKN Aerospace and their component business *Engines*. The company is moreover only reviewed in a general perspective, entailing a result with a lower level of company-specific attributes. Additionally, the evaluation process is limited to discussion with key stakeholders such that practical verification and *proof-of-concept* are out of scope for this report. Due to the time limit, the focus is on future prospects of an explorative nature regarding digital transformation, rather than the current and historical situation. It is however important to note that the current situation and conditions, as well as historical efforts within digital innovation, is imperative for the overreaching strategy.

1.3 Report structure

The report is split into two distinct sections: (1) the research methodology and (2) the company-specific application. Following the introduction chapter, the utilised methodology is described and motivated. In chapter 3 the findings from the literature reviews and industry benchmarking are presented, then analysed and discussed in chapter 4 which additionally marks the end of the first section. The findings from the research section will constitute the basis for the company-specific application whereby modules are formulated and combined into alternative module concepts, referred to as *concepts*,

in chapter 5. The concepts are then evaluated and screened until one concept remains, which will be refined into a recommended *action plan* to implement the modules. In chapter 6, both the applied methodology and the final action plan are discussed. Finally, in chapter 7 the research questions are revisited along with additional remarks of the study and recommendations for future work.

2

Methodology

In general, the applied methodology consists of two distinct phases. The first, which falls under the research methodology, is mainly focused on answering the research questions R1 and R2. The findings from this research constitute the basis for answering the company-specific research question R3 in the second phase.

2.1 Research methodology

To answer the research questions R1 and R2, a series of four sprints were performed. These are in chronological order: (i) company review, (ii) systematic literature review - drivers for digitalisation, (iii) industry benchmarking, and (iv) target literature review - value architecture of digital innovation.

Information was gathered iteratively in sprints over the four activities. These are presented in Figure 2.1. The purpose of doing this was to create a broad knowledge base and a relevant theoretical framework to support later procedures in the process. The methodology follows an agile approach (Cf. Atlassian, 2021), where each sprint is structured to gather, screen, process and evaluate new knowledge. This supports the action of quickly adapting the focus and following new threads based on prior knowledge. This enables the possibility to explore many opportunities, without investing excessively in subjects that deviate from the overall aim. During the planning segment, the aim and goal of each sprint were defined. While planning the next sprint, findings from prior sprints were considered. From the sprint planning, a list of keywords that represent subjects and areas to investigate was formed to facilitate literature search. At the end of each sprint, the newly gathered knowledge was documented through a collective summary of the compiled findings.

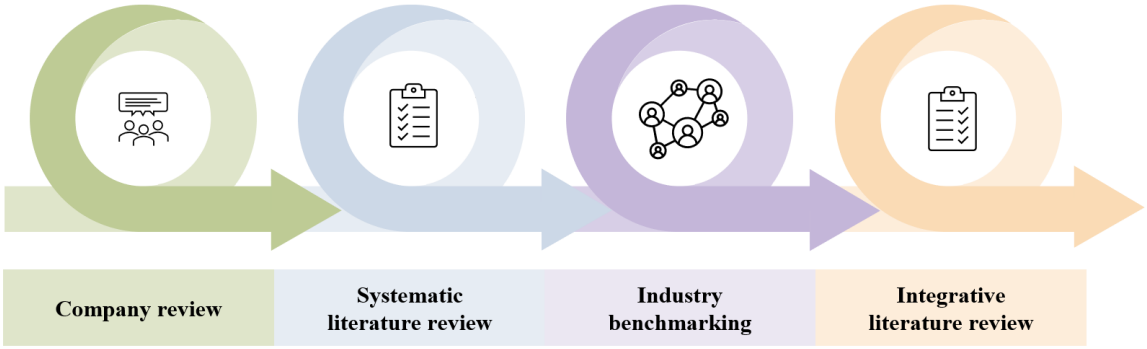

Figure 2.1: The applied research methodology to gather a broad knowledge base and insight of the field.

2.1.1 Company review - Qualitative research

Initially, the manufacturing company was studied to identify potential opportunities and threats that may be associated with digital development. This was done to better understand the challenges they are facing regarding the topic; the topic regards digitalisation within manufacturing, and specifically the value that digital development can create for the company.

The activity consisted of five semi-structured and open-ended interviews with key people associated with the internal digital transformation efforts from different level of the organisation. This was to allow follow up questions, to exploit the interviewees' knowledge to a higher degree and to explore a wider area of topics. The interviews were recorded, transcribed and analysed to reduce the risk of neglecting any information. The number of participants was not predetermined but rather based on the gathered information. Since the purpose of these interviews was within the explorative notion of qualitative research, the number of participants was decided by the amount of new information that contributed to an increased understanding of the current and envisioned state of the topic. Such, the participants were identified by selective sampling, and on one occasion by snowball sampling. Considering the ongoing COVID-19 pandemic, the interviews were limited to video conferencing platforms and were one hour long.

2.1.2 Literature review

Considering the topic novelty and prominence, it was considered imperative to conduct thorough research of the field initially. Like mentioned earlier, the topic regards digitalisation within manufacturing, and specifically the value that digital development can create for companies. The literature review was dissected into two domains: (1) drivers for digitalisation in manufacturing firms, and (2) value architecture of digital innovation. The former domain followed a *systematic literature review* methodology, while the latter domain followed an *integrative literature review*. The result of the processes is shown in Figure 2.2, and are described more in detail further on.

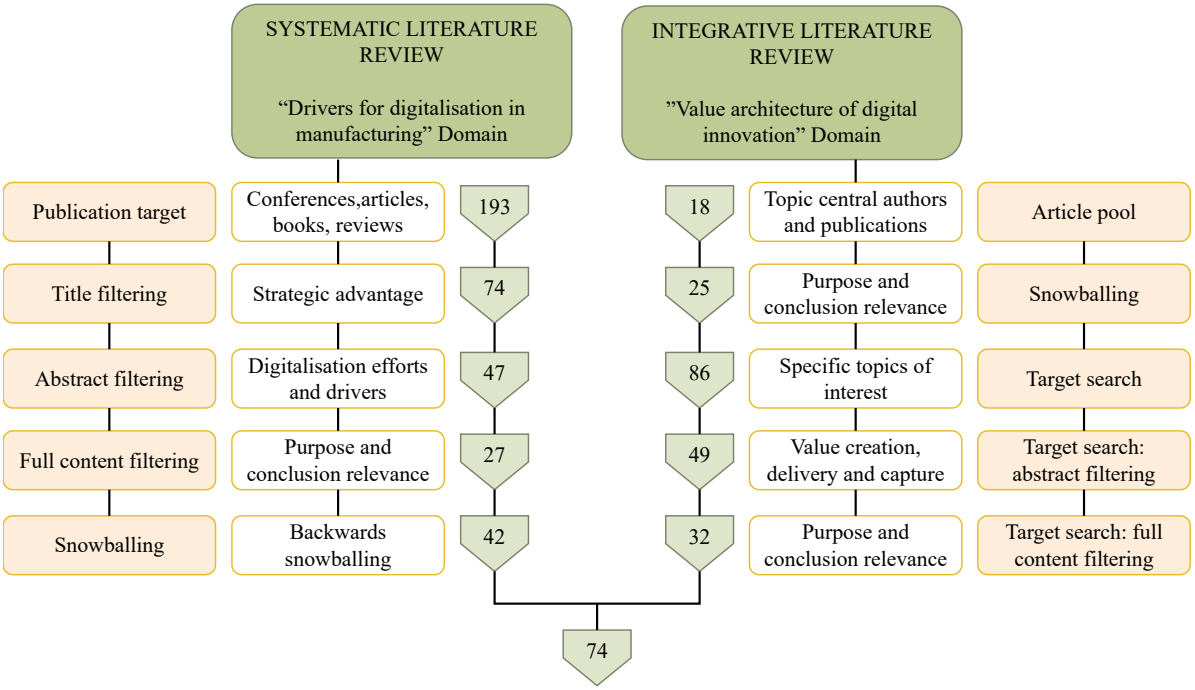

Figure 2.2: The process used for extracting relevant papers from the literature reviews.

Systematic literature review

For the first domain, a systematic literature review approach was deemed appropriate to gain a holistic overview of the current *state-of-the-art* of the field. In this literature review the database Scopus was selected as it provides effective tools, such as citation and keyword searching, to facilitate the review process (Falagas, Pitsouni, Malietzis, & Pappas, 2008). Additionally, Li, Kumar, Claes, and Found (2020) notes that "*Scopus is the largest and most comprehensive abstract and citation database of peer-reviewed literature*". The database Google Scholar was also considered, but it was considered to be sufficient to only utilise one database. The search was conducted on the 1st of March 2021 and includes all document types (articles, conference paper, book chapter, conference review, editorial), all source types (journals, conference proceedings, book series, books, trade journals), and no publication date restriction. The applied search string is presented below and can be copied into Scopus advance search to replicate the search.

> *"Manufacturing" AND "Digitalisation" OR "Digital transformation" AND "strategy" OR "Growth" OR "Competitiveness" OR "Competitive AND Advantage" OR "Performance" OR "Efficiency"*

The selected search criteria captured the essence of the topic; what drives digital development in manufacturing companies. These terms had to be present within either the paper's title, abstract, or keywords. From this search, a total of 193 articles were identified. Following, each article's relevance was analysed from their titles as a mean of screening, resulting in a reduced number of 74 articles. The same logic was applied by analysing the abstracts, resulting in an additional reduction. This screening process allowed a more in-depth review of 47 articles. Howbeit, the relevance of each publication varied, thus, the articles were reviewed to a different extent. In addition, a snowballing activity was performed that primarily traced references backwards in time to identify the original cited publications.

Integrative literature review

For the second domain, an integrative literature review was selected. While not as extensive as a systematic literature review it was deemed more suitable for the specific purpose, i.e. to examine specific topics of interest identified during the previous sprints - the systematic literature review and industry benchmarking. Rather than covering all articles within the domain like it is done through a systematic review approach, this methodology can be constructed more narrowly with the focus on the defined topics. There are, however, limited guidance for how one should conduct an integrative literature review (Torraco, 2005). That said some general guidelines exists, e.g. by Torraco (2016), that can be followed.

An integrative literature review is appropriate for both mature- and novel topics (Snyder, 2019). Generally, the aim with using this approach is to critically examine and scrutinise literature of a particular topic such that new knowledge and perspectives can be synthesized (Torraco, 2016). Snyder (2019) notes that the aim of the review may differ depending on if the topic is mature or novel. She describes the aforementioned as:

> *In the case of mature topics, the purpose of using an integrative review method is to overview the knowledge base, critically review and potentially reconceptualize, and expand on the theoretical foundation of the specific topic as it develops. For newly emerging topics, the purpose is rather to create initial or preliminary conceptualizations and theoretical models, rather than review old models (Snyder, 2019).*

The integrative literature review was centred around five identified topics: servitisation, product-service system, value architecture, value co-creation, and S-D logic. Following the definition of the topics, 18 articles were selected which were either heavily cited and/or had topic central authors, see Table 2.1. This resulted in an initial disqualification of more recent publications as they are less established.

Table 2.1: The initial article pool of widely established literature for the integrative literature review.

Authors	Title	Citations	Year	Topic
Baines and Lightfoot	The servitization of manufacturing: A review of literature and reflection on future challenges	1873	2009	Servitization
Oliva and Kallenberg	Managing the transition from products to services	3048	2003	Servitization
Vandermerwe and Rada	Servitization of business: adding value by adding services	2892	1998	Servitization
Mont	Clarifying the concept of product–service system	2508	2002	Product-service system
Tukker	Eight types of product–service system: eight ways to sustainability? Experiences from SusProNet	2416	2004	Product-service system
Baines, Lightfoot and Evans	State-of-the-art in product-service systems	2324	2007	Product-service system
Osterwalder and Pigneur	Business model generation: a handbook for visionaries, game changers, and challengers	14313	2010	Value architecture
Lindgreen and Wynstra	Value in business markets: What do we know? Where are we going?	964	2005	Value architecture
Lepak, Smith, and Taylor	Value creation and value capture: A multilevel perspective	1657	2007	Value architecture
Slater	Developing a customer value-based theory of the firm	1210	1997	Value architecture
Peppard and Rylander	From value chain to value network:: Insights for mobile operators	936	2006	Value architecture
Sjödin, Parida, and Wincent	Value co-creation process of integrated product-services: Effect of role ambiguities and relational coping strategies	75	2016	Value co-creation
Payne, Storbacka, and Frow	Managing the co-creation of value	4137	2008	Value co-creation
Vargo, Maglio, and Akaka	On value and value co-creation: A service systems and service logic perspective	3656	2008	Value co-creation
Grönroos and Voima	Critical service logic: making sense of value creation and co-creation	2610	2013	Value co-creation
Lusch and Nambisan	Service innovation	1567	2015	S-D logic
Vargo and Lusch	Evolving to a new dominant logic for marketing	17840	2004	S-D logic
Ulaga and Reinartz	Hybrid offerings: how manufacturing firms combine goods and services successfully	987	2011	S-D logic

A snowballing approach from the initial article pool increased the number of reviewed articles to 25. Here, the snowball traced references forwards in time to identify other relevant and more recent publications that had cited the articles or authors in the initial article pool. This also includes other publications within the topic from the same authors. From this, a targeted search was conducted through different online journal databases such as `https://www.emerald.com/`, `https://www.sciencedirect.com/`, `https://www.tandfonline.com/`, and `https://scholar.google.com/` with the aim to gain a holistic overview of the topic covering different perspectives. An important tool for selecting articles in this stage was the quality of citations; considering that the authors in the initial article pool are heavily cited and are central for the topic, see Table 2.1, the selected articles were considered being of higher quality if some of these were included in the references. The selected articles went through a two-step screening process to reduce the number of reviewed articles: (1) abstract filtering, and (2) full content filtering. Concerning the full content filtering, the purpose and conclusion relevance were highly considered as differences of perspectives are more prominent in these sections.

2.1.3 Industry benchmarking

The benchmarking is of an explorative nature and aims to compare industries and companies that can contribute with knowledge, insights and inspiration about how to quantify the value of industrial digital innovation and transformation. The activity starts with identifying industries, and specific companies, that fully incorporate or are transitioning towards incorporating digital innovations. Information is then gathered and compiled based on characteristics that can be utilised as comparative variables. The information is mainly based on what the companies present on their website. In the end, the results and insights from the benchmark are analysed and documented in a spreadsheet.

2.2 Company-specific application and evaluation

The second section of the project is mainly *internally* focused with regards to the manufacturing company in order to further evaluate and verify the gathered information from the initial phase. The general methodology applied in this section of the study follow a product development process. The specific process utilised consists of five main activities, see Figure 2.3: (i) Module formulation, (ii) Concept formulation, (iii) Elimination matrix, (iv) Pugh matrix, and (v) Final concept - action plan.

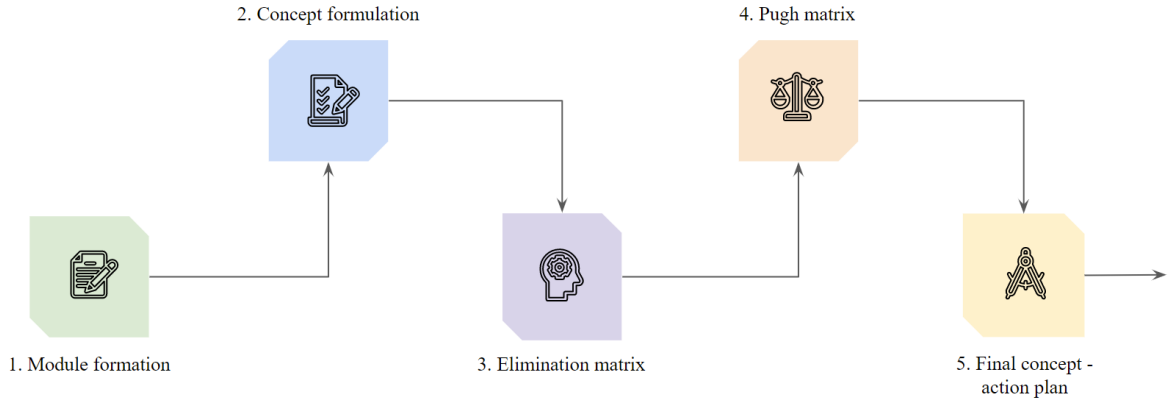

Figure 2.3: The applied methodology in order to synthesise a recommended action plan to increase the digital maturity in the specific manufacturing company.

The findings from the first section of the project - the research methodology - constitute the basis for this process. Here a set of *concepts* are developed based on the prior activities; concepts are here referred to as the set of strategic actions related to the digital innovations to increase digital maturity. Considering that the concept, in this case, regards a strategy (i.e. an action plan), the traditional product development process was adapted to accommodate this slight difference. The process utilised a funnel approach suggested by Wheelright and Clark (1992), in which a wide *funnel mouth* is gradually

narrowed down into fewer concepts through different means. As the number of concepts remaining decreases, the degree of detail is increased to facilitate the evaluation process.

