Making a Digital Transformation Framework for SMEs come Alive

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Making a Digital Transformation Framework for SMEs come Alive

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Abstract. When searching for information and gaining more knowledge about AI, smart industry, Industry 4.0 or other similar emerging technology areas, one may easily be overwhelmed by the vast amount. It is important not to forget that these emerging technologies, their possible implementations and abilities, cannot be fully understood, used and applied without context, i.e. a broader perspective, not only technology focused, is needed. Such broadened perspective could be understood as digitalization or digital transformation (DT) covering not only the technology itself but a broad scope of the business and organization.

But even with a solid understanding of the technology, domain, processes and value chain, it is not easy to move forward with digital solutions transforming the business. Not least, this challenge is a reality for many small- and medium sized manufacturing companies (SME) who often have limited resources both in terms of financial strength, and in number of employees. To keep competitiveness, SMEs need to continuously adopt and implement such emerging technologies and methods in their business. Though most research on DT do not focus processes and implementation at SMEs.

In this paper, we present our work on developing a DT framework. Our work is aiming SMEs in manufacturing and our primary target has been family-owned businesses studying practical implementations of digitalisation initiatives. The paper describes how the framework has developed from the initial versions, mainly based in literature, and how implementations at SMEs, along with contemporary publications, iteratively have developed and validated it.

Keywords. Digital Transformation, Manufacturing SME, Digital Maturity Analysis

1. Introduction

Continuously improving and optimizing your processes and value chains is a never-ending story for companies operating at a competitive market. The adoption and utilization of emerging digital technologies is essential for companies to sustain their competitive edge. When searching for information to gain more knowledge about AI, smart industry, Industry 4.0 or other similar emerging technology areas today one can easily be overwhelmed by information and statements about what different technologies and methods can deliver, its implementation and use. It is important not to forget, that technologies, their possible implementations and abilities can't be

fully understood, used and applied without context, meaning that a broader perspective, not only technology focused, is needed. It is from our perspective necessary to set digitalisation and digital transformation (DT) in a broader perspective. Digitalisation and DT is much more than just technology. In addition, current literature includes many different frameworks aimed at supporting manufacturing companies in digitally transforming their business, by indicating general business dimensions besides technology that comes into play. However, [1] concludes that no framework fits all, identifying a dissonance between research interest and business focus of DT, underlining the importance of developing and adapting the frameworks used for the organization at hand. In addition, in the literature, many raise a concern that small- and medium sized (SME) manufacturing companies are lagging behind in their DT. On a general level, [2] identify that many manufacturing SMEs have vastly different starting conditions compared to larger companies, where the manufacturing SMEs' overall digital capabilities and readiness to start a transformation journey is generally much lower. In our experience, these starting conditions implicate the process and dimensions that must be taken into concern when manufacturing SMEs embarks on a DT journey. Foundational prerequisites, such as sufficient knowledge, financial investment resources, integrated IT-solutions and proper data management that may be taken for granted in bigger manufacturing companies, may constituted severe hinders for manufacturing SMEs.

In this paper, we present an assessed and refined DT framework towards manufacturing SMEs. A design science research method process was followed and two iterations of the DT framework was conducted, with the aim of tailoring it towards the prerequisites and conditions of manufacturing SMEs, in order to assess and refine it. Such tailoring is important, since manufacturing SMEs have vastly different starting conditions compared to larger companies and their overall digital capabilities and readiness to start a transformation journey is generally much lower [2]. In addition, a design science research method process also contributes with a vast amount of detailed, empirical material, contributing to the cohesive body of knowledge on the state-of-practice with respect to DT in manufacturing SMEs. Thereby, we also contribute to the need of further research studying practical implementations of digitalisation initiatives in SMEs, expressed by e.g. [3] and [4]. The paper describes and discusses how the DT framework has developed from the initial versions, mainly based in literature, and how implementations in SMEs, along with contemporary publications, iteratively have developed and validated it. In addition, this work also contributes with a theoretical reasoning and refinement of existing theory regarding the relationship between the concept's digitisation, digitalisation and digital transformation.

The rest of this paper is organized as follows. The frame of reference is elaborated in Section 2. In Section 3 details are given regarding the design science research method process applied. In Section 4, the analysis of and the results from the assessments and consequential refinements are presented. Section 5 concludes the paper by discussing the findings and suggest ideas for future work.

