Desperately seeking industrial digital strategy: a dynamic capability approach

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Abstract: This study focuses on managers' perceptions of organisational capabilities for strategy formulation related to industrial digitalisation. A qualitative case study based on ten interviews in two manufacturing companies explores managers' perceptions of industrial digitalisation. A dynamic capability framework, consisting of the organisational capabilities sensing, seizing, and transforming opportunities, is applied to recognise and analyse nuances in managers' interpretation of prevailing organisational capabilities. Findings reveal that the studied companies have a limited maturity concerning knowledge, skills, and resources for industrial digitalisation which is needed in order to formulate a digital strategy. An additional core capability was discerned, i.e., 'seeking'. Seeking includes actions for articulating, appropriating, and involving in the very early phases of understanding and formulating a digital strategy. This article contributes to the existing dynamic capability framework by adding the core capability seeking illustrated in an elaborated and holistic 'dynamic capability loop'. The loop frames industrial digitalisation as a continuous process closely integrated with strategy formulation.

Keywords: digitalisation; industry 4.0; industrial digital strategy; strategy formulation; industrial digitalisation; organisational capability; management; manufacturing industry; dynamic capability framework; case study.

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1 Introduction

Digitalisation is a global movement with a series of actions and activities in transformation processes (Chanias et al., 2019; Karimi and Walter, 2015; Yeow et al., 2018). Digitalisation in an industrial context poses great challenges to the whole organisation. Industrial digitalisation is an instance of digitalisation reflecting efforts made in the manufacturing industry. It is a complex, contemporary phenomenon pushing organisations to effectively plan and manufacture goods and services in real-time and on-demand in new ways (Liu et al., 2011; Lorenz et al., 2015). Various interconnected technologies for real-time and smart production, referred to as Industry 4.0 (I4.0) technologies (Lasi et al., 2014), include information, computing, communication, and connectivity, applied to industrial production processes (Zheng et al., 2020). Adopting

I4.0 technologies allows for enhanced interconnections between employees, management, and production (Santos et al., 2021).

Hence, scholars acknowledge industrial digitalisation as a large-scale influence promising manufacturing organisations to reap the opportunities of I4.0 technologies of industrial production (Vial, 2019). However, for manufacturing organisations to act upon such opportunities pushes them to transform the whole organisation and businesses in new ways. Employees are argued to be more focused on integrating, managing, and controlling machines, work, and tasks. Such changes may stimulate the transformation of the production process, causing organisations to go beyond prevailing organisational structures as technologies may be replaced by new ones (Rueckel et al., 2020).

It is known that organisational capabilities and management abilities to connect to transformative processes generated by industrial digitalisation need to be considered throughout the whole organisation (Yeow et al., 2018). Earlier research shows that managers are less certain how they can benefit from I4.0 technologies and, in turn, industrial digitalisation (Andersson et al., 2018; Kane et al., 2016, 2017; Wellener et al., 2019). In this transformative context, management perceives the organisational environment as dynamic and elusive, making it hard to shape and strategise for organisational capabilities (Singh and Hess, 2017).

1.1 Problematisation

Formulating a digital strategy is not without problems and can be triggered at various levels and developed in different ways. Research reports discrepancy in knowledge when management analyse potential opportunities and challenges with I4.0 technologies (Chanias et al., 2019; Kane et al., 2016; Lokuge et al., 2019). Digital strategy formulations concern to what extent digitalisation strategies challenge established business strategies. It has been argued that attention needs to be drawn towards how and why digitalisation affects an organisation (Bharadwaj et al., 2013).

To formulate a digital strategy Yeow et al. (2018) suggest that it pass through three different phases for creating organisational capabilities: exploratory, building, and extending. When exploring, the formulation process is initiated when the organisation senses new opportunities and threats and begins to articulate a new strategy. Warner and Wäger (2019) propose using digital sensing to scan, screen and interpret future digital scenarios. This is an approach argued to require cross-functional teams and rigid strategic planning (Warner and Wäger, 2019). A digitally immature organisation often lacks a common understanding of the effects of industrial digitalisation (Bharadwaj et al., 2013; Kohli and Johnson, 2011), posing challenges for organisational transformation (e.g., business model, strategies, and actions for adopting I4.0 technologies). Addressing and utilising I4.0 technologies is argued to be part of a strategic formulation to generate effects on enabling, improving and transforming operations, functions, models, processes, or activities for a more profitable production (Zheng et al., 2020).

Research points to the fact that managers lack the ability to formulate a digital strategy, which may hinder an organisation's readiness for industrial digitalisation (Chanias et al., 2019; Lokuge et al., 2019; Sony and Naik, 2019). Lavie (2006) describes this as a knowledge gap to recognise what capabilities are essential when responding to technological change. In this article focus is on why I4.0 technologies should be

implemented, instead of what type, hence the implementation process within an organisation.