2.2.1 Module formation

Following the research methodology, module formation was the first step of formulating concepts. Each module was formed to include an action that increases the possibility for organisations to succeed in their digital transformation. They were formed based on the findings of the literature review, industry benchmarking and company review. More specifically they are in line with the literature, inspired by trends and satisfy specific needs identified during the company review. With the prior research as a basis, several unspoken and potential needs were identified in addition to those that were outspoken during the company review.

The modules were then categorised based on digital maturity, that is the organisation's ability to create value through digital innovation. For the modules that constituted a measure of when in an organisation's digital transformation they should be focused in order to allocate resources efficiently, develop a digital foundation and create value for the organisation to increase the chances to succeed with the transformation. This resulted in three different module categories, presented from early to late stages of digital transformation; *The digital foundation*, *The digital course* and *The digital future*. All modules and the categorisation were presented and evaluated with key stakeholders from the company for potential elimination or refinement. Prior to this, the current findings were presented to remove bias.

2.2.2 Module concept formation

After the modules had been validated with key stakeholders, the process of formulating concepts was initiated. Again with the support of key people, concepts were created by matching several modules from the previously defined stages "The digital foundation", "The digital course" and "The digital future". A total of twelve concepts were formulated based on different dimensions and synergies between the modules. Some examples of dimensions are the level of risk, degree of impact, long or short term results, relation to current core business and potential benefits. Each concept is given a generic name to symbolise the fundamental principles that the concept is built on. Synergies in this context refer to how well different modules work together and how they affect each other's potential value. The aim of the concepts was to represent alternative strategies and directions for the organisation to work with digital innovation and take on a digital transformation. The concept in this stage are comparatively generalised and low in detail, and do not encompass specific activities.

2.2.3 Disqualifying module concepts - Elimination matrix

The first step towards finding a final concept was to eliminate deficient concepts. In accordance with the proposed evaluation process by Eppinger and Ulrich (2011), an initial sifting process of concepts is conducted to eliminate solutions that do not conform with stated requirements. This can be performed with an elimination matrix. The fundamental principle of the matrix is that the concepts receive a simple grading for each requirement stating if it is fulfilled "[+]" or not fulfilled "[-]". All concepts that receive the grade "not fulfilled" on any criteria are directly eliminated (Johannesson, Persson, & Pettersson, 2013, p. 183).

The fundamentals of an elimination matrix were followed but it was refined to support the evaluation of concepts based on strategic actions. This refinement was inspired by the SFA matrix which is used to evaluate different strategic options before committing (Johnson, Scholes, & Whittington, 2009; *Strategy Evaluation SFA -Analysis*, 2019). Instead of specific requirements, the concepts were evaluated based on three criteria; if they were considered ***S****uitable*, ***F****easible* and ***A****cceptable* to drive and accelerate digitalisation within the manufacturing firm. These criteria are evaluated based on the company review and discussions with key figures.

In this context, suitable considers if the concepts consist of module combinations with synergies that contribute to the desired value for the organisation. Feasible concerns aspects such as if the concepts' combination of modules works together or if fundamental actions are missing. Acceptable evaluates the nature of the synergies in relation to the company, such as the concepts' potential risk and expected return. The elimination methodology is used to eliminate deficient concepts early and is adjusted to evaluate strategic actions. The evaluation was conducted for each of the twelve concepts and those who did not fulfil every criterion were eliminated.

2.2.4 Concept screening - Pugh matrix

The second and last step of identifying a final concept was to screen and compare the remaining concepts based on predefined criteria. For this evaluation, the detail level of the concepts was increased and then a Pugh matrix was used as it supports a structured and objective concept comparison. Pugh concept selection matrix, named after Stuart Pugh, is utilised for concept screening and aims at rapidly narrowing down the number of concepts for development (Eppinger & Ulrich, 2011). The concepts should be equally detailed and the criteria should be based on customer needs and wishes. The concepts should have names and can be further defined by sketches or text.

The criteria are represented in the left column and the concepts are listed in the first row of the matrix. Lastly, one concept constitutes the reference. This could be a product on the market, a well-defined concept or a product of the standard which the team wishes to surpass. When grading concepts, the scores of each criterion is relative to the reference concept and take the form of equal, superior or inferior. After each concept is rated, their ranking is calculated by summarising their relative values and ordering them from highest to lowest net score. The result indicates that the concept with the highest scoring is the strongest candidate for further development.

Likewise to prior tools, the Pugh matrix was adapted to be more suitable for the evaluation of strategies. This was again performed by inspiration from the SFA matrix and can thus be seen as a more detailed SFA evaluation. The criteria in the screening process build on the criteria in the elimination matrix but are more specific and rather concern the concepts fit with the company than the modules' synergies. The criteria are divided into three categories based on the SFA structure; ***S****uitability*, ***F****easibility* and ***A****cceptability*. The Pugh matrix was conducted with the concept most alike the company's current business as a reference with the aim of finding a better solution. The outcome was then presented to key stakeholders at the company, whereby the response would act as the last part of the evaluation to determine whether to proceed with the highest-ranked concept or iterate the process.

2.2.5 Refinement of the final module concept

Once the final concept had been selected, the refinement process was initiated to increase the detail level further. The different modules within the concept were deeper analysed whereby recommended practical activities were developed. The specific activities were developed based on the acquired knowledge, the conducted research and discussion with key representatives from the company. In addition, they were formulated to build on the synergies between the modules included in the final concept and maximise the potential benefits of the strategy. The amalgamation of these activities constitutes the final recommended action plan.

3

Research findings

The result of the first section of this study is presented in this chapter. This includes the four activities described within the research methodology. The findings presented in this chapter can be regarded as a theoretical framework as it reiterates what has been noted in the literature.

3.1 Systematic literature review - Drivers for digitalisation

Given the prominence of digitalisation, there exists an abundant amount of literature covering different aspects of the field. Digitalisation is not only a massive trend within academia but has proliferated itself within many different industries. Such there are equally many perspectives of what is considered to be digitalisation and the purpose of it. Many of the technologies that often are utilised in the context of digitalisation have existed for many years, such as Internet-of-Things, cloud computing, big data, advanced analytic, and smart devices. However, digitalisation and digital innovation do not only regard the implementation and extended utilisation of more advanced technologies, but also incorporate organisational aspects such as aligning people, processes, culture, strategies, and activities. A common misconception is the limited perspective of digitalisation which only includes the transition from analogue to digital and the implementation of advanced technologies to increase the performance or cutting costs. As noted in the introduction, this study adopt the definition coined by Björkdahl (2020), in combination with the description presented by Volvo Group (2021):

> "*...digitalization can be seen as increased generation, analysis, and use of data in order, on one hand, to increase the firm's internal efficiency, and on the other hand to grow the firm by adding value for customers* (Björkdahl, 2020)."

> "*Digitalisation means that digital technologies alter the way in which people and processes interact* (Volvo Group, 2021)."

To understand the potential effect and value that digitalisation may have, it is important to understand the underlying driving forces. That is, what are the fundamental purposes behind digital innovation. In the most simple way, the core causes can be explained by a change in either the *exogenous* or *endogenous* environment, i.e. the change comes either from outside the company or from within. The real underlying cause for the digital initiative usually overlaps both of these. From a systematic literature review, the digital initiatives in firms are often motivated by some internal need such as cutting cost, increase process performance and efficiency, improve product development processes, and facilitate decision-making. These internal drivers are on the other hand triggered by some external change such as customer needs, globalisation, competition, and value-chain disruptions. While the specific cause differs, the identified drivers can be placed under the two umbrella terms *(i) competitiveness* and *(i) resilience*.

Scholars within the field are in agreement in that digitalisation offer many opportunities to strengthen the firm's competitiveness in a changing market. It has become a necessity, rather than a choice, for businesses to adopt *Industry 4.0* - also known as the IIoT - to achieve market success (Butt, 2020), moreover, the integration efforts of digitalisation is a vital factor to this success (Hallstedt, Isaksson, & Öhrwall Rönnbäck, 2020). Some strong digitalisation advocates further argue that a digital transformation is crucial for the firm's survival in a globalised market (Govindarajan & Immelt, 2019; Rossato & Castellani, 2020), and in securing future company prosperity (Butt, 2020).

The digital era coherently offers great opportunities for the aerospace industry but lowers the entry barrier for young, more agile companies to challenge the current market leaders (Ludwig & Orchard, 2017). Even though digitalisation arguably offers great opportunities, long-lived manufacturing firms have historically been passive in adapting to the emergence and diffusion of digital innovations (Savastano, Amendola, & D'Ascenzo, 2018). Additionally, manufacturers often fail to capitalise on the full potential of digital technologies, such as IIoT, to see any considerable effects (Behrendt, de Boar, Koerber, Mohr, & Richter, 2021).

The findings show that one of the main drivers for digitalisation is to gain a competitive advantage (Rossato & Castellani, 2020; Martín-Peña, Sánchez-López, & Díaz-Garrido, 2019; Cimini, Rondini, Pezzotta, & Pinto, 2018) or even to remain competitive (Butt, 2020; Felsberger, Qaiser, Choudhary, & Reiner, 2020). The literature presents a variety of focal points which organisations can exploit to increase their competitiveness by successfully implementing digital technology. In order to leverage the integration of digitalisation, firms need to innovate their business models (Martín-Peña et al., 2019). To increase the chances of benefiting from the new revenue and value streams the business model need to be centred around new processes, expertisation regarding a hybrid of processes and products, and servitisation of new products (Weking, Stöcker, Kowalkiewicz, Böhm, & Krcmar, 2020).

While not as explicitly stated as competitiveness, the driver to increase business resilience is evidently present in several forms throughout the literature. Resilience regards the firm's ability to respond and adapt to presented changes and includes both predictable changes as well as unpredictable changes. Digitalisation can through this perspective facilitate the adaptation as a response to the changes, in addition, to predict possible changes in the future (Baurina, 2020). A common practice in manufacturing concerns predicting potential downtime and other unknown issues, and thus reduces unnecessary expenditures by increasing operational resilience (Lee, Bagheri, & Jin, 2016). A firm can increase operational resilience by continuously gathering machine data from the internet of connected systems, and converting it into useful information (Butt, 2020).

Changes can come in larger and more disruptive forms as well, which are evident by the global pandemic COVID-19. In these instances, business resilience is highly valuable considering that the entire industry experienced a near-complete shutdown. Business resilience can be considered essential for long term survival, as the current way of working will be challenged by new more agile market entries. Firms that are ill-prepared and slow in their adaptation to industry disruptive changes may not survive.

To reiterate, the identified drivers in the literature can be placed under the two umbrella terms competitiveness and resilience, which constitute the core driver for digitalisation within manufacturing. The specific drivers can be categorised into five generic themes, see Figure 3.1: (1) market change, (2) operational efficiency, (3) growth, (4) flexibility, and (5) external relations. Usually, digitalisation is driven by a combination of several of the presented drivers, and each company has its own set of drivers. In the literature, internal application of advanced technologies is the most common employment of digital innovation. This often concerns improvements of the current practises in order to cut costs, improve operational efficiency and performance, which revolves around the economical benefits of digital innovation. That said, the literature notes the importance of the corporate culture aspect of digitalisation in order to expand the employment of digitalisation.

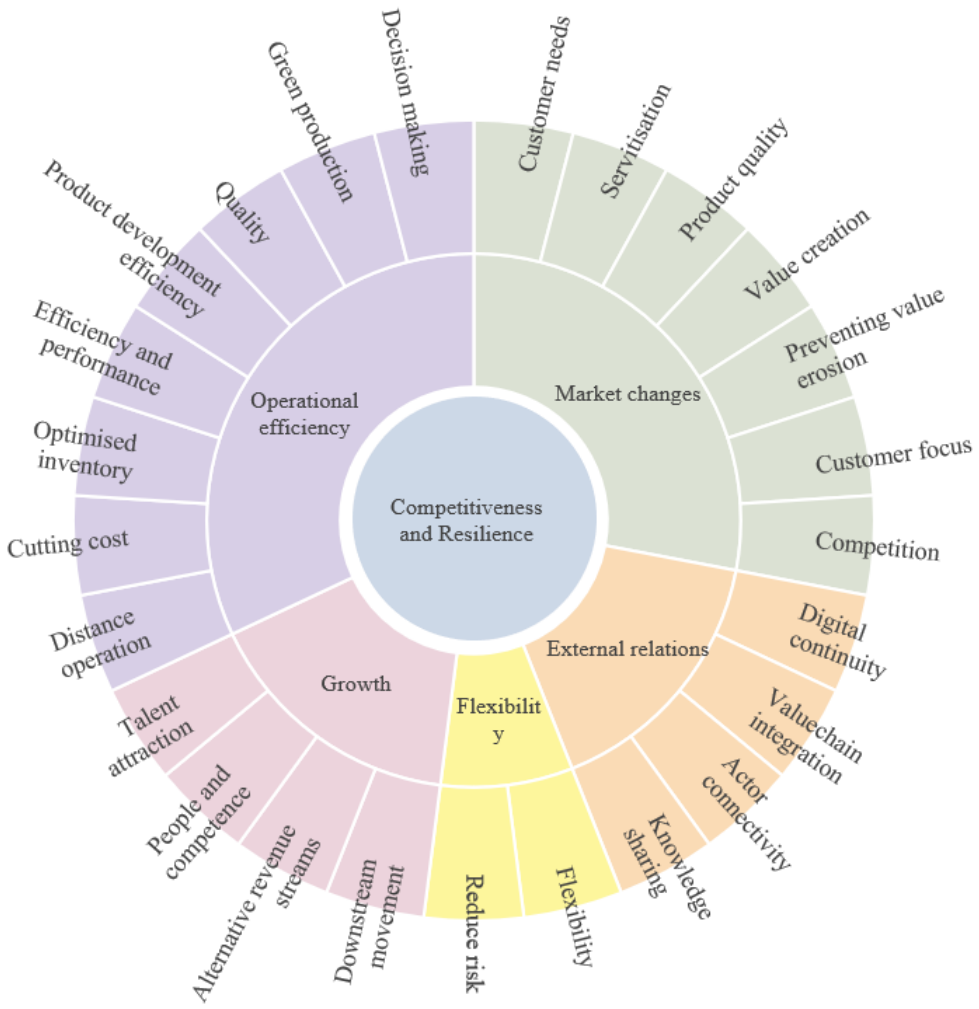

Figure 3.1: The drivers for digitalisation within manufacturing are encompassed by the two core drivers constituted by five themes.

3.1.1 Market change

Markets are never static and only exist at a moment in time when a transaction takes place (Bowman & Ambrosini, 2000). Likewise, the market for the manufacturing industry is changing (Felsberger et al., 2020). Sustainability has emerged as one of the biggest challenges and most crucial driver (Hallstedt et al., 2020), especially in the aerospace industry which is subjected to strict environmental requirements and future goals (ACARE, 2020). In addition, globalisation will continue to affect the dynamics of business over the next years (Viveros-Eulogio, Öhrwall Rönnbäck, & Ramirez-Portilla, 2015). Rossato and Castellani (2020) highlights the need of increasing long-lived firms competitiveness through digitalisation as the markets are evolving to be more globalised. A firm's efforts of adopting new technologies that foster efficient transfer of knowledge

and information play a vital part in utilising globalisation to promote growth and productivity (Viveros-Eulogio et al., 2015). This implies a desire to increase the general resilience as a driver, in which a firm can quickly adapt its operation when changes occur. By creating a flexible manufacturing operation, data can be utilised to enable quick responses to changes (Luz Martín-Peña, Díaz-Garrido, & Sánchez-López, 2018).

Customer needs: Manufacturing firms are investigating new solutions to meet their customer needs as global competition increases (Luz Martín-Peña et al., 2018; Martín-Peña et al., 2019). The market demands are fluctuating (Ordieres-Meré, Prieto Remón, & Rubio, 2020) and companies are challenged to meet the accelerated increase in customer needs (Savastano et al., 2018). In addition, the ongoing digital transformation of the industry changes the customers' proposition of value (Luz Martín-Peña et al., 2018). Digitalisation is however considered to be an opportunity for finding new solutions that can meet customer needs and increase competitiveness in the future (Hallstedt et al., 2020). An existing problem for manufacturers, specifically suppliers, to acquire the required data is that it in a high degree is the customers' property (Exner, Schnürmacher, Adolphy, & Stark, 2017). Nevertheless, the drivers for sustainable service-oriented, resource-efficient and digitalised solutions are customers needs and profitability (Hallstedt et al., 2020).

Using digital technologies to monitor equipment, analyse customer behaviour and predict customer needs provides an opportunity to provide unique solutions. Accordingly, the involvement of data in the early stages of the innovation process increases the chances of finding new solutions to offer in order to meet future needs (Hallstedt et al., 2020). One of the trending offers within the industry is predictive maintenance (Ponomareva, Usacheva, & Volkova, 2021; Chen, Zhang, & Wu, 2018; Rissiek & Bardram, 2017; Exner et al., 2017) and the customers express the value as optimised programs for maintenance where reparations only occur when it is needed(Hallstedt et al., 2020).