2. Frame of Reference

2.1 Digitisation, Digitalisation and Digital transformation

There are many concepts used for describing the adoption and applications of digital solutions in companies. The concepts digitization, digitalisation and DT are frequently used, sometimes interchangeably, to describe companies' adoption of digital solutions and capabilities rendered. In addition, the concepts are often used in a broad meaning and inclusive, covering many different

aspects related to the adoption and use of digital solutions. This causes confusion and disparate interpretations. To counter such confusion, several defined the concepts, as well as define the interrelationship between them in a three stages model. Bumann and Peter [5] (Figure 1), among others, outline this as a sequential model where digitisation is followed by digitalisation and in turn DT. In general, it can be said that digitisation means a transition from analogue to digital, for example, that assembly instructions are displayed on a screen instead of a paper-based system. Digitalisation refers to the use of digital technologies to improve and streamline processes. In the third stage, DT, the business model is transformed, often exemplified by how we watch movies at home: 25-30 years ago, we went to a video store and rented a physical video cassette that we then played via a video player at home. Today, the industry has been transformed, the physical devices have been removed, and the film is streamed instead. With the DT, the product has become a service.

The advantage of dividing it into several phases is that it clarifies that it is a process, not a single one-time-effort, and that the digitalisation goal then has been reached. In our work, however, we have found that the relationships between the different phases are not sequential and that the relationship between them is not 1:1. Later in the paper we will further discuss the basis of our reasoning and how we view the relationship and levels between these three phases.

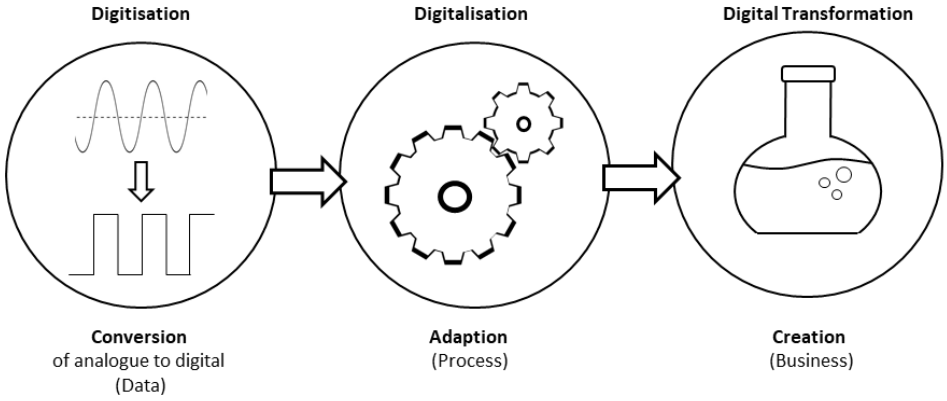

Figure 1. The abstraction levels and relationships between digitisation, digitalisation and digital transformation (based on [5]).

2.2 General definitions of digital transformation

However, a general definition of DT and the procedure of implementing DT is not clear. Vial [6] lists over 20 different definitions of DT in his work indicating that a comprehensive portrait of DT's nature and implications still is lacking. The strife of defining DT is continued by [7], analysing 134 definitions of DT and proposing a unified one. The work is proceeded, updated and extended by [8] adding yet some more DT-definitions and again trying to concluded them all into one unifying definition. The same ambition is also found in [9] proposing a unifying conceptual DT-framework based on more than forty publications but [10] concludes that the absence of a universally accepted definition of DT is still one of the primary challenges of the domain.

But even with a solid understanding of technology and the domain of DT, it is not always easy to filter out and understand the information or method that can be implemented in the specific situation in order to be able to move forward with digital solutions with an aim of transforming the business. Not least, this challenge is a reality for many SMEs who often have limited resources both in terms of financial strength and in terms of the number of employees [11]. But at the same time these SMEs constitutes a vast majority of all companies and are crucial for the economy in

most countries. The SMEs employ two thirds of the total workforce in the EU and more than half of the total value added and if delimiting the scope to manufacturing industry, the importance of SMEs is still at hand [12]. To keep competitiveness these SMEs, need to continuously adopt and implement such emerging technologies and methods in their business. Though most research on DT do not focus processes and implementation at SMEs [2, 10, 13-15].

Several attempts have been made, but no general or universal definition of DT has yet clearly gained general acceptance. Since DT is not only relevant within one specific, well-defined area but affects all sectors of society, with widely varying conditions and needs, a general definition will probably need further explanations and clarifications for specific areas or demarcations.