Consequently, managers need to integrate, build, and reconfigure internal and external capabilities to address a strategy that responds to industrial digitalisation (Hess et al., 2016; Yeow et al., 2018). In other words, formulating a competitive strategy for digitalisation is crucial for accommodating a perceived changing environment and transformative processes. Yet, it is reported that even if managers inherently are motivated and understand the potential of I4.0 technologies, they face challenges when trying to formulate strategies that aim to transform structures, business models, and processes (Hess et al., 2016). Such identified struggles are major challenges when managers are to identify organisational capabilities while building structures (Warner and Wäger, 2019). Knowledge and information processed within the organisation can help managers question, support, and inform a strategy formulation (Galliers, 2011).

Our argument is built upon the assumption that industrial digitalisation addressed by manufacturing companies needs a more continuous holistic approach including the human and organisational perspectives and not only the technological perspectives. Formulating a strategy should encompass a holistic approach of strategy formulation and is essential in a continuous transformation process.

1.2 Research aim and question

Given the above, this article aims to identify how industrial digitalisation influences and challenges organisational capabilities of formulating a digital strategy. To address this issue, the focus is on industrial managers' perceptions. The following research question is addressed:

- What are managers' perceptions of industrial digitalisation related to organisational capabilities for strategy formulation?

The following section outlines the dynamic capability framework (Teece et al., 1997) and how it is addressed in relation to strategy formulation. The methodology describes the case study of the manufacturing industry followed by results from ten qualitative in-depth interviews with managers. This article concludes with a discussion of the results and implications for future research.

2 Theoretical framework

The dynamic capability framework was initiated by Teece et al. (1997) and has since been addressed by many other scholars (Eisenhardt and Martin, 2000; Helfat and Raubitschek, 2018; Teece, 2007, 2014; Teece et al., 1997; Vogel and Güttel, 2013; Yeow et al., 2018). The framework was created to help describe an organisation's ability to deal with the dynamics of a changing environment (Teece et al., 1997). When an organisation tries to handle the endless stream of competing and conflicting information and actions, the framework can support management in building a competitive advantage. What is unique about the framework is that it focuses on short-term efficiency in terms of strategy formulation and has an evolutionary timeframe on creating and maintaining the ability to respond to threats and opportunities affecting the organisation (Teece, 2018).

Dynamic capabilities are activities channelling resources and organisational capabilities to maintain competitiveness. Resources refer to the strength or weakness of an organisation, such as knowledge of technology and routines, and capabilities to manage products and services. Such resources are both tangible and intangible and require an organisation to build, integrate, and reconfigure capabilities to remain competitive in a changing environment (Teece, 2014; Teece et al., 1997). The dynamic capability framework consists of activities clustered into three core capabilities: sensing, seizing, and transforming, see Table 1.

Table 1 The dynamic capability framework

Core capabilities	*Capability actions*
Sensing	Scanning
	Learning
	Calibrating
Seizing	Selecting
	Designing
	Committing
Transforming	Leveraging
	Creating
	Accessing
	Releasing

Source: Teece (2007), Teece et al. (1997), Warner and Wäger (2019), Yeow et al. (2018)

We argue in line with Teece (2007, 2014, 2018, 1997) that it is necessary to consider the environment when exploring dynamic capabilities. Given these various perspectives of the dynamic capability framework, he highlights a holistic and broad perspective on organisations' core capabilities.

2.1 Sensing – the capability to identify new opportunities

Sensing, the first core capability, refers to an organisation's ability to identify and create business opportunities. Teece (2007, p.1322) maintains that 'sensing (and shaping) new opportunities is very much a scanning, creation, learning, and interpretative activity'. Warner and Wäger (2019) argue that these processes are an act of analysing diverse information. Therefore, sensing should occur at all organisational levels, as this could help bring insight and information about environmental trends to middle and top-level management. When referring to dynamic capabilities related to strategic work Teece (2014) states that sensing is 'a strong element of diagnosis, which is important to strategy' (p.341). Sensing further includes three capability actions: scanning, learning, and calibrating (Teece, 2014; Yeow et al., 2018).

Scanning refers to an organisation's efforts to explore opportunities in the market, gather information from internal and external sources, and then filter relevant actions (Yeow et al., 2018). However, such an action could be hard for managers to cover due to the disruptive or long-term effects the I4.0 technologies may bring. Thus, I4.0 technologies are fundamentally reshaping traditional strategies by creating modular,

distributed, and cross-functional processes that require work to be carried out in a nonlinear way (Bharadwaj et al., 2013).

Learning, the second action, includes actions undertaken by organisations to evaluate potential opportunities by, e.g., monitoring performance or gaining more insight to assess and identify specific areas for further actions (Teece, 2014; Yeow et al., 2018). Learning is categorised as the synthetisation of actions that give rise to new knowledge and learning.

Calibrating, the third action, is when an organisation calibrates opportunities and realigns resources, engages in further know-how after probing specific actions to identify implications for future actions and competitive advantages in line with an envisioned future.

