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ENABLING DIGITAL INNOVATION IN PRODUCT-CENTRIC FIRMS THROUGH MICROFOUNDATIONS

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Research Paper

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Abstract

Digital innovation poses a threat for incumbent product-centric firms as digitalization blurs industry boundaries and lowers entry barriers to new entrants. However, digital innovation offers many opportunities for incumbents to sustain and successfully compete in the new digital space, if they can overcome the challenges associated with the development and adoption of digital innovation practices. This study empirically explores how incumbent product-centric firms based in Germany, Switzerland, and Austria master the challenge of digital innovation by looking for specific microfoundations through the lens of the dynamic capabilities framework. The grounded theory method is used to get a subjective view of practitioners. The study's contribution is two-fold. Firstly, it addresses criticism related to the practical application of the dynamic capabilities framework by providing a detailed view on specific underlying microfoundations. Secondly, it aims at expanding our understanding of how digital innovation evolves by providing key microfoundations deemed important by practice for the development of digital innovation among product-centric firms.

Keywords: Digital innovation, Dynamic Capabilities, Microfoundations, Manufacturing Firms

1 Introduction

The rapid progress of information technology (IT) over the past decades contributed to a wide range of digital services and products innovations (Liu et al., 2022; Porter and Heppelmann, 2015; Yoo et al., 2010a). IT is continuously evolving and changing the competitive landscape for incumbent product-centric firms. This lowers the barriers to enter the market allowing new players with strong technological capabilities to quickly gain market shares by offering novel digitalized products (Porter and Heppelmann, 2014). Digital innovation enables the horizontal integration of industries resulting in new offerings driving customer demand across multiple previously unrelated industries. As incumbents manage their product innovation regime based on the organizational logic and the principles of manufacturing (Svahn et al., 2009), which are very different from those in the digital product innovation context (Svahn and Henfridsson, 2011), they face the challenge to successfully compete in a newly created digital space. As a result, they have been outperformed by technology-savvy new market comers (Svahn et al., 2017; Yoo, 2013). In particular, product-centric incumbents must also adapt their business models and processes to leverage the benefits of the development of technology, and remain competitive as digital innovation creates new avenues for market opportunities (Lansiti and Lakhani, 2014; Porter and Heppelmann, 2014; Yoo et al., 2010a). Further, digital innovation affects the performance of the firm and it is considered a probable source of competitive advantage (Liu et al., 2022). Another implication is the radically changing product architecture, which leads to new products, ecosystems, and new opportunities to connect products beyond industry boundaries (Lansiti and Lakhani, 2014; Yoo et al., 2012). The e-book example describes well how new product characteristics can significantly change the industry boundaries and attract previously unrelated market players to offer new products on the book market previously dominated by the

publishers. Suddenly the well-defined publishing industry is disturbed by online retailers, software companies, and technology firms (Yoo et al., 2010b). It shows the magnitude of change incumbents need to go through to compete with the new market participants. This change becomes a real challenge threatening their business if they fail to understand the logic of the digital innovation regime (Fichman et al., 2014; Svahn and Henfridsson, 2011; Yoo et al., 2010a).

Hence, to compete in the digital space, incumbents must analyze and build innovation capabilities. In the context of technology-driven innovation, the dynamic capabilities (DC) framework has been widely used to explain the internal dynamics of the innovation processes (Teece et al., 1997; William J. Wales et al., 2013). Several researchers have reported its importance (Kindström and Kowalkowski, 2014; Teece, 2017, 2012). According to prior research, DCs allow for explaining the role of individual and organizational capabilities for supporting the firm's innovation practices (Chew, 2012; Teece et al., 1997). DC can be defined as a set of competencies to identify and reconfigure firms' resources ensuring a prompt reaction to economic and technological environmental changes (Teece et al., 1997). While the extant literature already provides a rich account on the concept of DC (Parviainen et al., 2017; Susman et al., 2006; Teece, 2014a) less attention is placed on the underlying elements of DC, e.g., processes, routines, and actors (Eisenhardt and Martin, 2000; Nambisan et al., 2017). Further, previous studies in the area of managing technology-driven innovation in organizations have enriched our understanding of the dynamics and challenges of such innovation, their common focus on macro-level explanations often miss the detailed practice view of the problem and neglect the role of the individuals managing technology-driven innovation (Fallon-Byrne and Harney, 2017; Nylén et al., 2015). In the special context of incumbent product-centric firms, it remains unclear which microfoundations are needed to succeed during an organizational reconfiguration for digital innovation. That offers new research avenues to deepen our understanding of the practical implications on organizational and individual levels in the product-developing firms and provide additional insights into how those challenges could be addressed.