2.3 Frameworks of digital transformation

The emergence of the DT area is described by [16] having three phases, "the Embryonic stage" 2000-2012, the "Development stage" 2013-2017 and the "Thriving stage" 2018-2020. Contemporary literature reinforces the phase of "the Thriving stage" beyond 2020 as the number of publications within DT continues to rise. Digital transformation was a rather insignificant publication field until 2018-2019 when the number of publications started to sky rocket [17]. One focus of the DT-frontier examined DT-frameworks and its applicability. Four dimensions of DT are presented by [18] and [19] describe the approach made by three German companies towards DT. They provide a list of strategic questions and associated answers to be used as guidelines when formulating a strategy for DT. As previously indicated the amount of published work on DT-frameworks are rising during this time and ten DT-frameworks are investigated, assessed and compared by [1]. Yet another DT-framework validated through workshops, conferences and an industrial case study is presented by [20] and [21] propose a framework modelling capabilities enabling organizations to reach further in DT. Verina and Titko [22] identifies three main categories of DT in businesses: Technologies, Processes and management, and People, emphasizing that DT extends beyond merely implementing IT-solutions. They underline that it encompasses a broader organizational change in combination with other areas such as internal cultural transformation and a customer centric approach as also indicated by others [4, 5, 23, 24]. Further on [25] evaluated seven digital maturity models on nine criteria and identified that the design of the maturity model is closely related to the intended user of the model. They underlined the importance of evolving such models from being purely prescriptive to becoming more descriptive without at the same time becoming too complex. A conceptual DT-framework indicating enabling factors on strategic, tactical and operational levels are presented by [26] and eleven factors concerning employees on individual, group and organizational level, is presented by [23] as key factors for a successful DT-implementation. Further on a study by [27] presents results from case studies at four big organizations exploring how they organize and manage their DT-journeys. Zaoui and Souissi [28] and [29] presents a DT-framework spotlighting the strategic character of DT and tries to determine the necessary steps to digitally transform a company. They report of a DT-framework implementation at an SME identifying dysfunctions limiting the impact: Lack of digital strategy, customer perspective neglected and that the DT of the company does not involve all stakeholders. Also results from [5, 17, 18, 30] highlight the importance of a digital strategy as central for a company to benefit from DT. A conceptual framework for DT is presented by [31] aiming to give guidance for organizational capabilities in the DT-process. From interviews a conceptual model of DT is built also indicating the importance of non-technological areas such as leadership, structures and culture developing the DT. Finally, [32] suggests a DT-framework which focuses on DT according to the following four dimensions, Resources, Information system, Culture and Organizational structure.

3. Research Method

In order to develop and validate a DT framework for manufacturing SMEs, a design science research approach was chosen. We consider design science to be a proper approach, since it focuses on developing and evaluating artefacts, which may come in various types; constructs, implementations, methods, and models [33, 34]. In addition, design science is a frequently used approach to address the complexity of building and evaluating artifacts and there are several different process frameworks suggesting iterative steps to take. In this work we align to the work by [35] suggesting the following process framework (Figure 2):

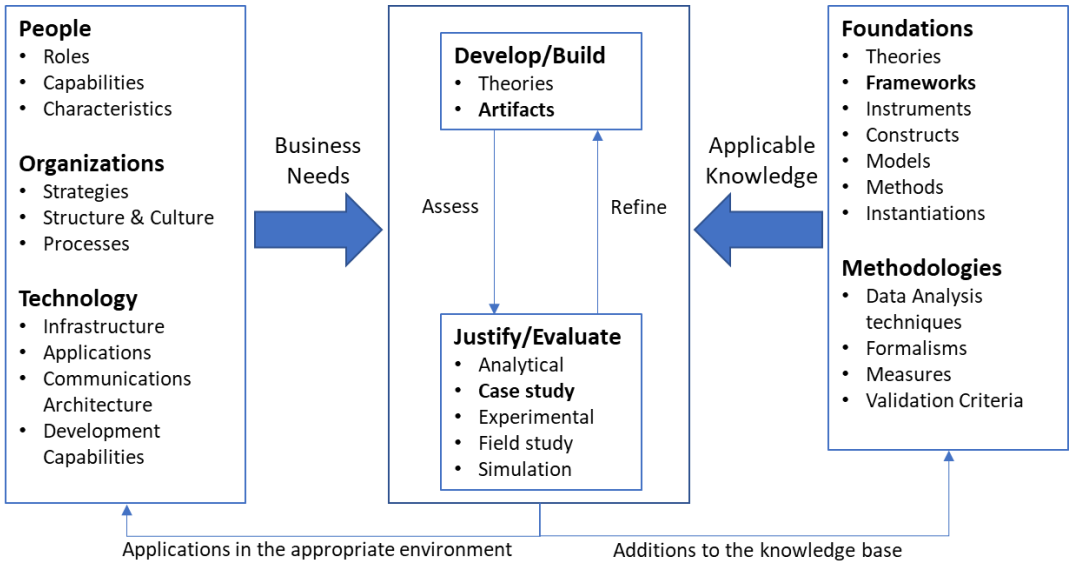

Figure 2. Process Framework for Design Science research (based on [35], p. 80).