Servitisation: Servitisation can be seen as the process of increasing the provided value by offering services (Luz Martín-Peña et al., 2018). In the context of digitalisation, many traditional manufacturers have started to incorporate digital technologies to enable aftermarket services and gain a sustainable competitive advantage (Chen et al., 2018). Luz Martín-Peña et al. (2018) argues that digitalisation constitutes both an enabler and a driver of servitisation. Accordingly, a large part of digitalisation efforts focus on introducing services and the digitalisation process drives the design of new PSS solutions (Martín-Peña et al., 2019). These PSS solutions are individualised and innovative product-service combinations that increases the delivered customer value and therefore also increases the providers competitiveness (Lerch & Gotsch, 2015). Digital opportunities creates a power shift in the industry as they move quicker than most companies can adapt (Luz Martín-Peña et al., 2018) and adds additional value with dedicated services (Savastano, Amendola, Bellini, & D'Ascenzo, 2019). Those companies which manage to undergo an early and efficient digital transformation will have an increased chance of incorporate and benefit from servitisation (Luz Martín-Peña et al., 2018).

3.1.2 Operational efficiency

Digitalisation contributes to an improved production process (Savastano et al., 2019, 2018). It has the potential to increase the efficiency of production development in manufacturing firms and heavily reduce the need for physical prototypes and artefacts (Björkdahl, 2020). The utilisation of ICTs also increases the effectiveness of developing new kinds of products and services (Luz Martín-Peña et al., 2018). The implementation of different high tech technologies, such as big data, IoT and cloud computing, in the product development process leads to reduced lead times (Savastano et al., 2019, 2018), optimised inventory, cleaner production (Rajput & Singh, 2020), and increased revenues (Ponomareva et al., 2021).

Process efficiency and performance: The use of digital sensors, accelerators and advanced software algorithms in the production enables real-time data feedback from the machines. The information translates into the optimisation of time and resources (Björkdahl, 2020), and fewer costly production stops and breakdowns (Ordieres-Meré et al., 2020). With the accessibility of real-time data, digitalisation also provides the possibility to increase factories throughput by setting up intelligent and connected systems (Ponomareva et al., 2021; Björkdahl, 2020). These digital systems can also be used for the optimisation of existing internal processes (Martín-Peña et al., 2019; Schuh, Frank, Jussen, Rix, & Harland, 2019), prediction of failures (Schuh et al., 2019), improvement of operational efficiency (Chen et al., 2018; Luz Martín-Peña et al., 2018; Savastano et al., 2018) and support an improved control over processes (Björkdahl & Holmén, 2019).

In the industrial digitalisation era, companies are constantly ramping up their investments in technology and solutions that enable their products, processes, machines and employees to be interconnected in one integrated network. This nourishes the collection and analysis of data, performance improvements and evaluations of company development (Chonsawat & Sopadang, 2020; Nagy, Oláh, Erdei, Máté, & Popp, 2018). Manufacturers adopt ICT to enable monitoring of products and processes that support new service-oriented strategies (Martín-Peña et al., 2019). The impact of I4.0 is undeniable and traditional manufacturing is being pushed to transform into smart manufacturing to facilitate the enhanced productivity and efficiency, which comes with exploiting advanced digital tools (Butt, 2020; Savastano et al., 2019; Cimini et al., 2018).

Process quality: Some manufacturing firms consider economising and quality improvements as the most essential outcome of digital transformation. Advanced technologies combined with more extensive and better data increases quality and decreases variance in the manufacturing process by making it more intelligent (Björkdahl, 2020). One underlying factor for improved quality and decreased uncertainty is the increased control that ICT-based control systems provide to the operators and decision makers (Björkdahl & Holmén, 2019). As digitalisation increases within the manufacturing industry, the capability of gathering and processing data is becoming an increasingly important differenti-

ating. The capability is a vital factor for competitiveness through quality improvements, increased product, service and process quality, and data quality in order to increase controlling and reduce the factor of human error (Felsberger et al., 2020). This is further strengthened by Antipov, Kuznetsova, and Aytasova (2020) which argues that digital technologies integrated with quality management systems should be viewed as essential tools for control, analysis and quality assurance of products and the competitiveness of the entire economic entity.

Operate from distance: The increased real-time monitoring and control enabled by advanced digital technologies provide new ways of satisfying customers. Co-pilots, digital twins and autonomous electrical machines are examples of solutions that can fulfil the expressed need of operating from distance (Hallstedt et al., 2020). Felsberger et al. (2020) states that one of the key drivers for manufacturers to implement industrial digital technologies is to achieve increased productivity and efficiency via smart and remote management. The technology constitutes the foundation that enables remote access and control (El Zaatari, Marei, Li, & Usman, 2019). This further leads to an important implication about digital factories that require fewer employees for production. As distance and salary play a decreasing role in production, factories and activities can be strategically positioned to a higher extent (Björkdahl, 2020).

Green production: Traditionally, the view on incorporating a sustainability agenda into the core of the organisation has been seen as something that needs to be done to fulfil requirements and comply with legislation. There is however a clear trend that manufacturers instead start to see market forces as a driver (Hallstedt et al., 2020). To support the new driver, the real-time data-driven I4.0 provides new approaches to achieve sustainability that minimises energy consumption, environmental deterioration (Rajput & Singh, 2020) and wastage (Ponomareva et al., 2021). Optimisation of resources and a reduced environmental impact can be achieved by implementing and exploiting data to support both production and operation activities (Chonsawat & Sopadang, 2020). Industry 4.0 is today one of the central driving strategies for companies to address the 3 R's; *reduce*, *reuse* and *recycle* (Rajput & Singh, 2020).

Decision making: The benefits that come with digital technologies shows on many levels within companies, including efforts to improve the decision-making process for managers (Antipov et al., 2020). Working with big data and cloud networks is a way to collect, analyse and utilise the available data for making real-time decisions (Ponomareva et al., 2021; Nagy et al., 2018; Zhang, Ren, Liu, Sakao, & Huisingh, 2017). The technologies support a deeper understanding and transparency of what is going on, which entitles managers to make better and more informed decisions (Ponomareva et al., 2021). Integrating systems for vertical information flow inside a company and horizontal flow with partners, to enhance management support is a large internal driver for digitalisation (Yli-Viitala, Arrasvuori, Silveston-Keith, Kuusisto, & Kantola, 2020). In some cases, the positive effects of digitalisation are limited to the ability to obtain and connect new data sources to gain information and improve decision making (Björkdahl, 2020).

Optimised inventory: The accessibility and usability of data increases throughout value chains, which results in an automated, predictive strategy for delivery of spare parts and active inventory planning (Rissiek & Bardram, 2017). The utilisation of data will support an optimisation of inventory (Rajput & Singh, 2020) and significantly reduce costs that are associated with unexpected production quantities and overstocking (Ponomareva et al., 2021).

Cutting costs: Digitalisation offers a major opportunity for firms to fulfil the tightening requirements by improving their operational efficiency to achieve significantly lower costs (Chonsawat & Sopadang, 2020; Yeh, Chen, Jwo, Lin, & Lee, 2020; Björkdahl, 2020; Chen et al., 2018). Reducing costs is a large internal driver for digitalisation (Yli-Viitala et al., 2020) and by utilising advanced technology for flexible and efficient processes, manufacturers are able to reach technical and economic benefits (Savastano et al., 2018) and reduce costs (Savastano et al., 2019). Björkdahl (2020) states that more than half of the studied firms consider digitalisation to provide equal or better opportunities to increase revenue than to reduce costs. However, as many as three quarters of them focused their attention on cutting costs. Björkdahl further explains that business leaders mainly focuses on cutting costs as a result of greater efficiency since the outcome, return of investment, is relatively predictable, fit with current strategies and provide a potential for short-term results. These digitalisation initiatives have been more successful than the underrepresented efforts aimed at growth. One determining factor for a successful growth agenda is the shift from increased efficiency in establishing ways of working to finding new ways of working (Björkdahl, 2020).

Digitalisation is an enabler for servitisation through PSS and by improving the use of digital technologies, such as ICT, services indirectly reduce costs while increasing profits (Martín-Peña et al., 2019; Luz Martín-Peña et al., 2018). Manufacturing organisations are quickly allocating their IT resources towards technologies like cloud computing, AI, big data and IoT to enable open information exchange between systems in order to strengthen customer relations (Martín-Peña et al., 2019), and reduce capital costs and costs related to information collection and management (Butt, 2020). These technologies also enable the replacement of preventive maintenance with AI-enhanced predictive maintenance, which results in savings related to production stops, time and resources, and maintenance and inspection (Björkdahl, 2020).

3.1.3 Growth

The literature highlights several concrete driving forces for digitalisation, but only a minority focuses on underlying drivers of a holistic nature. Growth as an explicit driving force for digitalisation is underrepresented in the literature but still the desired result of many digital initiatives. Digital initiatives with the aim of achieving, for example, servitisation (Vendrell-Herrero, Bustinza, Parry, & Georgantzis, 2017), operational efficiency (Björkdahl, 2020), organisational flexibility (Gillani, Chatha, Sadiq Jajja, & Farooq, 2020) all strengthen the market position and increases growth potential.

Downstream expansion: Firms that manage to make their traditional products intelligent have the opportunity of moving downstream and offer new complementary and operational services (Björkdahl, 2020). The trend shows that many suppliers move downstream to enable an expanded service offering based on their core competence (Wise & Baumgartner, 1999; Davies, 2004). They manage this by taking over service activities from the customers or by developing new downstream services (Björkdahl & Holmén, 2019). Wise and Baumgartner (1999) states that there are both financial and environmental rationals for companies to move downstream and capture additional value from service offerings. Digitalisation enables this downstream movement (Vendrell-Herrero et al., 2017), which also strengthen a dominant position in the value chain as the distance to the end user is reduced (Björkdahl, 2020). In addition, companies with global sales activities benefit from digital opportunities as they can perform downstream tasks independent of location with digital and remote-controlled services (Lerch & Gotsch, 2015).

Alternative value streams: Digitalisation involves increased use of digital technologies that support new value and revenue-producing opportunities (Sklyar, Kowalkowski, Tronvoll, & Sörhammar, 2019; Gartner, Inc., 2021). Accordingly, traditional business models are replaced with innovative and digitally focused models that aims to create alternative value streams while optimising customer access and interaction (Savastano et al., 2018). In the mean time, digitalised value chains become smarter and value-driven, and develop processes that can generate a new type of revenue and business value (Savastano et al., 2019; Büyüközkan & Göçer, 2018). Many companies see digitalisation as a strategic option to reduce the distance to the end users while also increasing their revenue streams and overall profitability (Björkdahl, 2020). Rissiek and Bardram (2017) states that digitally enabled solutions will generate new economies of scale and density for those who are able to derive increased value through digital efficiencies, digital services or business models based on networks. The development of digital technologies in combination with servitisation have provided new opportunities to introduce services and generate revenue across industries (Martín-Peña et al., 2019).

In accordance with the introduction of services such as predictive and condition based maintenance, Li et al. (2020) highlights that prior research implies that a higher revenue can be facilitated by a well developed PSS. This is supported by Lerch and Gotsch (2015) who states that novel PSS solutions constituting of both physical products and digital systems can promote growth. Even though the potential and desire for alternative revenue flexibility streams are clear, the reality shows a different aspect. A case study that discusses the digitalisation efforts of 26 leading manufacturing firms shows that the majority focuses on greater internal efficiency rather than pursuing a growth agenda (Björkdahl, 2020).

3.1.4 Operational flexibility

The digital era changes the dynamics of competitiveness in the manufacturing industry and in common with everyone else, aerospace OEMs is faced with fundamental challenges: decrease time to market, increase flexibility, continuously deliver product quality that exceeds authority and customer expectations, and increases sustainability and efficiency (Ludwig & Orchard, 2017). Manufacturers adopt digitalisation to improve flexibility and agility in terms of internal processes to ensure competitiveness in the changing environment (Butt, 2020). Flexibility in the context of digitalisation is the capability to create and utilise data in order to predict and quickly respond to changes, such as varying production demand and customer needs (Luz Martín-Peña et al., 2018).

Accordingly, flexibility drives digitalisation in companies that aim to become more resilient against operational disruption, increase customer satisfaction (Felsberger et al., 2020) and reduce risks (Chonsawat & Sopadang, 2020). Companies priorities to increase resilience can be to transit from several local IT solutions to standardised and cloud-based single solutions (Baurina, 2020). This will not only contribute to a quicker response to crisis situations but also help to predict them.

3.1.5 External relations

The fast development and adoption of digitalisation greatly impact business processes, causing a disruptive digital transformation throughout the industry value chain (Savastano et al., 2018). The digital era allows heavily integrated value chains that share information and collaborate to increase the efficiency and control, reduce lead times and improve coordination (Björkdahl, 2020). Manufacturing firms share data with customer and suppliers, and leading firms are increasing collaboration by adopting supplier interfaces.

The increased collaboration around data entails new types of challenges associated with intellectual property (Hallstedt et al., 2020). This results in a direct digital channel of communication that improves both parties' control over products and reduces inventory. Rissiek and Bardram (2017) adds that the accessibility and usability of data in the value chain contribute to a predictive approach for inventory planning and parts deliveries. They also highlight that the increased amount of information the integrator acquire from digital technologies contributes to valuable feedback to the suppliers.

Digital capabilities are fundamental for companies to start exchanging big amounts of data rapidly, enhance processes based on new knowledge, gain valuable insights from big data and facilitate collaboration and communication throughout their value chain (Savastano et al., 2018). As the industry landscape changes, an integrated approach is the only guarantee for a long-term success (Ludwig & Orchard, 2017). Ludwig and Orchard (2017) also states that a digitalised and integrated value chain should be the

common goal of all aircraft manufacturers. If companies manage to use their new digital capabilities to integrate the value chain, the traditional value chain model, with a linear process flow, is transformed into an integrated value circle (Savastano et al., 2018). Which in turn leads to new ways of collaborating (Hallstedt et al., 2020), increased activity traceability (Björkdahl, 2020), enhanced customer focus (Felsberger et al., 2020; Savastano et al., 2019) and long term relationships (Cimini et al., 2018).

Digitalisation also supports connectivity between actors (Luz Martín-Peña et al., 2018; Cimini et al., 2018) and is considered a cornerstone in the effort of integrating and connecting a value chain (Ludwig & Orchard, 2017). Digital technologies can create additional value by connecting different machines and players in a new digital value chain to address manufacturers' central business drivers (Savastano et al., 2019, 2018). The notion of value is further examined in chapter 3.3.1. An integrated value chain that utilises enabling digital technologies has an enhanced inter-organisational knowledge sharing that foster improvement (Butt, 2020; Björkdahl, 2020; Ordieres-Meré et al., 2020).

3.2 Industry benchmarking

To understand how the rapid development of digitalisation is affecting the manufacturing industry, it is important to gain industry insight by investigating other companies. Twelve companies were identified, partly together with GKN Aerospace, based on their relevance for the thesis, that is if they are within the manufacturing industry, aerospace industry or individual companies regardless of industry that are in the forefront of digital transformation. These companies were compared based on predefined criteria, but additional insights were noted on an individual level since the industry benchmark had an explorative and inspirational nature.

The subjective evaluation of the appearance of the companies' websites was conducted for each company. It was then compared with the information directly available on their websites regarding digital initiatives. It was a clear variation in attractiveness, modern appeal and structure between the sample companies that influenced the perception of their digital capabilities. Although, the result indicates no clear correlation between how modern and visually appealing the websites are and the type of digital initiatives and technologies that are targeted. The four companies appointed with a "modern appeal" was however all either start-ups or relatively close to the end user. Further, the information presented on the websites converges around different digital buzzwords such as; *AI*, *big data*, *connectivity*, *advanced analytics*, *intelligent solutions*, *sustainability*. Moreover, the four companies are perceived to possess a higher level of digital maturity as the presented information implies a direct impact on strategy and business aspects, not merely as IT solutions.

All sample companies present different digital initiatives and state that they work with high-tech technologies either directly on their home page or on a tab allocated for digital initiatives, or both. Visually presenting that they are working with advanced digital initiatives is a common theme among the companies and can affect their external perception. The digital initiatives are presented in a general manner without specific actions or details about the development process.

A strategic option that companies choose, independent of their role in the value chain, is to partner with a technology company to speed up or outsource the development of digital innovations, such as digital platforms, and digital transformation. These type of partnerships involve new industry entries that are digitally centred and contribute to the capability of developing high-tech innovations that support service offerings. Examples of these partnerships are Bombardier with Scale AI, Volvo Cars with Capgemini group and Pratt & Whitney with Collins Aerospace.

Another strategic option identified through the industry benchmark is to start a subsidiary with a focus on developing digital innovations. An example of that is General Electric, GE, that have a subsidiary called GE Digital that focuses on software applications and services in multiple industries. Within aviation, they have solutions to increase fuel efficiency, end user experience, increasing flight safety, predictive maintenance and empowering the pilots (GE Digital, 2021). Other strategic options are venture capital, innovation co-creation camp and platform for innovation with open data sets but these are found outside of the aerospace industry. There are challenges regarding data sharing, specifically convincing OEMs to share information that may be considered as sensitive trade secrets. Though Volvo Cars, for instance, released data of more than 40 years of safety research in *the E.V.A initiative* to support other car manufacturers in their development (Volvo Cars Corporation, 2021). This was initiated as they believe that cars should be safe for everyone, not just the average male. Safety is fundamental in Volvo Cars identity and this initiative accelerated the overall safety of cars while simultaneously strengthen their brand.