2.2 Seizing – the capability to address and utilise opportunities

Seizing, the second core capability, refers to an organisation mobilising to address opportunities and then utilising them. Warner and Wäger (2019, p.323) refer to seizing as 'to address opportunities or neutralise threats, incumbents require seizing capabilities that ensure leaders avoid hubris, deception, bias, and delusion and that allow firms to experiment with decentralised boundaries, digital platforms, and new business models'. Seizing is an act of strategy construct, and Teece (2014) argues that it should be connected to a guiding policy and coherent action. Seizing would then be the critical capacity for aligning a digital strategy as it implies an organisational ability to act upon identified opportunities. Seizing moves an organisation beyond the act of understanding (sensing) to focus on deciding what specific changes are to be made to capture identified opportunities.

Furthermore, Teece (2007) argues that all organisations could sense an opportunity yet not all can seize opportunity. Yeow et al. (2018) suggest that seizing includes the following actions enhancing capability: selecting among options, designing, and committing (Yeow et al., 2018). Selecting constitutes the actions organisations take when selecting among several options available to design its structure. This could also be the choice of different services, platforms, or products. Designing denotes an organisation's activities to plan and design new structures and processes (Yeow et al., 2018), e.g., to construct a digital business structure. Lastly, committing action refers to the decisions taken by organisations to implement preferred designs, such as options of services, products, platforms, and business structures (Yeow et al., 2018).

2.3 Transforming – the capability to change and realise opportunities

Transforming, the third capability, refers to an organisation's ability to be flexible, align new gained insight and activities, and hence internally change. Whereas sensing and seizing capabilities enable creating and discovering new opportunities, transforming capabilities underpin the realisation of strategic change (Bharadwaj et al., 2013; Warner and Wäger, 2019). However, as Warner and Wäger (2019) point out, digital transformation is challenging because the changing environment remains uncertain in combination with few or no identified required competencies. Transforming consists of four capability actions: leveraging, creating, accessing, and releasing (Yeow et al., 2018). Leveraging focuses on a new use of existing resources, e.g., aligning existing resources and knowledge with a new strategy. Creating is an action that covers the craft of

combining new resources and processes generating new knowledge. Accessing is the use of external resources needed to complement existing resources, e.g., incumbent firms need to craft digital strategies that leverage digital technologies and existing structures but may lack both competencies and technologies needed (Warner and Wäger, 2019). Releasing is the action of dropping no longer needed resources in a new digital business strategy, e.g., workforce, routines, and structures (Hess et al., 2016; Sebastian et al., 2017).

3 Research approach and method

The study reported in this article was designed as an interpretative qualitative case study (Baxter and Jack, 2008), and conducted from management and organisational perspectives of two international manufacturing companies. The two companies are partners in a university-industry collaborative research project that constitute the empirical setting of this study.

Case study research is appropriate for research concerned with identifying patterns of action and studying organisational contexts when emphasis is put on managers' perceptions, experiences, and understandings of a certain phenomenon (Maxwell, 2013; Yin, 2018). This study is not comparative; instead, the companies complement each other through the selection of managers and for generating various perceptions, actions, and possible strategy formulations of industrial digitalisation. Hence, the companies are not compared but rather considered as one analytical unit (Yin, 2018). Both industrial companies meet the criteria selection required as a relevant key sample and constitute the unit of analysis related to the aim of the study (Naderifar et al., 2017).

The partner companies in the case study are both global international industries, so-called original equipment manufacturers (OEMs) with production, business sales and services in a local and global chain of production plants. One company is in the aerospace engine sector and the other company manufactures gas turbines for industrial turbomachinery. They both produce and perform maintenance of cutting-edge components of high-quality product parts for aerospace engines and turbomachines. Both manufacture heavy and high-quality products, with advanced production processes, such as machining, including cutting, pressing, forming, and welding. The production at the two local Swedish sites particularly included in this study, is mainly arranged in functional production units with low degree of automation, long production cycles, and heavy reliance on manual operations.

3.1 Data collection

The data collection was ongoing during 2019–2020 with the perspective of active engagement and close collaboration built on an earlier research study (Lundh Snis and Hattinger, 2019). Hence, the company stakeholders influenced the design of the interview guide and choice of key informants (Maxwell, 2013). The qualitative data material consisted of ten in-depth interviews with managers with an engineering background and responsibilities for either technical development, IT architecture, production, quality, or logistics. They represented a mix of top and middle management levels equally distributed between the two companies, see Table 2.

Following the research question, the interest was to explore managers' perceptions of industrial digitalisation related to organisational capabilities for strategy formulation. The interview guide included three themes: effectiveness and strategy formulation, examples of initiated or implemented digital initiatives in production, and strategic competence development. Related open-ended questions to themes were performed in a dialogue:

1 How do you as a manager perceive digitalisation in the organisation?

2 Is there a digital strategy in place? If so, describe the formulation and application

3 Can you describe any engagement in digitalisation or digital initiatives?

The open-ended questions focused on the informants' reflections on their work practice concerning their function and responsibilities and the whole company context (Walsham, 1995). When clarification was needed supplementary questions were proposed. Interviews lasted between 45–90 minutes and were recorded and transcribed verbatim.