Moreover, Figure 3 illustrates the research process conducted in this work. The illustrated process is based upon the work by [34], p 58 and their proposed design science research method process. Following the design science research method, the refinement of the proposed DT framework for SMEs followed an iterative process, where the DT framework (i.e., the artifact in focus) was assessed and refined several times, and where empirical evidence from the participating SMEs was integrated with knowledge identified in the literature. Additionally, the findings from the assessments contributed with novel knowledge, addition to the knowledge base, as well as to the participating SMEs.

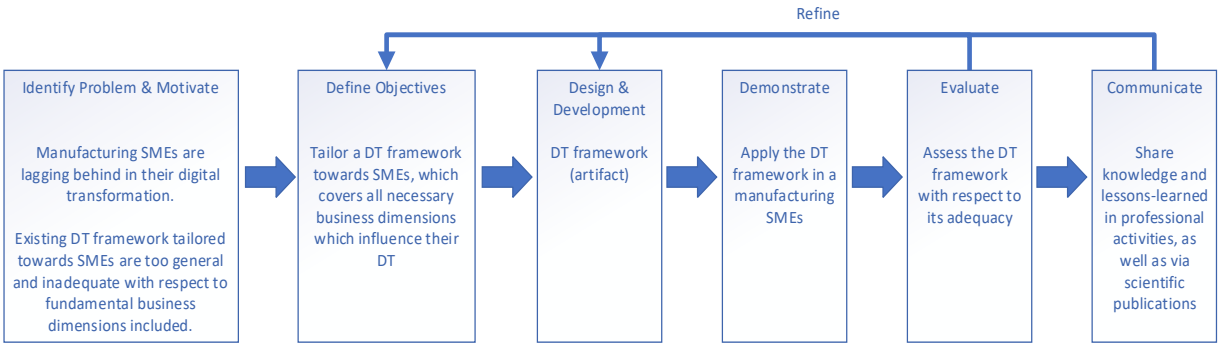

Figure 3. The research process or the work presented.

As a starting point for business needs, manufacturing SMEs are lagging behind in their DT and there are, as aforementioned, several reasons for that to be found in the literature. In relation, existing DT frameworks are often very general or originate from research conducted towards large organizations. Still, these DT frameworks was all considered as the foundational artifact to be refined. They all manifest themselves as applicable knowledge following the design science research process framework proposed by [35].

3.1 Selection and presentation of the case companies

In iteratively conducting case studies aimed at assessing and refining an artifact (in our work, a DT framework), the selection of the particular cases is vital and the cases must be proper representatives so that they may contribute with in-depth knowledge and insights in relation to the artifact being assessed [35]. For integrity reasons, we have anonymized the names of the companies. The case companies (hereafter referred to as Case 1 and Case 2) followed a purposeful sampling approach. Purposeful sampling is a technique widely used in qualitative research for the identification and selection of information-rich cases for the most effective use of limited resources [36]. This involves identifying and selecting individuals or groups of individuals that are especially knowledgeable about or experienced with a phenomenon of interest [37].

However, to give some contextual information regarding the companies, they are presented below (in the order the case studies were conducted):

- *Case company 1* is a family-owned Swedish manufacturing SME, founded over 110 years ago and located in the southern part of Sweden. The company has approximately 100 employees and a turnover of 24 M€ (data taken from the company's annual accounts for 2024). It has a main business in processing and machining sheet metal into products under their own brand. The company is active on the domestic, as well as global market and have business relationship with companies of all sizes. The case study was conducted 2022-2023.
- *Case company 2* is a family-owned Swedish manufacturing SME, founded over 120 years ago and located in the southern part of Sweden. The company has approximately 130 employees and a turnover of 22 M€ (data taken from the company's annual accounts for 2024). It has a main business in processing and machining sheet metal into products under their own brand, as well as under other brands (i.e., the company both have their own products and act as a contracted supplier). The company is active on the domestic, as well as European market and have business relationship with companies of all sizes. The case study was conducted 2023-2024.

3.2 Material collection techniques used

A variety of material collection techniques were applied as part of each iteration/case study. The material collection techniques applied, along with detailed numbers are given in Table 1.

Table 1. Distribution of empirical material and collecting techniques over the two case studies.