The digital solutions identified from the aerospace industry is mainly focused on flight data monitoring, and predictive and condition based maintenance built on advanced analytics. The younger and smaller companies also have solutions for 3D experience to digitally design, mobility networks and connectivity.

3.3 Integrative literature review - Value architecture

The value architecture of digital innovation concerns how value is created, delivered and captured. This domain was scrutinised through an integrative literature review where the five topics (i) value architecture, (ii) servitisation, (iii) product-service system, (iv) S-D logic, and (v) value co-creation, were explored. Value architecture as a topic concerns a more holistic overview of the concept of value, rather than specifically for digital innovation.

3.3.1 Value architecture

Understanding the concept of value is imperative to grasp the full benefits that digital innovation can contribute. Despite its importance firms are often unable *to define value, and how to measure it* (Anderson & Narus, 1998). A holistic perspective on value theory implies that "*...value for customers does not equal value for suppliers...*" (Lindgreen & Wynstra, 2005). This highlights the importance of understanding what value to create, and for who the value is created as this value encompasses specific preferences and such are often an elusive matter. An organisation should continuously re-innovate their product offerings and current way of working to remain competitive and mitigate *value erosion*. The effects of "*doing nothing*", i.e. not re-innovate the current business, will over time lead to a position where the current core business is in a declining state (Ericson & Koller, 2020). Additionally, it is not until the firm has something to offer of value for the customers, that the customers become valuable for the firm (Lindgreen & Wynstra, 2005).

Understanding what the value recipient values are is of utmost importance and has two dimensions, the absolute value, and the relative value (Browning, 2003). Browning (2003) notes that the dimension of absolute value involves "*the intrinsic value of the product or service; how well its attributes address customer needs*", while the dimension of relative value involves "*the change in a product's value depending on competing or alternative solutions to customer needs*". Within this paradigm of value, the perceived value of a product goes beyond pure economical values. Rather, value is *experientially* perceived and determined by the experience, and such defined by the customer(Grönroos, 2011; Vargo & Lusch, 2004).

Osterwalder and Pigneur (2010) introduces the premise of value architecture in the context of business models whereby the underlying principles for how value is created, delivered and captured are considered. Specifically, they note that "*a business model describes the rationale of how an organization creates, delivers, and capture value* (Osterwalder & Pigneur, 2010)". Grönroos (2011) acknowledge the nature of value creation as "*among the most ill-defined and elusively used concepts*". Additionally, a common misconception is that value creation have to originate from a *conscious, explic-*

itly considered process (Grönroos, 2011) that is designed to form some kind of worth, however, increased value can also *emerge* through *fortuitous* origins (Korkman, 2006), or through *use value* (Lepak, Smith, & Taylor, 2007; Bowman & Ambrosini, 2000). The use-value is in its most simple form the customer's willingness-to-pay for a specific product (Bowman & Ambrosini, 2000). Garcia Martin, Schroeder, and Ziaee Bigdeli (2019) describes the value creation process as "*...the way organisations meet customers' expectations*". Important to note is that it regards both external and internal customers within this context. Similarly, the value capture process refers to the way organisations retains the certain value that is created, and includes both tangible monetary value and intangible value such as company reputation, customer perception, brand, and employee satisfaction. Kaufman (2020) explains that organisations *must* capture some of the value created but also highlights that the customer value diminishes as more value is captured by the organisation, implying that there should be a balance that satisfies both parties of the transaction. Lastly within the value architecture is the value delivery process, which involves how organisations understand and realises delivering their value proposition (Slater, 1997).

3.3.2 Servitisation

Servitisation is a field that is closely related to the value architecture of digitalisation and can be defined as the firm's transformation from purely selling physical products to increasingly incorporating supportive services into the offering (Vandermerwe & Rada, 1988; Baines, Lightfoot, Benedettini, & Kay, 2009; Sjödin, Parida, Kohtamäki, & Wincent, 2020; Lerch & Gotsch, 2015). The transition towards integrating services into the current business further includes changing processes and capabilities in order to create, deliver, and capture new potential value from the emergence of advance technologies (Sjödin et al., 2020). In the context of servitisation, it is difficult to distinct between the value creation and delivery processes considering that the value is prevalently acknowledge to be co-created by both the service provide and the service consumer (Grönroos, 2011; Vargo & Lusch, 2008). This transformation within industries enable companies to enhance and expand the current business by services (Oliva & Kallenberg, 2003) and achieve inimitable competitive advantages (Baines et al., 2009). Sequentially, the industrial landscape changes and allow companies to compete in *new* ways and add value that was previously not possible (Garcia Martin et al., 2019).

Servitisation is *often* treated as a process from being product-oriented to being solution-oriented (Lerch & Gotsch, 2015), where different stages in the process imply more advanced services being incorporated with different associated potential for competitive advantage. The *product service continuum* introduced by Oliva and Kallenberg (2003) showcases this, and describes the complexity and role of the service in the *product*. Servitisation in its simplest form regards services being incorporated as an add on or supportive feature for the tangible physical product. Gradually moving along the continuum implies that the importance of the services increases. A more advanced form of servitisation regards *product-service systems* (PSS), which integrate digital and physical

assets into a coherent product that utilises synergies between the two; digital assets enhances the physical asset, while physical asset enables digital assets. Lerch and Gotsch (2015) state that "*...the complexity of services offered seems to influence the degree of digitalization*", suggesting that more advanced and complex services require a stable digital infrastructure that can support such service systems (Gebauer, Gustafsson, & Witell, 2011).

3.3.3 Product-service system

As presented previously, PSS represent a more advanced form of 'services' where intangible digital assets are combined and integrated with tangible physical assets to better meet customer needs, add value, and *untap* new ways to compete (Tukker & Tischner, 2006; Lerch & Gotsch, 2015; Lenka, Parida, & Wincent, 2017). The specific definition adopted in this study originates from Mont (2002), and later refined by Li et al. (2020) as:

> "*...a system of products, services and supporting infrastructure that interact with each other to jointly deliver customers better results than the sum of the individual components.*"

The proliferation of services has lead to the surge of many different alternative terms to describe this concept, for instance, *integrated product and service offering* (Sakao, Öhrwall Rönnbäck, & Ölundh Sandström, 2013), *smart connected products* (Porter & Heppelman, 2014), *integrated solutions* (Buxton, Hodgekiss, & King, 1997), *service transition* (Oliva & Kallenberg, 2003), *hybrid offering* (Ulaga & Reinartz, 2011), and *servitisation* (Vandermerwe & Rada, 1988; Baines et al., 2009). For the latter, servitisation, PSS is included within the presented and adopted definition for this study. Howbeit, servitisation is not limited to the form of services that PSS implies, but also includes less advanced forms such as add on services or supportive services. This distinction is important, however, not always considered or differentiated in the literature.

Similarly to servitisation where services can vary in the degree and form of servitisation and business arrangement, see for instance *the produce service continuum* by Oliva and Kallenberg (2003), PSS can also be dissected into different forms. Lerch and Gotsch (2015) presents *four generic stages* of a transformation model for transitioning to a PSS offering. The first two stages that they present, *manufacturer* and *IT-based services*, represent less advanced forms of services and can thus be argued are not within the definition of PSS used in this study. The latter two stages, *pure digital services* and *digitalized PSS* alter the traditional products to a degree in which the offering consists of services, and digital- and physical assets. Tukker (2004) introduces a categorisation of PSS by their related business models: (1) product-oriented services, (2) use-oriented services, and (3) result-oriented services. Like the transformation model by Lerch and Gotsch (2015), this categorisation overlaps the definition of servitisation as it describes the process from offering only pure products to only offering services. In their study, Lerch and Gotsch (2015) explore different forms of PSS, i.e. (1) smart service delivery,

(2) smart product optimization, and (3) digital brain.

1. **Smart service delivery**: services are fully integrated into the offering and such not considered as a mere supportive feature to the physical asset: an example of smart service delivery in manufacturing is predictive maintenance, which is within this context not regarded as a supportive service but rather a way to increase the product value by availability and reliability. This form of PSS operates at a late stage in the *product life-cycle* and aims to increase the lifespan of the products.
2. **Smart product optimization**: digital assets are used in a way to enhance and improve the physical asset. Services are also included in the offering in order to increase the performance of the core product. Doing the aforementioned will result in optimised usage of the product that can save resources or improve the output, such the focus is on the physical assets. This form of PSS operates primarily in the middle of the product life-cycle where the product is starting to mature.
3. **Digital brain**: this form of PSS incorporates data and information from the digital- and physical assets, to the development of future products and/or improve the current product. Feeding in information from the products affects the companies innovation activities and can have great benefits for the customer as the products are enhanced and developed with product data. This form of PSS operates in multiple stages of the product life-cycle, however, mainly in the product development and introduction stages.

3.3.4 S-D logic

As stated, servitisation is often treated as a process from being product-oriented to solution-oriented (Lerch & Gotsch, 2015), in order to better meet customer needs, add value, and enable new ways to be competitive (Tukker & Tischner, 2006; Lenka et al., 2017). Incorporating services into the offering sequentially entails a fundamental change in firms' value proposition; firms move from only selling physical products, into solutions consisting of both physical and digital assets. In the traditional value proposition, the value is created by the supplier and utilised by the customer. The value thus becomes directly attached to the physical product, and is only transitioned when supplier and customer engage in an economical exchange. The relationship dynamic is *value-in-exchange* since the customers are passive in the value creation process. This traditional perspective involves a *goods-dominant logic*, as the physical product is central.

In contrast, *the service-dominant logic* (S-D logic) encompasses a specific perspective on the subject of service innovation as "*...the creation of new value propositions by means of developing existing or creating new practices and/or resources, or by means of integrating practices and resources in new ways*" (Skålén, Gummerus, von Koskull, & Magnusson, 2015). More directly, it involves the economical and social interaction between the supplier and customer, where value emerges from *value-in-use* (Autio & Thomas, 2018; Vargo & Lusch, 2004). Here the focus is rather on the interaction instead of the product, equating to increasing importance of the perceived value of the

experience. Value in this perspective is thus experientially determined and defined by the customer (Grönroos, 2011; Vargo & Lusch, 2004). Within S-D logic, the co-creation of value between the supplier and customer is a central aspect (Garcia Martin et al., 2019); Lusch and Nambisan (2015) states that "*value is no longer created by one actor, but increasingly created through co-creation*". This conforms with Vargo and Lusch (2004, 2008) view, which notes that the supplier can only offer a value proposition which then can be utilised by the customer *to satisfy the value-in-use*.

As implied, the co-creation of value is a rudimental aspect of S-D logic. The purpose of engaging in a co-creation environment is to extend the supplier-customer value exchange from a singular interaction to a mutual *value-exchange-channel*. While the principle of *value-in-exchange* may still be present by selling physical goods, the S-D logic entails that relationships should be extended beyond the transaction (Autio & Thomas, 2018). Doing so the supplier-customer dynamic in terms of the economical and social interaction changes from *goods-dominant* to *service-dominant*, as both actors engage in the value creation process. In practice, this would mean that the firm moves from purely selling physical goods through a value-in-exchange transaction to engaging in a mutually beneficial relationship with customers (Payne, Storbacka, & Frow, 2008).

3.3.5 Value co-creation

As indicated by the S-D logic introduction, value co-creation is a vital part of service innovation. The emphasis is on the *dyadic* interaction between supplier-customer whereby the co-creation of value occurs "*..when the service beneficiary engages with resources made available by the service provider...*" (Autio & Thomas, 2018). Grönroos and Voima (2013) present a model for value co-creation, where the supplier produces resources and processes that the customer can utilise to create value independently. In this model value co-creation only occurs in the supplier-customer interaction, where both participate and engage in a joint value creation process (Grönroos & Voima, 2013; Lenka et al., 2017). This conforms with the presented view by Autio and Thomas (2018) who states that "*value co-creation occurs when various resources are integrated by the service provider and the service beneficiary*". The general goal of engaging in value co-creation is to maximise the potential benefits by combining and integrating resources through the interaction (Autio & Thomas, 2018). All the aforementioned suggests that "*the customer is always a co-creator of value*" (Grönroos, 2011; Vargo & Lusch, 2008).

The literature highlights the close relationship within the dyadic interaction between the supplier-customer. For instance, having a close relationship may facilitate and enable the identification of new value-creating opportunities through mutual information sharing activities (Garcia Martin et al., 2019). Here the value is co-created by a direct and conscious interaction between the supplier-customer dyad, however, it is important to underline that this is not always necessary. Rather, in some cases, value can be co-created by simply having the supplier provide the resources that the customer can engage with and create value, and per definition, value is co-created (Autio & Thomas, 2018).

4

Discussion of research findings

This chapter encompasses the key findings from the research methodology section, and are discussed and analysed within the scope of this project. The findings and conclusions are presented in a format that will be the basis for the second section of the project, the company-specific application.

What has driven digitalisation in manufacturing companies regards either business competitiveness and/or business resilience. From the systematic literature review, it can be concluded that digital innovation that targets internal applications close to the current core business is the most common; companies attempt to do what they already do, but slightly better. Here the digital innovation revolves mainly around the economical value of digitalisation. That is, the primary benefit of digitalisation is a more efficient organisation where the value is represented by e.g. reducing operating costs, increasing process performance, increasing product quality, and reducing lead time. While these economical benefits can be of great value to remain or even increase the companies competitiveness, they do not capture the entire value associated with digitalisation. Thus, digitalisation is within this context used for short term benefits with limited opportunities to capture greater value and do not consider the corporate culture aspect of the definition of digitalisation presented in the introduction.

The aforementioned analysis can be visualised in *Kotler's business cycle* (Kotler & Armstrong, 2010), which traditionally describes different stages of a product. Looking at the cycle from a more general business perspective, digital innovation often occurs towards the end part, see figure 4.1. This would imply that the way digitalisation often is employed, is not suitable long term as the cycle indicates a declining trend. Howbeit, it can be a good way to strengthen the current core business.

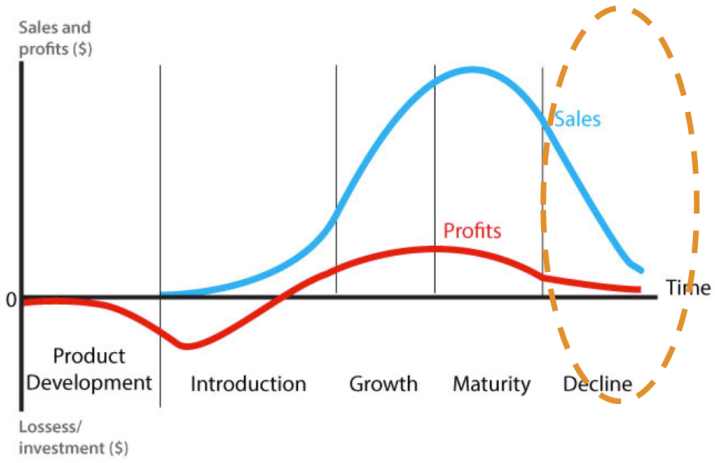

Figure 4.1: The employment of digitalisation is commonly focused on the improving the current core business, adjusted figure based on Kotler and Armstrong (2010).

While no clear evidence as to why digital development is internally focused has been found, it appears that digitalisation stays close to the traditional organisation. Considering that digitalisation is an abstract topic and that the purpose and value is to large extent unclear to many, the perceived best course of action is the least unknown. That is, to stay close to the current core business and continue doing what we already do in order to begin the digital development somewhere. This course of action requires the least changes and arguably have the least associated risks, thus it can be seen as an appropriate initial point for digitalisation. To reiterate, this way of employing digitalisation can be good for the short term benefits, however, digitalisation should be extended for the long term benefits. That said, if the digital transformation is not urgent, the internal employment of digitalisation can be utilised to experiment and establish a digital foundation and a culture that can adapt to the transformation in the future.

Remaining within this section of the curve is not desirable, and proactive efforts should be deployed to identify emerging opportunities that can reposition the company to a more favourable position to secure long term survival. Digital innovation can expand the current core business to increase the opportunities to capture more of the value of digitalisation. In industries where the product traditionally is a physical product, digital innovation enables the transition towards solution-based products which consists of both physical and digital assets, also known as product-service systems. In the product cycle curve, this would imply that the employment of digitalisation is increased by expanding the current core business, see Figure 4.2.