This study addresses this gap by examining the microfoundations of DC that incumbent product-centric firms need to successfully integrate digital innovation into their physical products and support services. For this purpose, we consider incumbent product-centric firms as organizations mainly focused on the development of physical products, characterized by a long tradition in the specific industry, along with well-established research and development processes. Throughout the paper, the terms traditional manufacturing, product-centric firms, or incumbent firms are used interchangeably. Therefore, the research question is defined as follows: *"Which microfoundations could be defined as enablers of digital innovation in incumbent product-centric firms?"* We use the dynamic capability framework as defined by Teece (2014b,2007) o distinguish the stages of digital innovation (sensing, seizing, transforming). Further, we argue that a specific set of microfoundations on the organizational and individual levels allows firms to assess and develop DC for digital innovation. Given the exploratory nature of the study and the complexity of the subject, we adopted a qualitative research methodology using the grounded theory (GT) by Glaser (1992) and took the interpretive philosophical stance, which is a well-recognized method, particularly in the field of IS (Orlikowski, 1993; Seidel and Urquhart, 2013; Urquhart and Fernandez, 2006). Our goal is to enrich the current understanding of the dynamics of digital innovation by providing suggestions of the organizational procedures and cognitive competencies (defined as microfoundations) required to develop digital innovation practices in incumbent product-centric firms.

2 Theoretical Background

Over the past decades, the innovation theme has received considerable attention from scholars and practitioners. There is a large volume of published studies describing the role of innovation in various disciplines and industries further developing the understanding of how innovation impacts organizations and society (Crossan and Apaydin, 2010; Salter and Alexy, 2013). With the increasing speed of technology development, a growing body of literature has investigated the impact of

technology on innovation development and its output since innovation is considered a critical source of competitive advantage in a dynamic environment (Teece, 2018; Teece et al., 1997; Tushman et al., 1997).

2.1 Digital Innovation

Digital innovation has attracted both academics' and practitioners' attention leading to multiple definitions of digital innovation leading to semantic differences (Hund et al., 2021; Magnusson et al., 2021). Probably one of the most cited definitions of digital innovation is the one provided by Yoo et al. (2010a) with a focus on the combination of physical products with digital features leading to the creation of new digitally enabled products. To be defined as a digital innovation, the newly created physical product shall be characterized by a high degree of newness (e.g., not comparable to the one which once existed on the market) and shall provide new functional characteristics, e.g., improved physical capabilities, new digital services, new customer experience. A distinguishing characteristic of digital innovation is not solely the direct innovation product, i.e., the product, service, or both, but also the ability to provide an entirely new value proposition with a wide-reaching impact beyond the organizational boundaries (Yoo et al., 2010a). Beyond the boundaries of digitally enabled products and with a focus on its impact, digital innovation can be defined as a *"…creation of (and a consequent change in) market offerings, business processes, or models that result from the use of digital technology"* (Nambisan et al., 2017). Due to its unique characteristics and impact, digital innovation emerges within the interactions of individuals with digitally enabled technology (Sandberg et al., 2020) creating a complex socio-technical context (Baygi et al., 2021). Hence, the interrelation between actors, technology, and digital artifacts shapes our understanding of digital innovation. A novel perspective (capturing the previous views on digital innovation) lays out a three-layered concept upon which digital innovation is built upon and linked to digital objects (Faulkner and Runde, 2019) and digital technology (Hund et al., 2021). The wide-reaching impact of digital innovation allows new market entrants to quickly take market shares of incumbent firms and provide high-value products to the customers. As a result, the incumbent is forced to explore new opportunities that digital innovation offers (Liu et al., 2022; Porter and Heppelmann, 2014).

2.2 Dynamic Capabilities

The dynamic capability framework seeks to explain how companies respond to fast-changing market conditions to preserve and gain a competitive advantage (Teece et al., 1997; Zahra et al., 2006). Essentially, there are three types of DC; DC related to sensing, seizing, and transforming. Performed in the given sequence, they ensure that activities for market screening and opportunities assessments take place, internal resources and evaluation of those is conducted, and finally, transformation activities are conducted in the firm to maintain competitiveness (Teece, 2014b, 2007). DCs focus on opportunities and if properly developed are unique to the firm and become a source of competitive advantage. Due to their uniqueness and adoption in a particular organizational context, they are not easy to replicate or to be sourced from the market (Teece, 2016, 2014a).