Iteration	Case company	Interviews	Gemba walks	Workshops
1	Case 1	11	2	2
2	Case 2	15	2	3

On top of that, during the assessments in each case company, numerous meetings and dialogs occurred, which also contributed in bringing information and knowledge into the assessment and refinement of the DT framework. All interviews conducted were open-ended and notes were taken and summarized. The interview lasted between 70 - 120 minutes and since an open-ended interviews guide was used, many follow-up questions were stated, allowing the respondents to elaborate upon personal experiences and perspectives. In sampling the respondents in each case

company, a broadness of perspectives and responsibilities was the main argument, since a diversity of perspectives and responsibilities was assumed to contribute with a rich material for assessing and refining a DT framework tailored towards manufacturing SMEs. The workshops concerned the companies' current digital maturity and status, as well as presenting their status in relation to the dimensions of the particular DT framework. The workshops included representatives from the managerial group as well as other employees with dedicated responsibilities in different functions/areas. During the workshops, notes were taken and the results of the workshops were thoroughly documented. Insights made during the Gemba walks were noted and general facts originating from studying important documents were collected. These notes and facts were also used as a baseline for developing questions for the interviews and to plan and set the purpose for the workshops.

4. Analysis and results

In the following section we analyse and present the results of design science research method process applied, following the iterative approach for assessing and refining the DT framework.

4.1 Iteration 1– Applying an existing DT framework and the assessment and refinement of it according to the prerequisites and needs of a manufacturing SME.

As indicated above, the research process for this followed the design science research method process, where the development of a tailored DT framework for manufacturing SMEs is the focal artifact. As indicated above, several DT frameworks are to be found in the knowledge base (literature). For the first iteration, we applied an existing DT framework.

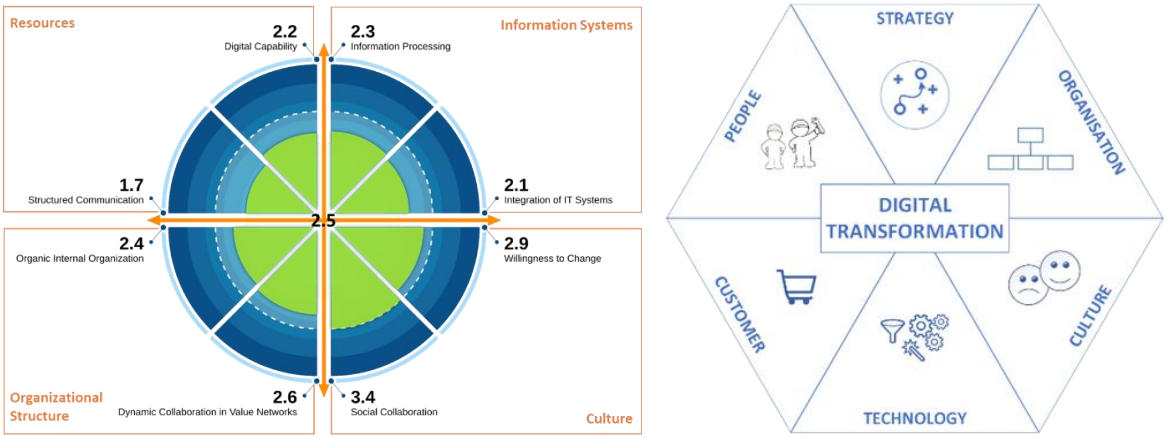

Figure 4A (left) The four main dimensions and their subdimensions of the Aachen framework (adopted from [32]). **Figure 4B** (right) The digital transformation framework presented by [5].

After reviewing literature and identifying potential candidates, we decided to use a DT framework developed by [32] as the fundamental artifact to assess and refine. It was chosen, since it is rather extensively published and also carefully validated through many studies conducted in German companies and their subsidiaries (domestic and foreign). The DT-framework developed by [32] (hereafter referred to as the Aachen framework) focuses on the following four dimensions, Resources, Information system, Culture and Organizational structure, and each of them having two sub-sections (Figure 4A). In addition, the Aachen framework is also complemented with a method to evaluate the current state of an organization with respect to its digital maturity, where predefined questions are related to each subdimension. This created structure and content for

conducting the interviews during the assessment in Case study 1, i.e., the first assessment and refinement iteration. The response of each respondent was interpreted and summarized by the interviewer into a score, on a six-graded scale (1-6), following the work by [32]. This score is then averaged into a final score for each subdimension (Figure 4A). In total, 11 open-ended interviews were conducted and summarized into a result presented to the case company. At the same time, it gave the opportunity to evaluate how the company responded in relation to the dimensions being focused on and it became evident that many of the questions wasn't tailored to fit the conditions of a SME. For instance, the formulation of the questions (translated into Swedish) was often rather technical and included advanced technical vocabulary that was not always understood by the respondents. However, the actual coverage of technical implications of a DT journey was considered a strong aspect and generated several novel insights for the case company, where aspects such as infrastructure, digital capability in systems, system integration and data management were thoroughly evaluated and proved valuable. Still, the case company did have problems to intuitively understand the coverage of the two technical dimensions included in the framework, where the labelling *Resources* and *Information systems* are very general and do not offer adequate guidance on what's in focus. Moreover, many of the respondents also reacted the lack of balance between very technical detailed matters (strongly related to the Resources and Information systems dimensions) and the rather broad, unspecific focus of the dimensions *Organizational Structure* and *Culture*.