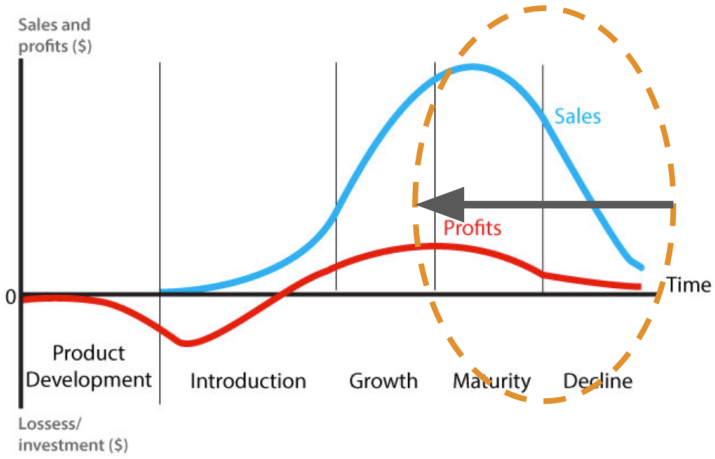

Figure 4.2: Digital innovation can expand the current core business and capture greater value by either (1) re-innovating the current business model or (2) creating a parallel business, adjusted figure based on Kotler and Armstrong (2010).

Expanding the core business with digital innovation entails the need for new or innovated business models to capture the value that is created. The one that creates value, is not necessarily the one that can capture it. One example of this is the value associated with predictive maintenance. This service is valuable for the customer but created by the firm. Thus fundamental changes may be necessary to adapt the organisation and its business model such that it can capture this new value. The most obvious changes regard the actual processes and activities that are designed to create and capture value; the current processes and activities are not designed to create and capture value through digital means such as data. As S-D logic suggests, the value created by digital innovation is associated with the overall experience rather than the quality of the physical asset. It is however crucial to neglect the company's core capabilities as they can represent a source of competitiveness and foster future prosperity if built on. Thereof, there needs to be a change in the corporate culture as well which is homogeneously prevalent throughout the entire company. Though, fundamentally changing to a more service oriented view tend to undermine the value of the physical product and the production.

By digitally transforming the company, Figure 4.3, there can be an industry-wide disruptive effect where the traditional way of working becomes obsolete and replaced by completely new business models and standards. Having digital innovation as a central part of the company will induce the greatest opportunities to capture the most of the value of digitalisation. The companies that are best prepared through working proactively and having a stable digital foundation and course can identify and act on emerging trends and opportunities.

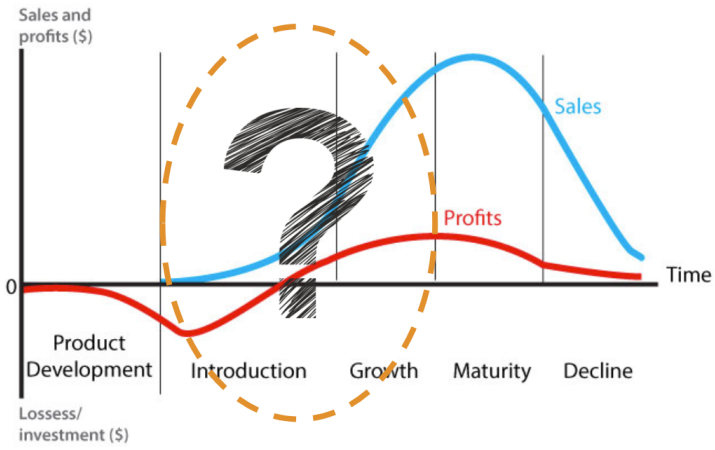

Figure 4.3: Digital innovation can have a disruptive effect for the industry where entirely new business models and value streams will be the new standard, adjusted figure based on Kotler and Armstrong (2010).

Digital transformation can be seen as a process in which an organisation successively incorporate digital innovation to increase the digital maturity level. In a simple way, this process attempts to bridge the gap between the current core business and the future core business. As the future core business often is unknown, the efforts should be focused on developing the capabilities and conditions that facilitate adjustments over time. This implies that digital innovation should be proactive rather than reactive in its nature, and therethrough transition the employment of digitalisation beyond the current practises. This can be accomplished in many ways, and the right course of action will differ between industries and companies as the notion of suitability, acceptability, and feasibility of the actions depends on both the external and internal environment. The actions can be divided into three categories depending on the deviation from the current core business, see Figure 4.4.

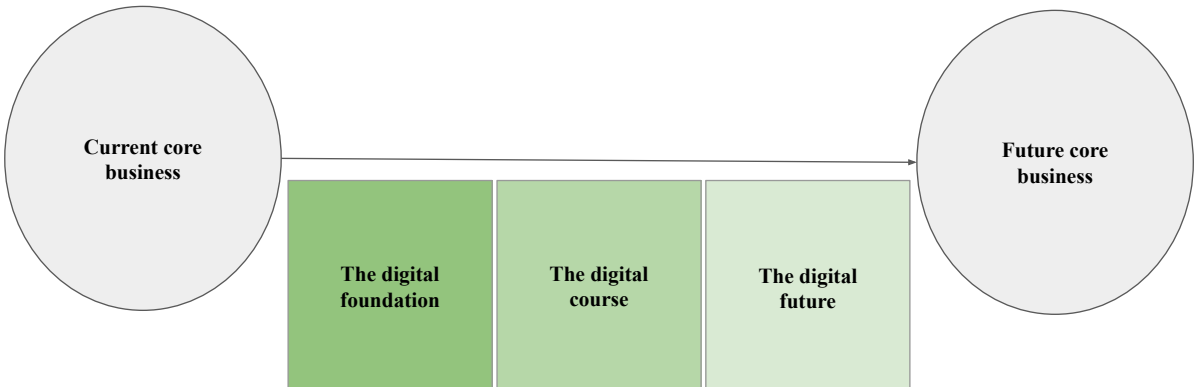

Figure 4.4: Increasing the digital maturity in the company will establish conditions where value can be created through digital innovation.

To enable more advanced digital applications to be incorporated in the company, a stable digital foundation should first be established to increase the general digital maturity. Doing so will significantly increase the likelihood for the company to successfully transform into becoming digital and being able to create and capture value through digital. Establishing a digital foundation can be done in close proximity to the current core business and practises, thereby not requiring considerable changes. Howbeit, the effects of digitalisation will be limited as it just complements the current way of working, such actions within this category are characterised by short term improvements. Noteworthy is that the benefits and value that these actions encompassing can be long term. The purpose of employing digitalisation within the current core business can in this context be seen as the establishment of capabilities and conditions to enable and facilitate a digital transformation.

Contrary to the digital foundation, the digital course is more dependent on the desired strategic path of the company as it is characterised as a deviation from the current core business. This implies that fundamental changes within the company are sometimes necessary to increase the likelihood to succeed. Additionally, a stable digital backbone should if possible be established prior as the rudimentary principle is to expand the employment of digital innovation that exceeds the current way of working. *The digital future* represents a future core business with characteristics that are radically different from the current core business. It therefore implies the need for large organisational changes to accommodate these differences. The chances for an organisation to successfully achieve the transformation towards this new core business increases in relation to their digital maturity.

5

Result of company-specific application and evaluation

In this chapter, the results of the second part of the project are presented. This includes the different parts of the product development process from which the final action plan was constructed. The chapter is structured in the same chronological order as was applied in the project and follows as: (i) Module formation, (ii) Concept formation, (iii) Elimination matrix), (iv) Concept screening, and (v) Final concept - action plan.

5.1 Module formation

The modules represent a holistic description of possible actions that can be acted on to increase digital maturity and accelerate the digital transformation in the company. The modules are based on the findings from the external research and are divided into three categories - (1) the digital foundation, (2) the digital course, and (3) the digital future - based on the perceived implication and deviation from the core business. Thereby it can be seen as a spectrum from minor changes to radical changes with regards to the current core business.

5.1.1 The digital foundation

The modules that require the least adjustments to the current core business constitute what is here defined as *the digital foundation* and are presented in Table 5.1. Through relatively simple actions, digital maturity can be increased that will subsequently improve the internal capabilities and conditions for a digital transformation to succeed. The fundamental principle is to establish a *digital backbone* within the company that is well prepared to adapt to emerging threats and opportunities. Having a stable digital backbone can enable more advanced adaptations of digital innovation. The focus is also to increase the ownership of data as the one who owns, controls, and understand the same data is better positioned to create value from it.

Table 5.1: A compiled list and description of the modules within *the digital foundation* category.

No.	Module	Description
1a.	Internal language	When digital capabilities and practices are incorporated by an organisation it is vital to have a common terminology. The existence of mismatched definitions between functions that hamper communication is a large risk if there has been several individual and disconnected digitalisation efforts. This phenomenon is identified during the company review and Li et al. (2020) demonstrates that mismatched definitions also are common in academia. This disadvantageous misalignment within the organisation is intensified over time as it makes communication and collaboration practices harder. A consensus of the internal terminology is a prerequisite for digitalisation and a digital transformation as it acts as a tool to unite driving forces and initiatives from different functions. A common terminology is vital for the employees to understand each other as well as the organisational strategy, goal and vision, which arguably is of utmost importance if anything is to be achieved. Important aspects of implementing a common internal language are that the employees understand why it happens, that it comes from top management and that it follows up with education and exposure.

2a.	Talent attraction	The activity a company chooses to invest in and the way they present themselves externally strongly affect their perception and attractiveness. Characteristics that make a company an attractive employer is affected by societal trends and the digital era is no exception. Industry 4.0 and the rapid development of digital technologies largely impact the capabilities needed in order to stay competitive. It is therefore important for companies to start the hunt for the digital talents of the future (Jackson & Dunn-Jensen, 2021; Baur & Wee, 2015). A fundamental action is to align their digital strategy with human resources and recruiting to clarify what type of competence is needed and facilitate a plan to attract it. There is a clear trend that companies expose their digital initiatives online to support a more digital perception of, the company. It is important to know the company's limitations and to have a clear understanding of what type of competence that needs to be attracted for the future. Govindarajan and Immelt (2019) states that manufacturers in general struggle with attracting digital talent, such as software engineers. The insight of what attracts different talent is an essential base to influence the external exposure, which in turn change the perception of the company. With different engagements in school projects and lectures etc., the company can choose what kind of content to show in order to affect how they are perceived.

3a.	Internal competence	The competence an organisation and its employees possess is strongly related to what can be achieved. In accordance with Wallin et al. (2015), capabilities for advanced systems and innovation, e.g related to PSS, are insufficiently developed in most manufacturing companies. Likewise, digitalisation and digital transformation are novel areas for many older organisations and require new capabilities in order to result in a successful outcome. With a deficient understanding of the potential and function of the new technologies, there is an increased risk that the potential will not be fully exploited and that investments will be done without beneficial returns. In order to address the problem and begin a focused digital transformation, it is fundamental that there is a common competence-base throughout the organisation. This broad knowledge base can be achieved by internal competence development such as courses, education and workshops. It is important to start as soon as possible to gain a basic understanding of the new technologies and their potential. The development of this digital competence at all levels within the organisation foster a common understanding of the subject that in turn lead to new ideas, application areas and collaborations. If a digital transformation is a part of the organisation's strategy and vision it is important that there is widespread competence and understanding amongst the employees. The majority of the employees do however only need to understand the basics in the beginning to ask the right questions and focus resources, but it is important that competence exists within all levels of the organisation. In addition, there must be at least a few with a deeper competence that can drive digital development.
4a.	Internal exposure	One way of getting attention, attracting people and demonstrating the seriousness of the initiatives at the beginning of a digitalisation journey is to focus on internal exposure. This will most likely attract both positive and negative opinions but at least it results in attention, and the risk of the initiative to just fade out decreases. The internal exposure and attention can be utilised to demonstrate examples of the potential of digital technologies, start a thinking process and involve people from different areas within the organisation.

5a.	Process optimisation	Process optimisation is one the most common drivers for digitalisation within the manufacturing industry. Aligned with internal efforts being over-represented and less difficult Björkdahl (2020), it is identified as an internal application of digital technologies that for many companies constitute the most natural starting point. The process optimisation can result in increased efficiency and quality, reduced costs and overall increased financial marginal for manufacturing companies. The internal application is focused on "do what we do, but better" and will not result in new revenue streams, neither provide the possibility to capitalise on all created value. This kind of initiatives therefore seldom live up to the anticipated financial benefits as the cost of implementing new hardware and software mitigates the effect. It is, however, an area of application that require relatively small changes, generates fast results and constitutes an example of the potential of digital technologies. It is therefore a strategic starting point for digitalisation in order to start working with digital technologies and the acceptability of the company culture. For a company facing an increasingly competitive landscape in a changing industry, the view on process optimisation should be to a strategic starting point with the focus on starting to work with new digital technologies, generate data and gain competence and experience. The aim should be to start the digitalisation process and create a foundation and possibility to identify and act on new revenue streams, not to settle with internal process optimisation as it in many cases is a negative spiral with decreasing marginals. It is important to understand that the competitiveness today and in the future differ. Additionally can new more digital-oriented companies enter the industrial landscape, as the entry barriers decrease with increased digital maturity. These new entries may change and disrupt the current conditions within the industrial landscape.

6a.	Digital infrastructure	The foundation of any digital transformation is the digital infrastructure that enables more advanced digital systems to be implemented (Lerch & Gotsch, 2015; Gebauer et al., 2011). A reliable digital infrastructure is a prerequisite for data insights of scale and is a common reason for projects to fail if not built with purpose (Rutten, 2021). It is strongly related to the data management processes in which data is collected and washed in order to translate raw data into valuable knowledge. When moving to more advanced digital systems, it is important that the digital infrastructure is capable of handling a large amount of data. Successful data management processes rely on a stable digital infrastructure that is compatible with handling the collected data. The digital infrastructure should have a structure throughout the entire organisation that enables the collected data to be utilised by any internal function where added value can be created. In practise, however, achieving a complete homogeneity is difficult but the target should be to have a standardised system that offer a secure and stable access to data necessary to provide and use for digital services. If there is no central control of data, there is an increased risk that the collected data can not be utilised properly.
7a.	Data and knowledge	Data is an intangible resource that has great potential to create value and is the fundamental aspect of digitalisation. According to Baur and Wee (2015), manufacturers primarily need to gather more data and make better use of it to capture the potential of digitalisation. It is therefore important to start collecting a vast amount of data and store it comprehensibly. While data can be valuable, it requires a proper data management process to translate raw data into usable knowledge and insights. To capture the value of data, one must first understand where and what value is being created and for who. Understanding this, the right data can be used appropriately. The one that creates value is not necessarily the one that can capture the created value, due to value being created outside the organisation's value capture activities or not being customised to capture the value created. The data management process should be well defined in order to maximize the potential to capture the value potentials; data collected from one part of the organisation may be valuable and useful in other parts of the organisation, howbeit, the data must then be both accessible and comprehensible.

8a.	Green production	Manufacturing firms' sustainability agenda has for a long time been driven by legislation, but a resource-efficient production has in a higher degree become a driver for development (Hallstedt et al., 2020). Digitalisation is highly correlated to sustainability and digital technologies within the manufacturing industry can be utilised for optimised production and increased process transparency. This in turn leads to a higher degree of knowledge about processes, managerial support and more resource-efficient production. In addition to the benefits directly related to digitalisation, digital technologies in the manufacturing industry drive sustainability forward and provide a further argument for competitiveness. With the focus on initialising a digital transformation resources need to be targeting the fundamentals that can open up new possibilities to the organisation, such as data, data architecture and competence. Green production is not seen as one of the fundamentals but rather as a beneficial value created for the organisation and can constitute a short term goal and a heavy argument to invest in digitalisation.

9a.	Strategic digital unit	A strategic digital unit is a function within the organisational structure that is responsible for defining the strategy for how to work with digital technologies. The function consists of a team with deeper or expert knowledge within the domain and is created to gather the forces around digital innovation. In the early stages of the digitalisation process, their knowledge and initiatives can be utilised for internal competence development, internal exposure and for defining a strategy that increases the organisation's digital maturity. The pros of remaining a function within the organisation are that it requires minor changes and therefore is quick to implement, they still have a close connection to other functions to promote collaboration and the direct insight of what happens within the organisation remains. The cons are to a high degree represented by the organisational culture, bureaucracy and inertia limiting a faster digital development. The strategic digital unit is responsible for the strategy but it is important to have direct involvement and communication with senior management for them to understand it, ask the right questions and allocate resources accordingly. In short term, this involvement of senior management is sufficient, howbeit, overtime the engagement from senior management should be fully integrated in the digital transformation. Depending on their level of digital competence it can be essential with an early focus on competence development.

5.1.2 The digital course

The modules that in some way expand the current core business is what is here defined as *the digital course*, see Table 5.2. Contrary to the modules in the digital foundation, these modules are more dependent on the desired strategic path of the company as it is characterised as a deviation from the current core business. This implies that fundamental changes within the company are sometimes necessary to increase the likelihood to succeed. Additionally, a stable digital backbone should if possible be established prior to these modules.

Table 5.2: A compiled list and description of the modules within *the digital course* category.