Table 2 Number of informants grouped by function

Function	*Numbers of informants*
Strategic manager, SM	4
Manager of engineering and development, MED	4
Production manager (second line), PM	2
Total	*10*

3.2 Data analysis

The data analysis of the transcribed text was conducted in four iterations. In the first iteration texts were coded through content analysis to interpret managers' perceptions of industrial digitalisation and organisational strategies, hence an inductive approach (Kohlbacher, 2006). All authors read through this analysis multiple times to verify the accuracy of the interpretation of the data. The focus in round one was to become familiar with the data and identify relevant excerpts.

In the second iteration, the dynamic capability framework (Teece, 2007) was applied as a coding scheme to identify managers' ideas and statements concerning company plans, applications, support, and other marks in the data that embarked on potential challenges of formulating a digital strategy. In this second round of analysis, managers' perceptions were sorted through the core capabilities of the dynamic capability framework: sensing, seizing and transforming.

The third iteration in the analytical process was identifying capability actions within each sorted core capability, see Table 1. This was a stage of explanation building, trying to understand managers' perceptions of industrial digitalisation related to prevailing organisational capabilities and the capability actions for strategy formulation. Hence, it was an analytical process of mapping the 'how' and 'why' (Yin, 2018), related to the empirical data and the dynamic capability framework.

This interpretative approach yielded a set of categories (core capabilities) and sub-categories (capability actions) inspired by the dynamic capability framework. Once all data were examined, a cross-group analysis followed, comparing the excerpts and the identified categories and sub-categories within each to determine whether they reflected a common analytical ground.

The cross-group analysis showed that the dynamic capability framework (Teece, 2007) was applicable for the data analysis. However, it revealed that the framework was insufficient in capturing managers' perceptions of early phases of searching for meaning and potential opportunities arising with an increased industrial digitalisation. Thus, an additional core capability was discerned, i.e., 'seeking'. This identified and added core capability came to be further analysed into three new sub-categories: articulating, appropriating, and involving.

4 Findings

Four categories were found to characterise the managers' perceptions of industrial digitalisation related to prevailing organisational capabilities and the capability actions for strategy formulation:

1 New core capability: Seeking – articulating, appropriating, and involving.

2 Core capability: Sensing – scanning, learning, and calibrating.

3 Core capability: Seizing – selecting, designing, and committing.

4 Core capability: Transforming – leveraging, creating, assessing, and releasing.

The four categories that emerged from the data embody interpretations that reflect how capabilities for strategy formulation are searched for (seeking), how they are identified (sensing), how they are utilised (seizing), and how they ought to change (transforming) the manufacturing companies' strategies. *Seeking* was identified throughout the data analysis as informants regularly spoke of a constant fumble for the meaning of industrial digitalisation. Many of the informants' interpretations of industrial digitalisation exposed unsynchronised, or even lacking, actions that were reflected in their ability, for example, to communicate, engage, and identify opportunities. Many informants reported a mixed understanding and a scattered interpretation of company plans, applications, and support of industrial digitalisation.

4.1 Seeking

Managers described digitalisation as an abstract form of knowledge that only a few people in the organisation could take advantage of. They expressed a feeling of lacking direction and necessary competence for strategy formulation related to digitalisation. At the time, strategy formulations were described as not locally anchored or related to specific initiatives. As such, managers perceived that they lacked full control of issues regarding digitalisation. They believed a formal strategy or a document described how the company should adopt various I4.0 initiatives but not an overall vision.

> "It [a strategy] exists within the organisation. There is one, but we don't have an explicit one locally. However, we have more initiatives that should be linked to that strategy. (MED)"

By discussing industrial digitalisation, one of the managers acknowledged seeking basic understanding. He perceived himself as acting on articulated agendas simultaneously as he was trying to search for formal agendas on digitalisation. The majority of informants

identified themselves as having little or very little knowledge about digitalisation. Many of them sought operationalised examples of how digitalisation could be an opportunity for more profitable production. Informants emphasised the importance of an informative strategy that included human aspects and competence development. The importance of prioritising learning and competence related to digital maturity was also stated as key elements when managers discussed digitalisation. They perceived it as important that every employee understand the meaning of digitalisation, how it affects them, and how employees are expected to participate in organisational development. They spoke of digital maturity as a needed mechanism for enabling change. For example, maturity was described in terms of the need to involve practical training and general competence related to organisational change. Informants spoke in terms of 'pitcher-of-a-leader' (production manager, PM), 'getting everyone on board' (strategic manager, SM) and 'if you are not in it with the basics, you do not know when to learn again' (manager of engineering and development, MED). One of the managers expressed a need for such maturity as a prerequisite to generate organisational advantages for a larger group of employees. However, the same informant did not show any interest in digitalisation relative to his tasks. He perceived that digitalisation initiatives were for other employees, without specifying whom, or functions as illustrated in the following quote:

> "Digitalisation is more than a fluffy image. It is smart and someone in the company will benefit – but not us. (SM)"

One manager elaborated on required strategies and their organisational readiness concerning strategy formulation, he stated that many of the employees regardless of function are often positive towards change related to digitalisation. However, the actual practical implications often remain absent since mechanisms were lacking:

> "Everyone is positive, but then one does as one wants…and you wonder why the system does not work. That is the problem that exists. (PM)"

However, instead of speaking of what was understood, some managers pointed out they have just started to understand that they do not grasp the complexity of digitalisation. As a result of the mixed attitudes towards perceived maturity, some informants gave the impression of there being informal consent to how digitalisation should be faced. Contrary to perceptions of there being no local strategy towards digitalisation, one informant stated:

> "In the past, the strategy included both business and digitalisation. But unfortunately, those who advocated this were referred to as backward-looking. (SM)"

Some managers made it abundantly clear that their organisations had a specific strategy and were able to discuss details of whether they perceived it as being holistic or not. Others described that they experienced a strategy for digitalisation at large (globally) but not at the local organisation. Notably, managers tended to connect with more local initiatives when discussing digital strategy formulation as these became concrete and manageable compared to an overall strategy related to digitalisation.

This newly found core capability and its capability actions are further elaborated in the discussion section.

4.2 Core capability: sensing opportunities

Regarding an organisation's ability to identify and create business opportunities, several informants talked insightfully of sensing strategies for industrial digitalisation, e.g., the need for roadmaps, competencies existing or needed, level of expertise, etc. An important aspect is that such insight was based on an individual, but not company-specific, understanding of digitalisation. As such, many managers discussed the need to understand the terminology and concepts of digitalisation. They mentioned the idea of a centralised function that would foster such a coherent view. A manager likewise promoted the more holistic viewpoint of strategy formation, that digitalisation is an integrated part of all organisational work. However, managers perceived a lack of basic level of understanding for industrial digitalisation:

> "Given the level of knowledge within the [management] group, I don't think it's easy to talk about digitalisation and think that it's merely mobile phones. That's at an extremely low level! (PM)"

One of the managers expressed that needed competence is not necessarily internal:

> "I think you will have to bring in those who can. Those who know digitalisation. You can't make anyone learn digitalisation in addition to his/her ordinary tasks. You have to bring in someone who has the skills needed. (SM)"

Findings related to the first capability action of scanning indicated that many referred to decisions of change regarding I4.0 technologies or methods of work having been made by an unidentified individual or function at a higher level. However, such comments did not always point to a low level of insight but were a way of directing the responsibility of understanding away from themselves. Yet, managers shared the idea that they (managers) needed to be involved in the process, arguing 'if you're not involved, you hardly know that you have to understand something new' (SM). When asked to elaborate on their perception, a cultural change was described as a mechanism for change:

> "It needs to change inside the company and find out how to avoid creating fear. (PM)"

In addition, managers spoke of the importance of a common terminology, which one can communicate for understanding and knowledge development, along with digital expertise and skills.

Evident in these perceptions is the view of interest, because employees described to have a large technology-driven interest, just not driven by digitalisation. Digitalisation was not seen as a subject that motivates changes at shop-floor level since it is too abstract. For example, the organisations usually work firmly project-based with specific resource constraints and gains, i.e., business case. As a result, managers found it easier to describe digitalisation in terms of innovations or specific technologies:

> "We have a lot of digitisation generals who bring in lots of 3D and products in 3D, but we don't really know what the customer wants. (SM)"

The managers in this study received little official information about industrial digitalisation, or what it could entail in their organisation. When managers were interviewed some tended to address digital administration and office work instead of digitalised production. Some managers viewed it as role models when discussing digitalised production. However, these informants also acknowledged that digital

production requires something, or someone who understands I4.0 technology linked to specific parts of production:

> "I, as a manager, need to understand the terms and concepts of this field that I'm not very experienced in. …[you] need to surround yourself with competent employees. It's difficult to succeed in doing everything with old knowledge. (SM)"

Regarding the second capability of action learning, managers perceived that digitalisation seemed to happen unpredictably and ad-hoc, not linked to the needs or even challenges met in production, e.g., quality, capacity, or lack of capacity. Managers pinpointed that the organisation can only be as digitalised as the lowest level of basic understanding.

The lack of formal terminology about digitalisation resulted in managers drawing knowledge from LEAN in conceptual implementation. Importantly, they did not compare digitalisation to LEAN management, but to the cultural wave and implementation it brought. For example, findings revealed that digitalisation was discussed at formal and informal forums yet in an exploratory rather than a clear-cut way:

> "The basic foundations of digitalisation need to reach the company in some way. Why do we do that?... in the same way we talked about LEAN. (MED)"

Regarding commitment, one manager insisted it does not matter if the phenomenon is digitalisation or pure welding skill if relevant employees are not involved in the latest trends and talks. Hence managers stated that it does not matter how fancy a strategy may be, either way, it is the lowest level of involvement that is the cornerstone in change management.