In addition, as indicated above, digital strategy is one of the most important prerequisites for a successful DT in any organization. The *strategy* dimension is, except from one generic question, totally absent in the Aachen framework, yielding problems in the management group of the case company. They needed a stronger anchorage into strategy, for the framework to be truly relevant. The importance of a digital strategy has also been manifested by many (e.g., [38, 39]).

The respondents of Case study 1 also questioned the absence of *leadership* as a separate dimension and emphasized that the leadership ultimately is responsible for the development of the company and has the mandate to decide upon the other dimensions. Moreover, it also became apparent that the evaluated framework had a far too strong emphasis on technological aspects, for being relevant to a manufacturing SME. Finally, when evaluating the framework, it also turned out to focus too little on the people as well as the culture dimensions. The case company focused on the well-being and development of their employees, and often referred back to expressions like (translated from Swedish) "*we want all our co-worker to thrive*", "*we are situated in a small village, so we need to compete with soft values, not only salary*" or "*internally, we have a culture of supporting each other*". In summary, the Aachen framework was strong in technological matter, although the technological dimensions were hard to interpret and understand. In addition, dimensions such as strategy, leadership, organization, culture and people, were to a large degree neglected. The first iteration of the artifact, i.e., Case study 1, yielded many valuable insights on dimensions that needed to be included and also guided the search for additional DT framework in current literature, which could guide the refinement of a DT framework tailored towards manufacturing SMEs.

Hence, as part of refining the DT framework, to become more adequate to the prerequisites of SMEs, additional DT frameworks were considered, as part of the body of applicable knowledge in theory, following the process framework for design science research presented by [35]. During our initial literature review, we identified, as indicated before, a number of DT frameworks. In preparation of the second iteration, i.e. Case 2, we refined the proposed DT framework with non-technical dimensions, by combining the current framework with the DT framework developed by

[5]. Their framework originates from an extensive literature review of existing DT maturity models, where they conducted a meta-analysis on the most frequent dimensions included. From these, they included the top-six dimensions in their framework. These are (Figure 4B); Strategy, Organisation, Culture, Technology, Customer and People (employees at the company).

In many ways, the DT framework developed by [5] compensates for the drawbacks of the Aachen framework identified during the first assessment in Case 1, by covering most of the missing non-technical dimensions. However, when analysing the framework presented by [5], it also became evident that it lacks the same emphasis and details regarding the technological dimensions, which were considered as a strength in Aachen framework, by clustering all technical matters into one dimension, simply referred to as *Technology*. In addition, the actual coverage of technical implications of a DT journey was considered a strong aspect of the Aachen framework and generated several novel insights for the case company, where aspects such as infrastructure, digital capability in systems, system integration and data management were thoroughly covered. Hence, in the refined version of the framework, we decided to remain with a two-folded division of the technological dimensions following the Aachen framework. However, since the case company encountered problems in intuitively understanding the coverage and content of the two technical dimensions included in that framework (Resources and Information systems), we decided to relabel them into *IT-infrastructure* and *Data management*. Moreover, the dimension *Customers* was included in the framework by [5] and we decided to also include that dimension in the iterated DT framework, although the Aachen framework as well as the Case company 1 only briefly included customers as an aspect of digital transformation. The reason for such inclusion is simply that the definition of DT which we adhere to relates to the transformation of the business model, and alternative ways to generate incomes, which is intimately related to customers. The vitality of customers as a key dimension in a DT is also emphasized by many others (e.g., [14, 17, 40]). Hence, we advocate that the customer dimension is necessary. Additionally, we also included "*puzzle piece-pins*" in between the dimensions in the illustration, trying to capture and highlight the fact that they are related and even overlapping. During the first case study, a lot of dialogue during the interview and workshops related to overlaps between e.g., *leadership* and *strategy*, as well as *leadership* and *employee*. Finally, in synthesizing the results of the first assessment with the novel insight gained from the knowledge base, the refined version of the DT framework became (Figure 5A).