No.	Module	Description
1b.	External company perception	The external perception of the company reflect how the company's capabilities are viewed and can influence future opportunities. The partners and other players view on the company are closely related to how much responsibility and what type of tasks they trust the company with. The literature agrees upon digitalisation as a source for new opportunities in the value chain (Björkdahl, 2020; Lerch & Gotsch, 2015; Butt, 2020; Hallstedt et al., 2020). When innovating the organisation in terms of digital, the company need to develop a new type of capabilities that in turn can contribute to increased creation of value. In order for the company to capitalise on the potential of the new technologies, it is important that the external company perception reflect the new capabilities. Changing the perception can be challenging for an older company that has been in the industry for a long time but is essential to externalise digital innovations and create more value. For the company to be trusted with a new type of activities and a greater responsibility they need to focus resources on external exposure that can contribute to a perception that reflects the new capabilities. It is important that stakeholders have insight in the company's digital initiatives to strengthen the company's position. It can for example lead to increased responsibility in the value chain, new activities, alternative revenue streams and increased competitiveness.
2b.	Industry insight	Continuous and up to date market knowledge can provide the organisation with insights into how the industry landscape is changing. This information provides an indication of what competitors are focusing on, future revenue streams and new aspects of competition. The industry insight allows the organisation to work proactively for competitiveness and engage in important relationships by altering or empowering their strategy and resources. An essential aspect is that the resources focused on industry insight should target information that supports a potential future business and not only the current.

3b.	Value chain integration	The literature converges around the view on value as something that is maximised when it is co-created and that tight relationships increase the chances of beneficial solutions. According to Ludwig and Orchard (2017) an integrated approach is the only guarantee for long-term success. Common problems when developing solutions for external application is to understand the needs and to create a solution that is beneficial for all involved parties. Value chain integration should focus on creating tighter relations with the aim of understanding each other's internal processes better. This insight leverage all parts as it opens up possibilities to directly identify needs and contribute to activities to satisfy those needs. A closer and more transparent relationship is vital to identify new opportunities for co-development that in turn lead to more individualised solutions that provide an increased amount of value. However, it is of uppermost importance to underline that intellectual property and trade secrets should be thoroughly considered (Hallstedt et al., 2020). The aim of investing in closer relationships is also to build trust and demonstrate new capabilities that can be utilised to increase the company's responsibilities in the value chain. However, internal digital practices must already be developed as it is a prerequisite for the company to quickly capitalise on these new opportunities and for this strategic activity to be beneficial.

4b.	Data sharing	Data is becoming an increasingly important source of power as industries are digitally transformed. With innovative business models and renewed offerings to capture the value of digital innovations, data in this context is the prerequisite to create value. A general rule is that companies closer to the end user have a more natural way of accessing user data and utilises it as a competitive advantage. Another perspective of data is that it lowers industries entry barriers and can be the only property needed for IT-based companies to become influential players. Björkdahl (2020) and Rissiek and Bardram (2017) highlights the importance of sharing data and information in the value chain. Coherently, data is identified as a great enabler for development and competitiveness. Companies, therefore, need to identify what type of data they need to open up certain opportunities and what data they possess that can be valuable for others. When data is treated as a valuable resource it can act as a key argument for partnerships, negotiations, development, sales and other strategic actions. If it is possible to identify other companies with valuable data, or that need the company's internal data, it is an indicator to evaluate if data sharing, trading, purchasing or sales is a strategic option for further development or to strengthen relations. Data sharing in particular can facilitate value co-creation and open new opportunities, but the fundamental focus is to start treating data as a valuable asset.

5b.	Servitisation	Digitalisation can enable an increased value to the customers by complementing the traditional physical product with services. This is also known as servitisation and can be accomplished by either offering basic supporting services as an add-on feature, or more advanced solutions where the offering is comprised of both physical and digital components - PSS. Sjödin et al. (2020) states that new processes and capabilities are fundamental for the integration of services. There are multiple aspects that need to be considered in order for this to be successful. Most notably is the cultural aspect; the company transitions from selling physical products to offering solutions and services. This implies that the core business is changing and such the business model must also be innovated. From an engineering perspective, this transition can be hard to accept since the focus shifts from developing products and new solutions to repairing and maintaining the products. Maintenance is a service within manufacturing with high prominence. In the case of more advanced services, predictability can be highly valuable. However, this introduces the service paradox; the services provided to the service recipient diminishes the value for the service provider.
6b.	New revenue streams	Digitalisation may introduce digital innovations that have the potential to create new revenue streams for the company (Sklyar et al., 2019; Gartner, Inc., 2021). Contrary to servitisation where digital innovation may lead to an increased value of the product through services, these digital innovations represent other applications that go beyond the traditional product. In these cases, the business model should either be altered to incorporate the new revenue streams or restructured where the current business model works in parallel with a new business model. That said, new revenue streams may also be established by selling services rather than incorporating them into the same product offering which servitization could imply.

7b.	Downstream expansion	When the digital foundation, with data, technology, capabilities and practices, is well developed and accepted within the company it can be strategically utilised to expand the current business and move downstream in the value chain. This is aligned with Björkdahl (2020) who states that the development of intelligent products facilitates downstream movement and reduce the distance to end users. In this phase, the focus of digitalisation efforts is no longer just internal optimisation but rather the external application. Questions to be answered are related to how digital technologies and data can support and extend the current business, mainly by externalising digital innovation. By finding external application areas and successfully capitalise on them, the company strengthen their competitiveness and status as a problem solver and solution provider. This can in turn increase the company's responsibilities within the value chain and support their prospects of expanding downstream. Many companies do however struggle to identify external areas of application that is beneficial for both their customers and themselves. It is therefore important to allocate resources to mitigate that risk. For example to identify customer needs by tightening relationships and promote co-creation of value.

8b.	Digital continuity	If the level and understanding of digitalisation is noticeably unbalanced within a value chain it will hinder the potential for individual actors to fully create, deliver and capture the value of digital innovations. For example, actor connectivity and communication is a central factor for value chain integration that is negatively affected by varying levels of digital development (Belhadi et al., 2021). For instance, when Airbus developed introduced a platform it required its customers to develop new digital capabilities in order to capture its value (Google Cloud, 2021). This unbalanced digital transformation impedes further development as a result of an increasing mismatch of competence, communication, capabilities, culture and collaboration. Customers and suppliers need to be receptive in order to succeed with the aim of externalising digital innovations to support or extend the company's business. It can therefore be a strategic action to support other actors in their digital transformation to make sure that the digital transformation can continue. If this support is offered for free to strategically chosen actors it can strengthen relations and status and at the same time boost the company's own development. The investment in others can also be a strategical action to create value by getting more insight into their organisation, start co-development projects or accessing certain data.

9b.	Company culture	Company culture is a fundamental part of any organisation and should be considered in strategy. When changing or transforming an organisation, the people and processes should as a consequence also change so that it is appropriate for the transformed company. Govindarajan and Immelt (2019) argue that digital transformation will have a significant impact on industrial company culture, but that the culture itself prove to constitute a barrier for change. They further state that manufacturers adopt continuous improvement, while digital companies instead believe in constant innovation. Therefore, the people must be willing to accept the changes and adapt to the new way of working if it is to sustain. A digital transformation may alter the way the company operates, thus the way people and processes communicate and interact should also be customised. Transforming an organisation entails a need for change in the company culture. For instance, if an organisation decides to transform its core business into being solution- and service-oriented, the company culture has to adopt a service-dominant logic as well. Important for this transition to work in practice is that the people are willing to accept this change.
10b.	Separate unit	Many manufacturing companies suffer from relatively long product life cycles that cause strategies to stretch over a long time horizon. As digitalisation increases within the industry, the lead times and life cycles decreases causing a more competitive landscape. Companies that traditionally have strategies stretching over many years now incorporate digital technologies that are rapid and ever developing. A central aspect to be at the forefront of digital development is that digital technologies are of a fast-changing nature and can quickly become obsolete. The digital strategy can therefore not fall under the same time span as traditional physical products. A separate digital unit within the company is a strategic way of exploiting the speed of digital technologies. They should act with the freedom to iteratively explore different initiatives with the aim of demonstrating and driving the digital transformation. The strategic option requires small organisational changes and provide direct development since the unit still is within the company. The potential value created from this unit comes in several formats but for the company to see concrete results it can be strategic to initially focus on measurability.

5.1.3 The digital future

The digital future implies an overreaching future goal with digitalisation. The modules presented in Table 5.3 are deemed to be either decoupled from the current business or influence it to great extent. These modules are thereby considered to imply the need for larger changes to the core business. Additionally, a digitally mature organisation is likely to be required to integrate the benefits of these modules.

Table 5.3: A compiled list and description of the modules within *the digital future* category.

No.	Module	Description
1c.	Platform	Externalising internally developed digital platform solutions is a strategic option that can result in additional revenue streams and value. For example, Airbus developed a cloud-based platform for photo imagery to increase value for their customers (Airbus Defence and Space, 2021; Google Cloud, 2021). During the industry benchmark, it was identified that this is an emerging trend among companies with direct contact with end users, partnering with technology companies to realise it. It was also identified as a tool to reduce the distance to end users. Taking a digital innovation to the market do however require deep competence, broad capabilities and an organisation that can capture the created value. The strategic options are many depending on the desired value but it is essential to understand customer processes and needs to successfully create, deliver and capture the value. The organisation can for example strengthen co-development and partnership, increase insight and access data by providing other actors with a platform solution. Depending on the nature of the platform, the organisation need to innovate their business model for new financial models, develop new capabilities and allocate resources to take advantage of the restructured relationships.

2c.	Data-driven	Incorporating and utilising data in the operation is something that should be prominent from the outset as there are a plethora of opportunities that can be derived from the *right data*. Inefficiencies in the data management systems and data architecture can act as a major barrier to capture value (Baur & Wee, 2015). Sequentially, to be completely data-driven, a stable digital foundation needs to be established. Having this digital backbone enables the possibility for more advanced applications of data. An example of this is utilising data for product and process development; with an abundance of collected data, future products may be optimised based on the best possible design with the available data (Zhang et al., 2017). Generally, data will also facilitate decision-making processes since "the best" option can be determined on facts. To reach this point, a data-friendly company culture needs to be established in which people trust the data. While the data may highlight "the best" option, scepticism of how the data was processed may counteract the decision. Gaining trust is a long process, and to reach a data-friendly company culture there needs to be transparency of the data.
3c.	Strategic alignment	Prior actions have focused on the digital foundation, extending the current core business and creating the possibility to identify and act on future opportunities. A standardised way of working with data and collaboration between functions have been essential but to extend the core business further, or innovate it, organisations can develop a deeper strategic alignment. The aim is to gather the digital initiatives and align them to collectively support the organisation in a broader digital transformation. A clear direction for the whole organisation needs to be defined in order to transform the business further and strengthen competitiveness.

4c.	Venture capital	The rapid development of start-ups are becoming a larger threat as digitalisation lowers the entry barriers in the manufacturing industry. The time needed for a not yet digitally transformed company to acquire new capabilities and develop digital innovations by themselves can result in an environment with lost competitiveness and market shares. Well established companies can instead exploit the increased market competition by starting, or investing in, venture capital as an effort to outsource and speed up their own development. This was during the industry benchmark identified as a strategic option chosen by Volvo Group (AB Volvo, 2021) and BMW (BMW Startup Garage, 2021). The focus of the investments should target start-ups that drive the company forward in the digital transformation and include areas that support a potential future business. The nature of the venture capital therefore explorative and should not only exist to support the current business.
5c.	Open source	Driving a digital transformation and developing digital innovations can be challenging and puts pressure on internal competence and capabilities. The progression can be slow if the organisation suffer a low level of digital maturity or lacks capabilities to handle the development internally. Speed and deep competence can be determining factors for the success of digital innovations. Instead of trying to acquire new competence internally, organisations can search for help externally. One way to push the development of internal digital innovations forward is co-creation by releasing code or research data as open source and reach out to the industry and society. This strategic move exploits a broad and worldwide competence that can boost the development without having to invest resources to acquire competence. The organisation exposes their internal initiatives to the public, but this, in particular, can create value in terms of status and perception as digitally capable. Another strategic option is to focus on co-creation through open source within the value chain. This demands a certain level of digital continuity or can be a tool to achieve it. Volvo Cars, for example, released over 40 years of data related to safety research in order to increase the overall safety of cars while simultaneously strengthen their brand (Volvo Cars Corporation, 2021). Independent of which strategic option for open source, it is important that the organisation allocate resources that can be involved in the co-creation of value, understand the value and are able to capture it.

6c.	Subsidiary	Constructing an entirely new organisation that is attuned for the envisioned future company from the outset should be considered for large and complex changes. Here the subsidiary is not bound to the old practices in the parent company, but rather free to experiment independently. Two examples identified during the industry benchmark is GE with their subsidiary GE Digital for software applications and services, and Volvo Cars with Polestar, M, and Zenseact to accelerate the development in relation to different trends. In the case of digital transformation, the subsidiary may act as guidance for the parent company. This implies that the subsidiary is a smaller version of the larger parent company, and represent the envisioned state for the future. The learnings should continuously be incorporated in the parent company, thus it is important that the senior leadership transcends both the companies. In the case of digitalisation, the most noteworthy learnings regard the way people and processes communicate and interact. Thus it is of utmost importance that the subsidiary has a digital company culture (e.g. being data-driven) that is well prevalent. Additionally, the subsidiary may also explore potential future core businesses. A challenge with this option is that potential synergies with functions within the parent company cannot be utilised as easily.
7c.	Start-up	Similar to a subsidiary, creating a start-up may also be considered for large and complex changes. Specific for this option is the discrepancy from the current core business; if the start-up operates within an entirely different business, the learnings may not be appropriate or applicable for the original company. Such, the start-up is completely detached and are free from all the old practices. While this approach does not benefit the origin company's digital development directly, if done properly it can explore potential future core businesses in the long term and create a new revenue stream short term.

5.2 Module concept formation

While the modules by themselves represent different types of possible actions that can accelerate digital innovation, combining several of these into *concepts* will further increase digital maturity. The fundamental idea is to assemble key items for potential *action plans* to drive and accelerate digitalisation forward within the manufacturing company. Such, the concepts are generated and formed on that basis. In total, twelve different concepts were formed by the authors using a creative approach. These were generated based on themes and focused on potential synergies between modules. For example, the concept "Existing" is formed based on the company's *existing* current core business and constitute modules that require a relatively low amount of change. Hence the name is reflected by the fundamental theme that the concept was built upon. The concepts were later discussed, and refined based on input from each other. The refinements involved solving obvious weaknesses and disconnected modules. The twelve concepts are in low detail at this stage, however, constitute a coherent foundation for an action plan, see Table 5.4.

Table 5.4: Four of the twelve formed concepts, the concepts not shown here were generated in similar manner.

Existing (reference)	Internal guiding star
1a. Internal language	1a. Internal language
2a. Talent attraction	2a. Talent attraction
3a. Internal competence	3a. Internal competence
4a. Internal exposure	4a. Internal exposure
5a. Process optimisation	6a. Digital infrastructure
6a. Digital infrastructure	7a. Data & knowledge
7a. Data & knowledge	
9a. Strategic digital unit	1b. External company perception
	2b. Industry insight
4b. Data sharing	3b. Value chain integration
7b. Downstream movement	5b. Servitisation
9b. Company culture	9b. Company culture
	10b. Seperate unit
2c. Data driven	
	2c. Data driven
	3c. Strategic alignment

Daughter star	Venture
1a. Internal language	1a. Internal language
2a. Talent attraction	3a. Internal competence
6a. Digital infrastructure	4a. Internal exposure
7a. Data & knowledge	6a. Digital infrastructure
	7a. Data & knowledge
1b. External company perception	
2b. Industry insight	1b. External company perception
4b. Data sharing	2b. Industry insight
6b. New revenue streams	4b. Data sharing
7b. Downstream movement	6b. New revenue streams
9b. Company culture	9b. Company culture
2c. Data driven	2c. Data driven
3c. Strategic alignment	3c. Strategic alignment
6c. Subsidiary	4c. Venture capital

5.3 Disqualifying module concepts using elimination matrix

In order to narrow down the number of concepts, a simple elimination process consisting of an elimination matrix was performed. The result of the matrix can be seen in Figure 5.1. The purpose of an elimination matrix is to screen away concepts that do not fulfil the requirements in addition to obvious inferior concepts. The three criteria applied in this study regards whether the concepts are suitable, feasible, and acceptable which constitute common evaluation aspects within strategy development. Suitability concerns aspects such as whether the strategy (1) uses the companies strengths properly, (2) are aligned with the corporate business goal, and (3) fulfils the given purpose with the strategy. Feasibility considers if the strategy can actually be implemented in the company and concerns whether the company have (1) the resources, (2) aptitude, and (3) capabilities, required for the strategy. Lastly, acceptability concerns aspects related to (1) the potential risks, (2) expected returns and benefits, and (3) the probability of success. These were evaluated based on the company review, as well as, discussions with key figures for the study; the key figures contributed with discussions and insights, however, did not steer the evaluation direction.

Elimination Matrix				
Concept	Suitable	Feasible	Acceptable	Decision
Existing	+	+	+	Existing
Open sorcery	-			
Daughter star	+	+	+	Daughter star
Skippy	+	-		
Minimalist	+	-		
Venture	+	+	+	Venture
Twin star	+	+	-	
Risk junky	+	+	-	
Internal guiding star	+	+	+	Internal guiding star
Climate warrior	+	+	-	
Current star	+	-		
The conservative	-			

Figure 5.1: The twelve generated concepts were assessed based on the three strategy criteria suitability, feasibility, and acceptability.