> "It does not help to write digitalisation means this, on any document or PowerPoint slide. One has to get the chance to ask and think. (PM)"

In terms of calibrating, almost all managers argued digitalisation may not be a way of leveraging production unless the basic principles of why are solved, since digitalisation per se will not solve anything. They pinpointed that one must understand underlying factors to *why* to committing. With respect to one's illiteracy, one manager illustrated how he thought the organisation was unable to use collected data:

> "The job is that we can get data…. I don't know how much data we generate. But what is it good for? (SM)"

4.3 Core capability: Seizing opportunities

The majority of managers believe they have taken the opportunity to initiate digitalisation initiatives in their businesses, that is, mobilising to address opportunities and then utilising them. For example, they describe when the opportunity for sound digital initiatives arises, they will not miss it. However, they were also describing how difficult and risky seizing opportunities could be:

> "We cannot digitalise everything. Now we are bubbling, all initiatives are good. But someone should receive everything and if nine of ten projects are not a good hit, there is a risk of it [digitalisation] becoming a buzzword. (SM)"

Some managers were anxious about how to keep the quality when initiatives are bubbling:

> "It's important that we as leaders gather and maybe, this was good, but we delete these four… So there we try to industrialize it. (SM)"

As such, some managers pinpoint the importance of industrialising initiatives – copying good initiatives to another area or part of production. However, some voices stressed that they struggled to select several possible initiatives. For example, some are unwilling to seize digitalisation initiatives if benefits and values are not specified in a business case or included in a business plan. In such cases, they were worried how to translate the business case into actual means:

> ""What is the business case? You have to have an idea. (SM)"

> "Many digitalisation or numbers are what management needs to present to top management. But it is not an ordinary person who translates into what I should do. (SM)"

The need for a formal business case is seen both as hindering for not cultivating small innovative initiatives, and as an opportunity to make the pilot initiative more well-known within the organisation. Managers want to know more about the business value behind pilot projects and what resources are being allocated. This is argued as being part of a transparent exploration process for the whole company. Notably, company practice was to standardise and industrialise as far as possible to save resources. This was operationalised using business cases. However, it was pointed out that standardisation is perceived as an obstacle to digitalisation when initiatives were forced to fit into different business cases. One manager anxiously described this as threading a fine line between shutting down creativity [initiatives] and keeping the standardised structure functional. It was seen as a clash between the traditional business structure and adapting to new needs. From a management perspective the committed design of initiatives becomes essential:

> "IT is starting to make themselves heard now. We must not end up where we have started to build 35 different I4.0 initiatives that do not talk to each other…(MED)"

4.4 Core capability: Transforming opportunities

Findings revealed stray examples of organisational capabilities complying with transforming. Managers showed stray examples of the organisation's ability to be flexible, align new gained insight and activities, and hence internal change. Managers related transforming to I4.0 initiatives and wanted to talk about such matters. They stressed how the challenge is the phase of transformation, i.e., how an initiative is to be implemented. Informants spoke of mechanisms related to all three core capabilities that make it difficult to stimulate the wanted pace of change. Managers were more prone to describe their perceptions when discussing organisational involvement for industrial digitalisation. However, managers pointed out that much depends on the context and not just the overall maturity in the company:

> "It [implementation] can take different lengths of time depending on the place and background. If you bring technology into a group that is looking for a solution, it is much easier than when you introduce new technology in a place that is already ticking. (PM)"

Managers described how hard it can be to continuously keep the digital maturity level up:

> "It's enough that we have high pressure. Not everyone is mature and interested in change. It takes a certain mentality to constantly bang your head against the wall and get ahead. (MED)"

Regarding creating, another mechanism that became clear when managers reflected was the feeling of exploring. Managers often ended or started their interview with the integration being complex without pinpointing where complexity arises or for what reason. Accessing, or even releasing, actions for digitalised production remained absent. Instead, they returned to their primary focus on seeking a conceptual understanding or from the perspective of a business case, highlighting how I4.0 initiatives need to fit with the rest of the organisation for an initiative to be considered to add value:

> "When we come to I4.0 or digitalized and integrated environment, it becomes extremely complex when you must make them stick together. It becomes a neat job and if you then have a lot of jerry rigs that are not quality-assured and controlled. It will be hard to keep them alive… (MED)"

4.5 Summarised findings of managers' perceptions

Managers could not point out functions or roles in the organisation when talking about strategy formulation tackling digitalisation. When highlighting managers' perceptions, uncertainties or discrepancies of functions and structures in the organisation it became explicit that there is a lack of personal interest and directions of actions. Organisational structures were analysed as hindering or supporting I4.0 technologies enabling digital and efficient industrial production. However, both changes in structure and information flow is reported to be precarious to alter. Organisational structures were not seen as a tool for formulating a digital strategy among the informants, rather seen as a condition to consider when designing for progress of industrial digitalisation. Such structural mechanisms were not in place, nor had the right timing in the case.