4.2 Iteration 2 – Assessing and refining the redeveloped DT framework with an increased focus on balancing technical and non-technological dimensions

The second application and assessment of the refined version of the DT framework fundamentally followed the same steps as describe above (Iteration 1), with some extensions in focal points during the Gemba walks and the interview conducted. Although the framework proposed by [5] lack a related method/digital maturity assessment, they include several subdimensions of each dimension, which they argue serves as a guidance for organizations embarking on a DT journey. They manifest the support offered as follows: "*In summary, the six action fields or dimensions of digital transformation, as unveiled by the literature review, provide a framework for organizations to master their digital transformation journey*" [5], p. 30. Hence, the questions used during the interviews in Case company 2 were the same questions adopted from the Aachen framework as in case study 1, with added questions originating from the work of [5] (primarily covering questions related to added dimensions). For example, following the subdimensions included by [5], we developed questions like (translated from Swedish); *Do you execute a digital strategy that is documented and communicated, how is the internal cross-functional collaboration manifested, do*

your employees has a freedom to experiment, how do you structure and execute the competence development of co-workers?

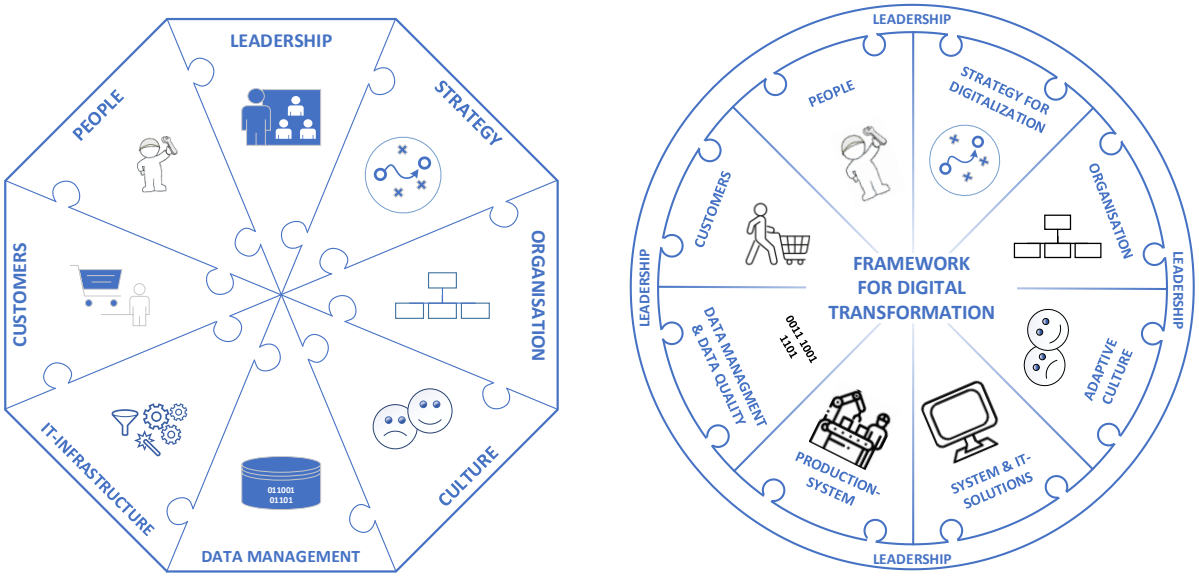

Figure 5A (left) Refined version of a DT framework tailored towards SMEs after the first iteration.
Figure 5B (right) Second refined version of a DT framework tailored towards manufacturing SMEs.

The assessment of and results from the second iteration (Case company 2) contributed in validating the added dimensions as well as generated novel and valuable insight for the second refinement of the proposed DT framework. A stronger focus on including the dimensions originating from the work by [5] clearly compensated for the rather weak linkage in the Aachen framework towards more non-technical dimensions. This resulted in a much more in-depth dialogue with the respondents in relation to the dimensions complementing and enhancing the dimensions lacking in the Aachen framework. However, the application and assessment of the first iterated version of a tailored DT Framework for SMEs, revealed some vital results which strongly influence the additional refinement thereof. Firstly, Case company 2 strived with separating the dialogue concerning the dimensions related to data management and IT-solutions. Primarily, they internally made a stronger separation between the value creating process and support processes, which made it hard to separate the dialogue concerning IT-solutions and data management in relation to these two dimensions. Due to the heritage of the company, with a strong craftmanship-based production, this isn't surprising. Hence, it became apparent for a DT framework to cover vital dimensions, the *production system* needs to become a separate dimension. Under such dimension concerns such as; connectivity of production equipment, level of automation, and digitalized production planning support may be included. Secondly, as manifested by many (e.g., [39, 41-43]), manufacturing SMEs often lack internal technical competencies, which further contributed in making it hard for them to fully understand the dimensions *data management*. In our interpretation, data management as a concept was not focused on by many in the company and only few realized the close relationship between data management and data quality. Hence, to make it more obvious, in the second refinement of the DT-framework, that dimension was relabelled into Data management & Data quality. Capturing the data quality aspect and emphasizing its importance is crucial for SMEs, since they often encounter challenges related to data quality issues (e.g., [42, 44]). Consequently, the results of