As the concepts in its core concern a type of strategy, i.e. it will ultimately evolve into an action plan, these were deemed appropriate and sufficient for the given task. These are usually assessed in a number of related criteria that covers different aspects of the criteria, some of which are introduced above. However, to reiterate, the authors deemed a general interpretation of the criteria to be appropriate and sufficient for the given task.

5.4 Module concept screening

From the elimination process, four concepts remained which were assessed to be suitable, feasible, and acceptable solutions in order to drive and accelerate digitalisation within the manufacturing firm. The following step in the evaluation process consisted of comparing them against one another. For this task, a *Pugh matrix* was selected as it provides a structured and objective approach to compare concepts. The method is additionally well known and has been used extensively by the authors, which facilitates and legitimise the evaluation further. The criteria used in the screening process builds and the three criteria utilised in the elimination matrix, i.e. suitability, feasibility, and acceptability. These three criteria are here regarded as categories, and further dissected into more specific criteria that cover different important aspects.

5.4.1 Four remaining module concepts

The following section describes the synergies and dimensions of the concepts not disqualified in the elimination matrix. The four remaining concepts have been further developed to an equal degree of detail.

A) Existing

The concept "Existing" is the closest to, and build on, the existing core business of the company. That is, it requires the smallest amount of organisational changes. The initial strategic actions focus on building a digital foundation that is centred around a standardised way of working with data. In addition, the early focus is to create a common terminology, develop or attract digital capabilities and increase collaboration. A strategic option is to allocate a function within the company that is responsible for the digital development. They focus investments and resources on developing digital innovation for internal process optimisation.

The future state of this strategy is an improvement of internal processes with the aim of improving manufacturing capabilities, increase value chain responsibilities and move downstream. The digitalisation efforts are mainly focused internally, which makes the implementation relatively concrete and straightforward, and independent of others. The efforts can be locally focused, reducing the internal impact on practices and structure. Nevertheless, the initial investments for a digital infrastructure and data generation can be expensive. Since the focus is on internal processes, the investments show rapid results and the value can appear more concrete but is to a high degree limited to monetary value. The captured value from digital innovations will probably not meet the expectations as the strategy focuses on internal application with no business model innovation.

B) Internal guiding star

In accordance with concept A, the initial strategic actions of the "Internal guiding star" is centred around the digital foundation and capabilities but the aim is different. In this strategy, the initial actions are essential enablers of a digital transformation that increases the possibility to identify and act on new opportunities. The early digital efforts are rather utilised as a tool to start and accelerate the digital transformation than to create additional monetary value. Instead, the focus is to create a solid foundation of infrastructure, knowledge, capabilities, practices and start generating data to increase digital maturity. The internal focus, such as process optimisation, is beneficial in the early stages as the key is to start working with digitalisation. The future state of this strategy is however to increase the created, delivered and captured value by expanding the core business. The focus, therefore, shifts from internal to external application of digital innovations when the digital foundation is developed.

The externalisation results in resource allocation towards activities that support the identification of new opportunities. These are new ways of creating value based on digital innovations, such as industry insight, value chain integration and company perception. Another strategic action to accelerate the digital transformation, and reduce the risk of value erosion, is to create a separate unit within the company that operates with more freedom and in an agile way. In this way, the unit can rapidly evaluate different initiatives and contribute with knowledge to the rest of the company. The strategy requires an organisational change but also significantly increases the digital maturity and potential for creating and capturing value. The digital transformation is started internally while the externalisation increases and exploits several potential dimensions of value from digital innovations.

C) Daughter star

The concept "Daughter star" differ some from the two prior. The initial actions are still focused on building a digital foundation around data but not on rushing the development of digital capabilities throughout the organisation. Resources are instead allocated to develop a digital infrastructure and facilitate collaboration by knowledge and a common terminology. It is however still essential to start generating data in a standardised way.

The fundamental principles in this concept are inspired by Volvo Cars strategic approach with numerous subsidiaries such as Polestar, M, and Zenseact to innovate with industrial trends such as servitisation and electrification (Volvo Car Group, 2019). The strategic option of starting a subsidiary to develop digital innovations allows the parent organisation to continue within its core business and not rush the digital development. This can be beneficial in a large organisation as it can be challenging and slow to shift direction, leading to a high risk of value erosion. The subsidiary should focus on developing digital capabilities and exploring digital innovations outside of the parent organisations core business to identify new revenue streams. The acquired capabilities and successful initiatives can then be incorporated in the parent organisation to accelerate the digital transformation and redefine the core business.

The subsidiary facilitates a quick way to start exploring new opportunities as it is a tool to accelerate digital innovation while avoiding internal resistance. This strategic option reduces the risk for the parent to drive an unsuccessful internal digital transformation but increases the risk for the parent company's core business to become obsolete. The speed of the subsidiary also increases the risk for the parent company to fail to capture the value created by the subsidiary as a result of a deficient digital maturity.

D) Venture

Outsourcing digital innovation is key in the "Venture" concept. This concept is inspired by the *BMW Startup Garage* strategy, which seeks smaller start-ups "*...with an innovative technology, product or service that can make a significant contribution...*" (BMW Startup Garage, 2021). This initiative emerged when the automotive industry faced disruptive changes caused by rapid development of global connectivity, stricter regulations and lowered entry barriers. "Venture" is similar to the prior concepts during the initial phases. That is, it also focuses on developing a digital foundation, a standardised way of working with data, internal knowledge and capabilities to increase digital maturity. The aim of this strategy is to capitalise on the lowered industry entry barriers and accelerate digital innovation through venture capital. The investments target start-ups that contribute with solutions that are outside the company's core business to identify new revenue streams.

To capture and incorporate the value from venture capital, this strategy requires that the company has a solid digital foundation and is digitally mature. The strategic option of investing in venture capital allows the company to leverage from young digitally based start-ups that possess expert knowledge. It has a high uncertainty but also reduces the risk for the company as the organisation do not need to be adjusted to internally handle the development. Industry insight is an important activity for the company as investments can speed up the development of digital innovations within specific areas.

5.4.2 Comparing concepts using the Pugh Matrix method

The Pugh matrix, see Figure 5.2, provided a relative comparison between the four remaining concepts and an indication of which was the best strategic option. Concept A, "Existing", was chosen to be the reference as it constitutes the strategy closest to the current state. Which makes it the concept to beat in order to prove the potential benefits of a more radical change. The result indicates that all the three other concepts are inferior to the reference regarding the suitability, that is the utilisation of the company's strengths and opportunities, and addressing threats and weaknesses. This trend also applies to acceptability as the result shows that the concept "Existing" has the lowest relative scores on expectations, internal company reaction and potential risks and benefits. The only category in which concept A was inferior to the others was feasibility. This supports the idea of "Existing" being the concept closest to the company's current core business since it is practically applicable with a low degree of organisational change, does not require completely new capabilities and is overall more straightforward to implement. The result shows that the concept with the highest relative scoring was concept B, "Internal guiding star". Nevertheless, the process and result were presented for key stakeholders and it was concluded to proceed based on the indication from the Pugh matrix, that was to define "Internal guiding star" as the final concept.

Pugh Matrix					
Category	Criteria	Existing (reference)	Internal guiding star	Daughter star	Venture
Suitability	Capatilising on strengths	0	+	0	0
	Reduce weaknesses	0	+	+	+
	Capatilising on opportunities	0	+	+	+
	Adress threats	0	+	+	+
Acceptability	Expectations	0	+	+	+
	Potential risk	0	0	-	0
	Potential benefits	0	+	+	+
	Internal company reaction	0	+	0	0
Feasibility	Practically applicable	0	-	-	-
	Degree of organisational change	0	-	-	-
	Prior experience	0	+	-	-
	Current capability	0	-	-	-
	$\Sigma +$	0	8	5	5
	$\Sigma -$	0	3	5	4
	$\Sigma 0$	12	1	2	3
	Total	0	5	0	1
	Decision	NO	YES	NO	NO

Figure 5.2: A structured relative comparison of the four remaining concepts with a Pugh matrix.

To summarise the concept selection, several activities were planned in advance to support the evaluation of strategies and then carried out according to plan. In total, a number of twelve different concepts were evaluated. The continuous involvement of key stakeholders in different stages of the process promoted co-creation and ensured that the concepts were aligned with the company's envisioned future state and at the same time contributes to increased digital maturity.

5.5 Final module concept - Action plan

The last remaining concept is the "Internal guiding star". It is the concepts that scored the highest in the relative evaluation and the strategy align with the company's envisioned potential future state. The actions are presented in relation to the stages of *the digital foundation*, *the digital course* and *the digital future*, see Figure 5.3. The action plan constitutes a recommendation of how the organisation can focus their actions. It is based on the research findings, compiled information from the company review and industry benchmark, and the evaluation process.

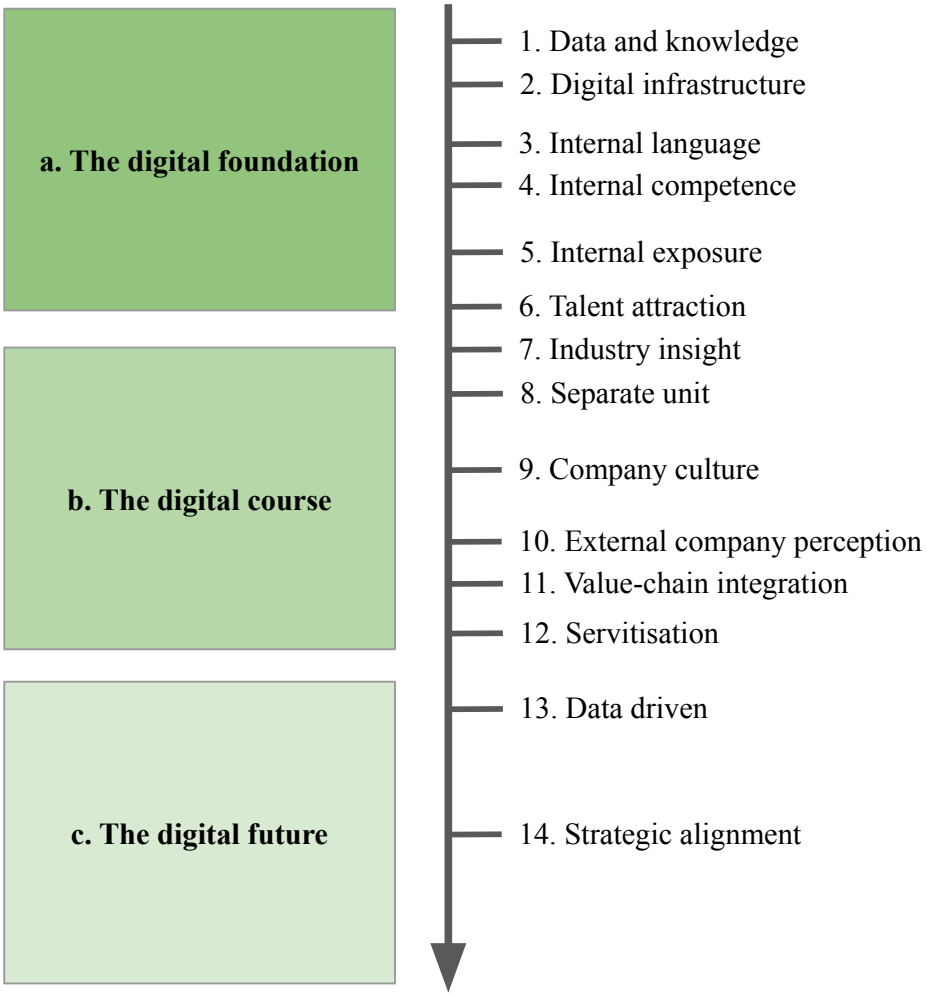

Figure 5.3: The concluded path forward with regards to *the three stages* for the manufacturing company in order to increase the internal digital maturity and further accelerate digital innovation.

Firstly, it is important to start working with data immediately, sequentially data management activities such as collecting data, processing data, and storing data should begin sooner rather than later. Initially, the data may be used for internal applications in close proximity to the current core business for *fast* value. This should over time extend beyond this to ensure long-term business resilience. Specific actions can be seen in Table 5.5. The fundamental digital infrastructure should likewise be developed early so that more advanced digital systems can be integrated over time. The two aforementioned activities, data management and digital infrastructure, constitute the digital foundation on which the digital transformation will ground. Here it is crucial to start the development towards homogeneously established practices that are defined throughout the entire organisation. The same practices should thereby be the same for all the functions to facilitate collaboration and information-sharing. Additionally, the data collected from one part of the organisation should easily be available and comprehensible for other parts as well to extend the possible application space.

Table 5.5: Actions that support the development of the digital foundation.

Action	**Description**
Generate data	Invest in data generation capabilities and different measurement technologies.
Collect and process data	Develop a standardised format to collect and process data that makes it applicable throughout the organisation.
Store data	Develop practices and infrastructure to store data in a way that makes it easily accessible.

Following, the establishment of a common organisational language should occur. The primary purpose is to align the general internal digital transformation efforts and increase the common digital maturity. Related actions are presented in Table 5.6. Thus the focus is shifted away from isolated digital innovation where advanced digital technologies are only integrated and applied in order to do what is already being done, but better. While the economical value derived from isolated digital innovation are concrete and can be of great benefit for the organisation, the conclusion suggests that this should not be the sole reason. Rather, the long term goal with the *isolated* digital innovation should go beyond improving the current practices. Having a common language within the context of digitalisation is vital as the topic is an elusive matter. For this reason, it is essential that everyone understand and mean the same when communicating. Digitalisation is a topic where the purpose and definitions are *unclear* to many, or even unknown. Additionally, different functions have their own set of definitions and frameworks; within marketing digitalisation means one thing, within product innovation it means something else, and so on. Similarly, the internal competence should be innovated and developed such that digitalisation is incorporated into the base competence of the employees. Understanding

technologies and concepts that may disrupt and revolutionise industries such as AI, big data, and servitisation may pose to be significant in the future.

Table 5.6: Actions related to internal language and internal competence.

Action	Description
Educate board members	Increase the digital knowledge and awareness of the board members. E.g. through courses, workshops and seminars held by internal or external experts. This is fundamental for focusing resources and accelerating digital development.
Create a common terminology	Define a common terminology that is communicated by top management. Employees need to be exposed to the definitions through different internal media, educations and workshops in order to accept and embrace it.
Develop base competence	Employees at least need a broad basic knowledge of areas related to digitalisation to facilitate development and understanding. This can, for example, be achieved through education, workshops and seminars.

A relatively simple way to further drive digital innovation forward is to increase the internal exposure of ongoing and successful projects. This could help to increase the awareness and implications of digitalisation, while additionally showcase the benefits and opportunities. Increasing the internal exposure through specific actions, see Table 5.7, will simultaneously improve the base competence of the employees within digitalisation, proliferate the common language, and strategically align isolated digital innovation. This action helps both the suggested short term goal by strengthening the current core business, while also facilitate the suggested long term goal of extending the employment of digital innovation.

Table 5.7: Actions to facilitate awareness and engagement through internal exposure.

Action	Description
Internal media	State the importance of digital initiatives by clearly exposing them on the company's internal media channels.
Top management support	Make clear statements that the top management is pro digitalisation and supports the development. It is also important to follow up with initiatives that confirm the support, e.g. investments and education.

Cross-function involvement	Internal exposure can be performed through the involvement of different key people. It can be in the co-creation of digital innovation across function borders to facilitate collaboration.

When a stable digital foundation has been established, the digital *stance* should shift to being proactive in its nature. These kinds of activities, that target talent attraction and external company perception, are shown in Table 5.8. Being proactive includes the prospect of securing future capabilities and competence in advance. Thus, the company should enter the pursuit of talents that will accommodate future demands and skills. Securing talents do not only involve attracting young talents, but rather attract the *right* and *best* talents. What should also be noted is that future capabilities will likely differ from the current demands on capabilities, such the aspiration should be to secure a wider spectrum of competence that traditionally may not be associated with the industry. Doing this will make the capabilities more ambidextrous as it does not only focus on satisfying today's needs, but also the future needs. Thereby the company could use digitalisation to increase the perception of the company and such attract new and more talents. Similarly, the external company perception is important for the future not only with regards to attracting talents but also in terms of the future market position. Digitalisation may change and disrupt the industry where opportunities may emerge, for instance, to reposition the company in more favourable positions in the market. The external view of the company can contribute to closer relations with existing partners, but also facilitate the engagement of future relations within the market.

Table 5.8: Actions that contribute to a change in the company's perception and attract talent.

Action	**Description**
Involve student ambassadors	Increase exposure and awareness at universities of interest by involving students as representatives for the company. These work as a middle hand and can host intriguing activities that positively affect the company's reputation.
Host events	Invest in activities such as hackathons, co-development and open source events that reflect a different, digital, view of the company. These can both contribute to solutions and result in a positive effect on the company perception.
Refine project work involvement	Review how the company collaborates with universities and how it affects the perception of the company. Involve in student projects within more areas and with an increased digital focus to become more attractive.