The dynamic capability framework has been extensively used in the field of Information Systems to deepen our understanding of the innovation processes related to IT in fast-changing environments. (Barreto, 2010; Henfridsson et al., 2009b). However, despite their broad theoretical adoption, the DCs received a fair amount of criticism for their macro level of analysis and the difficulties to operationalize and measure DCs (Fallon-Byrne and Harney, 2017; Zahra et al., 2006). That led to the growing recognition of the importance of their underlying routines and resources, and accounting to a lower and more detailed level of analysis in organizations. To increase the empirical compatibility of DCs, Teece (2007) introduced microfoundations as the building blocks of the DC.

2.3 Microfoundations of Dynamic Capabilities

Microfoundations are unique constructs to evaluate a specific set of firm capabilities as they cover both the individual and organizational levels (Teece, 2007). They are granular enough to provide detailed insights on processes and practices, and abstract enough to be used to determine categories of specific actions and beliefs rooted at the organizational level. With the introduction of microfoundations on the individual level, the empirical relevance of the DC has increased as they now could explain the role of individuals in developing DC based on their cognitive capacity (Helfat and Peteraf, 2015; Teece, 2007). Further, microfoundations build upon processes and procedures at the organizational level of the firm (Adner and Helfat, 2003; Teece, 2007). By integrating these two distinct characteristics, microfoundations offer a powerful concept to better understand the dynamics related to DC providing a lower level of abstraction. Further, they allow for deeper empirical analysis as the uniqueness of the digital capabilities is determined by the configuration and alignment of microfoundations. In the area of DC research, microfoundations have been recognized as a key emerging topic (Wilden et al., 2016) which shall address the limitations of the DC framework in regards to practical application in the organizational context (Barreto, 2010; Helfat and Peteraf, 2009) and lack of explication (Abell et al., 2008; Eisenhardt et al., 2010; Felin et al., 2012).

3 Methodology

Our minor adaption of the GT approach relates to selective coding which included meta-theoretical frameworks (Mueller et al., 2019; Sarker and Lau, 2001). As we did not incorporate the “paradigm model” as suggested by GT based on Strauss and Corbin (1990), we are more true to the idea of "emergence," as suggested by Glaser (1992). Instead, we identified a broad theoretical framework (meta-theory), which we identified as relevant based on our interaction with the data. Due to the wide-ranging socio-economic impact of digital innovation, we employed a theoretical framework well known in the field of IS to better relate our findings to the existing body of knowledge. Therefore, we considered the DC framework as defined by Teece (2014b, 2007) as the main mechanism for detecting artifacts and narratives and for extracting a storyline grounded in the data. In the research, artifacts and narratives will aid in categorizing data and concluding the level of a substantive theory. The GT (Glaser, 1992) offers the framework to collect qualitative artifacts and answer questions grounded in the data (Fernández, 2004; Tan, 2010). This is where GT helps to do “knowledge claims about how individuals interpret reality” (Suddaby, 2006). For the research, the simultaneous process of data collection and data analysis during the empirical data gathering has been followed as recommended (Glaser, 1992; Urquhart et al., 2010). The use of such an adapted and more flexible approach is in line with recent and established reviews in IS literature demonstrating that the GT approach is subject to idiosyncratic interpretations and flexible deployments (Matavire and Brown, 2013; Seidel and Urquhart, 2013).

3.1 Data Collection and Analysis

We employed a multi-case study design to make our results more generalizable. The interviews were conducted using a semi-structured questionnaire. Thus, all relevant aspects of the questions were covered, and participants' answers were more credible. The questionnaire was built as follows; an introduction of the purpose of the study and the direction of the research; a general section addressing the background of the interviewees, area of responsibility, and company information; During the interviews, the participants have been asked to describe how they manage the digital innovation activities and which competencies, processes, or routines they consider important for the future development of digital innovation. Few questions addressed the challenges of digital innovation development leaving space for reflection of the participants and the opportunity to collect specific recommendations. Open questions have been formulated encouraging discussion and open setup for sharing individual experiences. After each interview, the data has been transcribed, anonymized, and

coded (Urquhart et al., 2010). Following the original Glaserian GT approach, the generated codes have been analyzed and grouped to identify categories, their properties, and relationships among the categories. These stages were not isolated. True to the philosophy of GT we adopted the process of theoretical sampling (Charmaz, 2008) to allow for data emergence through the data collection and analysis processes. The approach led to minor adjustments to the questionnaire. Data analysis phases consisted of open, selective, and theoretical coding based on the Glaserian GT method (Glaser, 2001, 1998, 1992) with adaptations to incorporate the DC framework as meta-theory for inductive concept building (Sarker and Lau, 2001). For instance, during the review of the open codes and their categorization in selective codes additional consolidation of open codes has been conducted to reduce the number of open codes and focus on the properties of the selective codes. Similarly, during the theoretical coding, regrouping of open selective codes has been conducted, since the definition of the core category has evolved, and additional properties and relationships arise. Reconsideration of the meaning and naming of the categories occurred during the entire coding process.