Case study 2 revealed a need to separate the technological dimensions into three redefined and renamed ones. In the dialogue with the company, this resulted in the following refined dimensions; *Systems and IT-solutions, Production system, Data management & Data quality*. Thirdly, the results of the case study also indicated that the responsibility and importance of the leadership wasn't captured sufficiently enough in the current illustration. Several members of the management group of the case company state that the leadership should be considered omnipresent in relation to the other dimensions, since the leadership is e.g., deciding upon the strategy, having the responsibility towards customers and co-workers, and sets the internal culture through its actions and behaviour. In addition, [32] and [5] do already emphasize the importance of leadership in their DT frameworks, but only as aspects or subdimensions. So, even though we already included leadership as a separate dimension as a result of the first iteration, we refined the framework additionally, by including the leadership as an encircling dimension, in an effort to capture its omnipresence. Fourthly, the strategy dimension cause confusion, since it is intended to focus on a digital strategy, but it was constantly, during the interviews, debated in relation to the general strategy of the company, i.e., the business plan and overall related strategies. Therefore, in the second refinement, the dimension was relabelled into *Strategy for Digitalisation*. Finally, the dimension Culture proved difficult to understand, since it is a very broad concept allowing for many different interpretations. In the proposed framework, it is included to depict the importance of a culture catalysing behaviours such as driving change, willing to take risks, and trying to take advantages of novel digital solutions. However, during the interviews it became obvious that the concept culture was very broadly interpreted and many replied with statements regarding norms and values in a very general manner. Hence, as a means to refine the framework and give a more solid foundation for the dimension culture, we adopted the theory proposed by [45], defining seven elements of an adaptive culture necessary for a successful DT, including elements such as; embracing the power of data and analytics, valuing speed before risk minimization, and engaging in experimentation and rapid learning. All these elements are vital for becoming successful in a DT. Since [45] refer to these as elements of an *adaptive culture*, the renaming of the dimension was done accordingly. To conclude, as a result of the second refinement of the proposed DT framework, it became as described in Figure 5B.

5. Discussions and Future Work

Digital transformation is a daunting undertaking and following the empirical findings from the two case-studies, manufacturing SMEs are progressing, but they need more concrete, hands-on support for being successful. This opens an arena for further investigations, where the framework needs to be complemented with more hands-on aspects to investigate and handle. Bumann and Peter [5] calls them sub-dimensions and [32] supply them as included questions. This approach is feasible, but needs further refinement to be fitted towards manufacturing SMEs. Moreover, they also need more support in relation to how. Our case studies also identified a lacking knowledge within the companies on how to proceed with their DT. We identified a learned behaviour originating from automating the production, which fundamentally build upon a very reductionistic approach, where one process step at a time is reviewed and analysed with conventional production development methods. After implementing improvements, new measures are taken and yet another automation project is initiated. If agreeing on the fact that DT is about business development and fundamentally centres around horizontal data streams throughout the company, this traditional approach is a perfect recipe for disaster. Therefore, we call for additional studies aimed at making the frameworks even more detailed with respect to

important aspects to consider, but even more importantly, further studies aimed at supporting manufacturing SMEs with methodological/process steps on how to process with their DT.

In addition, one of the major, more general results of empirically investigating and developing the framework has been the realization of the dichotomy between, on one hand, current literature depicting DT as a process with a reachable goal, and on the other hand, the two companies describing it like a moving target, where the technological development renders a situation where you never cross the finish line. Following this strand, our revision of the logic behind the relationships between digitisation, digitalisation and DT is important. By separating the concepts into different levels of abstraction, the DT journey may be divided into more reasonable chunks to address, where the iterative nature of our refined version also may act as a comforting understanding that you're never done, without inflicting a sense of being overwhelmed.

Finally, we also adhere to the proposition by [46] claiming the importance of studies towards manufacturing SMEs that actually considers the strategic work conducted in specific companies, instead of presenting strategic recommendations based on generic findings, although we expand the scope needed beyond the automotive industry and include all types of manufacturing SMEs.

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