Perceived increased complexity combined with low digital maturity challenge the work with formulating a digital strategy. Digital maturity is essential and is influenced by the changing environment. Hence, building digital maturity can help management question, support, and inform a digital strategy formulation. However, findings state managers struggle with allocating time and focus and are desperately seeking the meaning of industrial digitalisation.

5 Discussion

In this study we explored managers' perceptions of industrial digitalisation related to organisational capabilities in the process of formulating a digital strategy, i.e., strategy formulation. We emphasise that the expanded dynamic capability framework was fruitful to explore managers' perceptions of and approaches to strategy formulation.

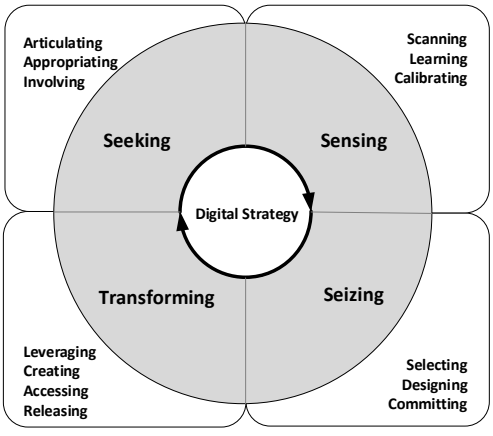
Galliers (2011) and Chanias et al. (2019) argue for a strategy formulation to be more holistic and transcend traditional functions. Dixon et al. (2014) share a similar approach by suggesting a dynamic capability lifecycle framework, in which managers play a key role leading digital innovations. In line with Teece (2007, 2012), scholars (Chanias et al., 2019; Dixon et al., 2014) argue industrial digitalisation affects the organisation horizontally. However, such a view embarks on an organisational construction and reconstruction of the application of I4.0 technologies. While this is important it is not the

first issue affecting managers, but it is the first trembling steps initiating sensing, seizing, and transforming that is of great concern, e.g., seeking.

5.1 Dynamic capability loop for digital strategy formulation

By contributing to research on theories of dynamic capabilities (Teece, 2007, 2012; Warner and Wäger, 2019; Yeow et al., 2018), we propose a conceptual and enhanced framework that visualises the process of recurring work of digital strategy formulation, illustrated in Figure 1. Our proposed framework adds an additional core capability, *seeking*, with the following sub-categories (actions): *articulating*, *appropriating*, and *involving* opportunities that are discussed in the following sections.

Figure 1 Dynamic capability loop for digital strategy



5.1.1 Articulating – ability to create a common terminology

Managers seem less keen to prioritise creating a holistic understanding of digitalisation. As reported by previous research (Kane et al., 2017; Peter et al., 2020; Warner and Wäger, 2019), a common organisational culture with shared terminology is highly valued when pursuing industrial digitalisation. Our findings showed the need to articulate operationalised examples, which could help move digitalisation from the abstract to the concrete. Articulating a common terminology may translate to a digitalisation-oriented mind set and understanding (Singh and Hess, 2017). However, creating organisational structures that favour a common perception and experience of digitalisation could foster a homogeneous culture, suffocating the innovative pace often connected to digitalisation. Arguably, knowledge of utilising I4.0 technologies needs to not only be commonly communicated but recognised as potentially hindering, or supporting, mechanisms, i.e., ways of providing services, and perceived problems at both production and managerial levels. In the core dynamic capabilities (sensing, seizing, and transforming) matters were not about understanding the changing environment or potential changes but cross-functional articulations for translating the means of digitalisation (Warner and Wäger, 2019). While current staff may have a different, less digitalisation-savvy mind set and may lack the required capabilities to cope with upcoming changes, coherent procedures

could support companies by guiding appropriation of their existing technological capabilities to weigh current understanding. Matt et al. (2015) stress that early actions can be taken if expectations of digitalisation are not met, but then clear procedures on the reassessment of transformation actions are needed.

5.2 Appropriating – ability to diagnose organisational mechanisms

The ability to diagnose organisational mechanisms – appropriating aims – for planning, applying, and supporting organisational capabilities is in line with the ability to construct and reconstruct actions for change management (Teece, 2007; Warner and Wäger, 2019). Even in early phases of formulating digital strategy, managers stressed the importance of negotiating and renegotiating knowledge and resources. Sony and Naik (2019) argued that managers must be more agile towards getting an organisation ready for implementing I4.0 technologies. While a few informants showed no basic coherent conceptual understanding, most took advantage of I4.0 technologies in local initiatives. Compared to previous research, managers seem to neglect a holistic perspective complying with initiatives to only concern single functions (cf. Chanias et al., 2019; cf. Kane et al., 2017). Appropriating organisational structures could entail the perceived contradictory action of articulating and creating a common mind set that sometimes misaligns with current ones (cf. Yeow et al., 2018). To exemplify such tensions, informants articulated significant focus on formulating a business case for I4.0 initiatives instantaneously as describing the misalignment of such a way of tackling seizing opportunities.