Increase external exposure	Review how the company present itself through different external media channels. Include and expose information that state that the company are investing in digital innovations and will be competitive in the digital future.
Enhance customer involvement	Involve customers in the co-creation of digital innovations as a strategy to create increased value and change the perception of the company's capabilities.

Additional recommended actions, Table 5.9, related to increasing the industry insight concerning digital innovation in order to identify trends and changes that can have industry disruptive effects. This is not limited to existing actors in the aerospace landscape but also involves new smaller entries. While small entries and start-ups may not initially pose a big threat, if successful they can over time develop into strong players in the market as it is easier for these to adapt to changes and opportunities quicker. Although the smaller entries do not have the benefits of larger organisations, they are also not restricted by the challenges and barriers that commonly are present in these large organisations.

Table 5.9: Increase the chances of identifying opportunities and trends to accelerate and focus the development of digital innovations.

Action	**Description**
Assign specific responsibilities	Define and assign an area of responsibility that covers the insight of what is happening in and around the industry that can influence the development of digital innovations.
Continuous strategic revision	Develop an agile and rapid practice of how to act in relation to emerging trends. E.g. evaluate if it is needed to invest in partnership, acquisition, internal development or co-development.

A possible approach to imitate a small fast-moving company, and thereof also copy many of its strength, is by establishing a particular unit that can work within the large company while not being restricted by e.g. its structures and cultures. Specific actions regarding this unit is presented in Table 5.10. That is, rather than attempting to transform the entire organisation at once, a *separate unit* can be constructed from scratch. Doing this could circumvent many of the challenges present within large organisations such as transforming corporate culture, navigating through complex bureaucracy, and innovating the business model. The presented challenges would require great changes in the current practises and business model, and thereof the associated risks are greater as well.

The underlying principle is to utilise the separate unit as a reference - or *a guiding star* - for the large organisation; the separate unit will represent what the large organisation should look like in the envisioned future state and in terms of the company culture. The unit can thus explore and experiment more *freely* while also display the full potential of transforming the entire organisation into the digital era. The learnings and success can thereafter be gradually and continuously incorporated into the organisation, without attempting to perform many radical changes at once. If successful, the separate unit could eventually have a strong business case to be turned into a subsidiary that has more freedom to explore beyond the limits of the current core business and practices.

Table 5.10: Demonstrate the value and accelerate the development of digital innovations through a separate unit.

Action	**Description**
Demonstrate example	Strategically focus on some areas of application where the effects of digital innovations are concrete and easily measured.
Agile testing of digital innovations	Create an organisational structure that allows the unit to work rapidly and agile to test and iterate digital innovations based on different trends and ideas.
Continuous knowledge sharing	Develop practices to continuously learn from the units initiatives and incorporate successful solutions throughout the entire organisation.

For manufacturing companies, a suitable course forward to expand the employment of digital innovation is through servitisation and value-chain integration, see related actions in Table 5.11. Both of these paths can work isolated from each other, however, there are great synergies between the two if they work in parallel. To succeed a decent level of digital maturity is preferable, hence their position late in the prior chart, see Figure 5.3. That is, the afore-presented actions should be performed prior as they all will increase the digital maturity while developing better conditions for this course to succeed.

Table 5.11: Increase value and accelerate servitisation through value-chain integration.

Action	**Description**
Deepen relations	Invest time and resources to deepen relations in order to increase insight and collaboration.
Digitalise information flow	Co-create digital innovations with customers and suppliers to create a common interface and facilitate clear and one-sided information.

Share data	Identify internal data that can be shared with external players to increase value. Also, identify external data that can increase value and possibilities for services if accessed.

Lastly, the two modules *data driven* and *strategic alignment* are proposed. Their placement in the chart is however a bit misleading as these are fundamentally incorporated in all of the actions so far, though subtle and mostly indirectly. For instance, utilising data for decision-making is considered to be within the frame of *data driven*. Howbeit, the module refers to complete data driven operation. Likewise for strategic alignment; improving the conditions for internal communication will for instance improve the strategic alignment of isolated digital innovation. These two action modules thus constitute an absolute goal towards becoming digital.

6

Discussion

This chapter reflects on the study in its entirety, such the final action plan is discussed as well as the methodology and process applied to reach our conclusions and recommendations. Additionally, a discussion regarding ethical consideration related to digitalisation and digital innovation is included.

6.1 The action plan

An action plan has been compiled that constitute a path forward to drive and accelerate the digital innovation within the manufacturing company, which the authors deem to be suitable, feasible, and acceptable within the given context and conditions. This action plan was derived from a product development process in which the company participated to assist the evaluation process. That said, the key figures had a passive role in the evaluation and thus did not steer the project, i.e. they gave insight through fruitful discussions.

Considering that the study has an explorative approach, GKN Aerospace was not examined nor reviewed in any greater detail. Additionally, internal information and trade secrets could have limited the opportunities to explore and discuss possible solutions. Thereby, the aerospace industry and GKN Aerospace's position in the value-chain became the focal point for the action plan. Due to these limitations, it is difficult to assess *exactly* what should be done from an external perspective. Also, the prerequisites are different for every company and therefore the actions will be different as well. The specific actions are not the most important, it is that the module is focused. Instead, the modules are specified further for every step as guidance and each specific company, including GKN Aerospace, can adapt and adopt the modules in the best possible way for their company. Noteworthy is that examined literature rarely highlights specific actions or what one can do in practice, thus the modules are formed by analysing and interpreting the literature. Thereof, this study contributes to this knowledge vacancy by concretising specific actions towards achieving the desired benefits of digitalisation.

The result in the study is not a specific framework or action plan that says exactly what to do, it is a general guide to identify and concretise the efforts of a digital transformation. It supports organisations in allocating resources to the right areas at the right time to increase digital maturity. Lastly, the developed action plan has not yet been verified. Also, if one wants to use the result of the study, it is important to examine the exact conditions prior.

6.2 The process

The overall process was successful, as the theoretical framework is both targeted and explorative, and the developed action plan supports the function Strategy and Business Innovation in their work. The project was divided into two distinct phases: the research methodology and the company-specific application. This division of the study facilitated several aspects of the study. For instance, it was deemed early in the project that an external view of the subject was desired. This would support the creative parts of the project by not limiting the potential actions to the existing structures and conditions of the company. Conducting the research at the beginning of the project allowed this. The authors could thus explore potential actions forward by studying the literature and the industry.

A few improvements were identified when reflecting on the process. Firstly, since the interviews were conducted through digital platforms, it was noticeable harder with discussions and understanding each other. Introducing mediating tools from the start could have made it easier to comprehend. Secondly, the evaluation process was not iterated to refine the concepts since they were approved by the key stakeholders. This is seen as a result of the study being of an explorative nature without a concrete desired result. The company review could have been more extensive in order to identify specific needs and requirements. However, the involvement of key stakeholders from an early stage did allow continuous evaluation of the process and concepts. This ultimately led to the result of the process being suitable for the company.

The two literature reviews were considered to be well-executed as the information gathered was useful and sufficient. The material covered provided a broad knowledge base of the targeted areas. The number of publications covered was adequate for the study as the information converged and the amount of new input stagnated. Some clear directions from the literature could be translated into potential actions. However, for the most part, there was no clear indication of how a company could employ digital innovation. Thereof, the authors had to scrutinise the literature and *read between the lines*.

6.3 Sustainability and ethical consideration

Ecological sustainability: European Union present digitalisation and sustainability as the two greatest challenges of our time that are highly interconnected with each other. The societal sustainability agenda can drive the digitalisation of society, while digitalisation can contribute to more sustainable solutions. Sustainability is an essential aspect of the aerospace industry as there are strict requirements and legislation concerning environmental footprints and material traceability. The increased ability of processing data affects business as it contributes to increased insight and more informed decisions. This, in turn, leads to, for example, decreased freight, resource optimisation and in-use energy consumption. Additionally, have climate change alter customer behaviour within the transport industry entailing new market demands. Sustainability efforts have traditionally been focused to fulfil legislation and stricter requirements. However, societal development converges to a proactive approach where competitiveness can be created through sustainability. Proceeding with sustainability efforts in a reactive nature will likely not be sufficient for sustainable development, and innovative and radical solutions will be the future normal. Data may enable manufacturers to introduce new types of services that use material and process information to accommodate the increased demand on traceability of environmental footprints.

Social sustainability: A common debate within the political landscape is the impact that technical development, such as increased automation, has on society. When machines and computers can perform a specific task better than humans can, they are often replaced. If the purpose of digitally transforming the organisation is purely economical, it would eventually result in fewer job opportunities for people as AI continue to develop. Furthermore, would traditional simple tasks increase in its complexity, requiring a more highly educated and technically savvy workforce. The aforementioned would thereby exacerbate social issues in society such as unemployment, segregation, and inequality. To mitigate the potential social effects of technical development, more specifically digital innovation, the corporate strategy and goal should have a higher ambition that goes beyond pure economical growth. This premise supports the idea that digitalisation regards not only the utilisation of new more advanced technologies to gain economic values but also how people and processes communicate and interact.

Responsibility regarding data driven decision: Digitally transforming an organisation entails gradually integrating data into every part of the organisation and ultimately becoming fully data driven. This would imply that decisions are less connected to individuals and their intuitions. Decisions based on *objective* data and information may lead to better and faster decision-making that can effectively improve the company's business. However, if every decision is based on data and something still goes wrong - who is responsible for the decision? In the traditional decision-making process, the individuals that made the decisions are likely to bear the responsibility. Who would bear the responsibility for e.g. accidents caused by data driven decisions? Is it the lead-

ership that approved the data driven processes? Is it the engineers? Or is it some other stakeholder involved? Removing the subjective factor and the human intuition in the decision-making have its many benefits, and will likely result in *better* decisions. That said, sequentially the responsibility for the decisions is also removed since the data itself cannot be held responsible for the decision.

Ownership of data: As digitalisation proliferates within society, the value of data will likely increase remarkably as it constitutes an integrated part of digital innovation. The one that *owns* and control the data are the one that possesses the power. This issue becomes even more delicate when it considers personal data from end consumers. Looking at more digital mature industries such as IT, we can see that great efforts are being dedicated in order to protect individuals from unregulated data usage. Large social media platforms, for example, has access to a plethora of data that represent the consumer at an individual level; information from every part of the consumer's life can in theory be gathered and sold to whomever if no regulation existed. Nowadays there are regulations of what type of data can be distributed and how. As society becomes more digitally savvy, more regulations with data are likely to emerge. Within the manufacturing industry, the same ethical consideration may present itself as data from external sources may be incorporated into the internal digital systems. Such, questions regarding who owns the data and how it can be distributed and used will need to be considered.

7

Conclusion

This chapter includes the conclusions drawn from this study. The three research questions are revisited and answered. Then a general conclusion with regards to the aim is established. Lastly, additional remarks and future recommendations are presented.

The result of this thesis is concluded to be in agreement with academia, trends and predictions regarding the manufacturing industry and society. The presented result aligns with prominent actors within the topic and the EU strategy *"Shaping the digital transformation in Europe"*. In comparison to prior research, this thesis contributes with concretised aspects of how to approach digital transformation in order to increase the level of digital maturity. The close alignment with the current *state-of-the-art* within the topic additionally increases the credibility of the findings; *International Data Corporation* (IDC) extensively reports on the topic and highlights similar perspectives (Cf. International Data Corporation, 2021; Paquin, 2021; Hojlo, 2021).

R$_1$ *What are the driving forces for digitalisation in manufacturing companies?*

The identified drivers for digitalisation within manufacturing constitute either some sort of competitive advantage and/or business resilience for the firm. These two terms encompass the core drivers and can be categorised into five generic themes: (1) market change, (2) operational efficiency, (3) growth, (4) flexibility, and (5) external relations. Usually, digitalisation is driven by a combination of several of the presented drivers in this study, and each company has its own set of drivers. The internal application and utilisation of advanced technologies are the most common employment of digital innovation. This often concerns improvements of the current practises in order to cut costs, improve operational efficiency and performance, which revolves around the economical values of digital innovation. Additionally, digital innovation often occurs in proximity to the current core business, i.e. use digitalisation to improve the current way of working and do what is already being done, but better.

$\mathbf{R}_2$ *How can the value of a digital innovation be created, delivered and captured?*

The value of digital innovation has two distinct dimensions, the traditional monetary value and the intangible value. That is, within the context of digital innovation value goes beyond pure economical values and also includes how the organisation retain values such as company reputation, customer perception, brand, and employee satisfaction. Organisation should continuously re-innovate their product offerings and current way of working to remain competitive and mitigate value erosion. The effects of "doing nothing", i.e. not re-innovate the current business, will over time lead to a position where the current core business is in a declining state.

A common trend to create, deliver, and capture value associated with digital innovation is through different types of services that accommodate value for both internal and external stakeholders. The transition towards integrating services into the current business, also known as servitisation, further includes changing processes and capabilities in order to create, deliver, and capture new potential value emerging from digital innovation. These trends enable companies to internally enhance and strengthen the current core business and compete in new ways. This can have industry disruptive effects where companies that are ill-prepared to adapt to the new norm may eventually find themselves in a declining position. Lastly, the one that creates value through digital innovation is not necessarily the one that can capture the value. Thus the current practices and business model should be altered such that the value created by digital innovation can also be captured by the company.

$\mathbf{R}_3$ *How does digital maturity affect the traditional view on products and how they create value?*

Digital maturity is essential for companies that wish to digitally transform their business, and successfully innovate their organisation so that new value can emerge from becoming digital. In organisations with low digital maturity, digital innovation is often reactive in its nature and mainly focused on the extended utilisation of new advanced technologies that can improve the current core business and increase competitiveness. A strong indication for low digital maturity is neglecting the connection to strategy and business, and solely associating digitalisation as an IT practice managed by the IT department. Our conclusion is that the limited view of digital innovation can be of great value for an organisation that wishes to increase its vested interest in digital innovation, however, the benefits are limited and short term. Instead, organisations should shift the approach to a *proactive stance* in order to develop good conditions to (i) identify and capitalise on potential opportunities that may present themselves, and (ii) identify and mitigate potential threats and exogenous changes that may disrupt the industry in the future.

Our analysis of the literature suggests that increasing the digital maturity in the organisation can affect the perspective of the traditional product. That is, by increasing the vested interest for digital innovation the view on what the product is can change as it becomes ever more evident that the product constitutes more than just the physical asset the more digitally mature the organisation is. Sequentially, the notion of value must be revised to accommodate this transformation as different forms of value becomes increasingly important. As value exceeds the traditional monetary dimension, the insight of to whom digital innovation create value is essential. It is thereof crucial to understand that value differs between stakeholders, meaning that value for the customer does not necessarily equal value for the supplier.

While companies may have a long history with digitalisation, the full value and benefit that it can provide is often overlooked. Considering the premise that many do not know the full value of digitalisation or even understand the reason for why they have vested interest in the topic, it is difficult to know where to begin in a digital transformation. This causes companies to position their digital development close to their current core business since it is the least unknown. The majority of digitalisation efforts are thus focused on improving the current business, where a lot of the digital development occurs internally and focuses on process efficiency. However, this does not always target the exogenous changes (threats and opportunities). Additionally, the value created by digital innovations can not always be captured within the current business model. Such, business model innovation is required to capture the full benefits that digital innovation create. This might work in the current situation since digitalisation is a novel area within the manufacturing domain but to survive and achieve long term competitiveness, companies need to capitalise on a broader value of digitalisation by finding new ways to compete.

7.1 Future recommendation and additional remarks

The foremost recommendation if the results of this study are to be applied is to examine the current conditions within the company and its business landscape. As highlighted previously, the results and conclusions have moreover not been verified in practice and should thus be assessed further to secure a *proof-of-concept*. The presented modules are not finalised and can thus be refined or complemented by new modules. It is next to impossible to know how the industry and market landscape will look in the future, thus the strategic approach regarding digitalisation should be continuously revised and reiterated. A good initial point is to consider what value has been created through digital innovation previously within the company to validate and construct the path forward.

Value in the context of digital innovations is imperative to understand, however, heavily underrepresented in the literature. It is much more than the traditional monetary value and includes more intangible values that are difficult to measure. Further research of the dimensions of *the value of digitalisation*, should be conducted to support the understanding of how to quantify the value in order to formulate strong business cases. That is, to weigh investments in comparison to value instead of the more definite monetary return of investment.

The employment of digitalisation within the framework of Kotler's business cycle analysed in this study can further be investigated. Instead of compiling the findings from the literature, more thorough case studies can be performed to analyse where digital innovation occurs, and the purpose of digitalisation. Additionally, the presented modules can also be investigated to assess their impact on digital maturity in different *stages*.

Finally, the authors want to emphasise that digitalisation is not only about the integration and extended utilisation of more advanced technologies. Rather it involves the business strategy concerning the increased capabilities and opportunities revolving around data. This extended scope of digitalisation has the possibility to disrupt the current business landscape and may propel the competitiveness and business resilience of the company.

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