The action of appropriating is argued to be the ability to diagnose organisational mechanisms which support a responsive mind set (Rueckel et al., 2020). Since digital strategies affect the entire company, and their execution may result in resistance from different areas of the company, seizure of industrial digitalisation in strategy formulation should be a cue for more effective use of resources. This means taking time to reflect on supportive mechanisms that allow for the ability to diagnose, which is in line with the change management perspective (Teece, 2018).

5.3 Involving – ability to engage

One of the identified mechanisms hindering the organisation's ability to reconcile capabilities was the collective understanding, which includes all employees, potentially identified as digital maturity manifested in verbal indifference (cf. Kane et al., 2017). Indeed, Hess et al. (2016) argued that the initial coherent mindset and organisational involvement are essential for industrial digitalisation. In the findings of Magalhães (2006), issues of formulating a strategy depend on the context in which it is to be implemented.

Regarding the collective understanding and progression of digitalisation initiatives, there was difficulty coping with marginal digital maturity (Warner and Wäger, 2019). It was manifested in the way managers recognise their inability. Some informants even showed fear of the low organisational digital maturity. Informants described an overall low involvement, stating that they had to bring in new employees who can handle changes related to digitalisation to fully become digitalised. This indicates a shift in perceptions of employees moving from appreciating long-term experience and skill, to instead viewing them as individuals who delay development. This also indicates a shift in responsibility as managers push the focus of industrial digitalisation away from strategy

formulation. The question arises whether informants should be addressing competence concerning single technologies or potential neglect of responsibility. Nonetheless, holistic strategy formulation could improve digital maturity (Karimi and Walter, 2015), based on cross-functional involvement. Multiple employees with different views, knowledge, and competence, may be involved.

5.4 Digital strategy formulation – dynamic capabilities continuously adjusted

A central contribution is based on managers' perceptions of digitalisation trajectories, which we argue will have to be continuously adjusted. Thus, a more holistic discussion beyond the current framework of dynamic capability is required. Instead of viewing the dynamic work as process oriented (Warner and Wäger, 2019; Yeow et al., 2018), we argue it should be viewed as a loop. Findings showed that industrial digitalisation processes often include managers' limited ability to understand what changes are needed and how to respond to identified needs. Organisational mechanisms for a manufacturing company's ability to plan, apply and support digital capabilities were lacking. Actions of articulating digitalisation are recognised as important for creating initial means of appropriation to deal with and perform industrial digitalisation through involvement. Due to the complexity of re-structuring for digital strategy formulation, the dynamic capabilities should be based on recurrent and continual cross-functional work. The environment will continuously generate new opportunities and challenges over time; agendas and strategies will likely have to be continuously adjusted (see Figure 1). The suggested seeking capability becomes a way of contributing to a more continuous view of the dynamic capability framework (Dixon et al., 2014; Warner and Wäger, 2019; Yeow et al., 2018) to digital strategy formulation. Thus, it would be reasonable to assume that the context in which the digital strategy is to be formulated is of greater concern for managers. That formulation issues would depend upon such a context in which the looping takes place (cf. Magalhães, 2006), i.e., dynamic capability loop for digital strategy (see Figure 1).

6 Conclusions and implications for future research

This paper has contributed to a new approach by proposing an enhanced framework, *dynamic capability loop for digital strategy* (Figure 1), that visualises managerial and organisational digital strategy formulation as a continuous loop. Based on theoretical reasoning and empirical evidence, the dynamic capability loop is developed. The loop model is a theoretically bound conceptual framework that provides a systematic and holistic reference model for any digitalisation study that considers digital strategy formulation. It is a further development of the core capability framework but adds a process-oriented perspective such as a loop metaphor. It further includes a process that categorises digital strategy work into four, not just three, key activities, i.e., the seeking, the sensing, the seizing, and the transformation actions. Hence, it adds the first action 'seeking'. The loop framework also provides a comprehensive conceptualisation to indicate the engagement and negotiation that managers continuously do to desperately seek for and strategise industrial digitalisation. The loop framework – dynamic capability loop for digital strategy – has the power for exploring, understanding, explaining and

further, suggesting potential future research directions. We conclude that managers show a seeking orientation towards industrial digitalisation and thus a focus needs to include the initial phases, as they need organisational support in their desperate seeking for digital strategy formulation.

As with all exploratory research, this study is not without limitations. One limitation is the potential transferability of the suggested framework to a wider research context and it is thus unclear if it applies to a broader industrial context in changing dynamic environments. Future studies are encouraged to include non-managerial employees. To move the suggested framework forward, further qualitative research in different contexts and with dissimilar informants may validate the new core capability seeking and the related added capability actions (articulating, appropriating, and involving).

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