3.2 Case Selection and Interviews

The research focused on large manufacturing companies with strong ties to physical product development. For the generalization of the results was important to select companies with a similar background. The following main criteria have been defined for the case selection; large manufacturing enterprises with the first experience in digital innovation; firms operating internationally and with headquarters in Germany, Austria, or Switzerland (DACH region). It was important to reach out to decision-makers active in the field of digital innovation who could provide a holistic view of the problem and share their experience, current challenges, and strategy. Not all the approached decision-makers agreed to participate in the research. Therefore, our fieldwork resulted in 11 interviews with participants from six manufacturing firms in different industries in Germany, Austria, and Switzerland. The firms can be considered incumbents in their industry as they have between 25 and 75 years of history in manufacturing physical products. They are operating globally with revenues between EUR 400M and EUR 4000M and employees in the range between 1000 and 20000. There are specific similarities among the firms in terms of the R&D processes for physical product development, service offerings, and digital innovation expertise. The interviewees hold mainly managerial positions with a focus on digital innovation activities; strategy and/or product-related. Their involvement in digital innovation covers strategic activities for digital innovation projects and reaching out to leading digital innovation projects and programs. Considering that GT is a powerful instrument to understand the individual perspective of the actors, the combination of various roles and firms in the study provides a diversity of experience and perspectives helping to identify key microfoundations for digital innovation development. The interview process started in 2019 and was conducted over 14 months, including data analysis and coding after each of the interviews. The participants were informed about the purpose of the study and that the confidentiality of the answers is guaranteed. The interviewees have been taken in person or online and lasted between 45 to 90 min.

4 Findings

This section aims to answer the questions which are the main microfoundations that enable product-centric firms to carry out digital innovation activities. Interview quotes are used to support the interpretation of data. The emerged microfoundations have been assigned to the DC as defined by Teece (2007) using them as a meta-theoretical coding device. The findings are summarized in Figure 1. To provide a deeper understanding of the practical implications of the findings, the 16 identified main microfoundations of digital innovation capabilities have been assigned to the organizational level (8) and individual level of analysis (8). The following sub-sections provide explanations of these microfoundations as enablers of digital innovation activities.

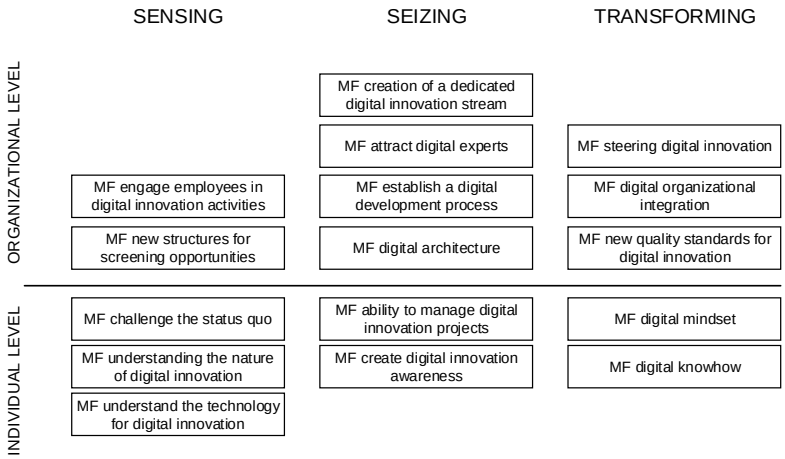

Figure 1. Microfoundations enabling digital innovation activities

4.1 Microfoundations for Sensing of Digital Innovation

Sensing addresses the capabilities of the firm to search and identify new market opportunities (Teece, 2014b, 2007). The changing competitive environment and the convergence of industries as external factors set under pressure manufacturing companies to act in a fast-paced competitive space. Five core categories summarizing capabilities on organizational and individual levels emerged from the data. On the organizational level, participants stated that the involvement of employees in digital innovation activities is an important step for creating awareness of the importance of digital innovation. As digital innovation cannot be solely a senior management topic, the openness and readiness to ***engage employees in digital innovation activities*** are considered important for overall success**.**

"First, the understanding of the C level is going down to the department heads. …And how this can help them to be more successful. ….we are going to have sessions in different areas and locations with other employees to inform them and to discuss what is this about. " (#3)

As various organizational dynamics take place in the firms the initial process of scanning for digital innovation is unstructured and uncontrolled. There is no clear separation between opportunities screening and the core development of digital innovation. In a rather iterative process, both steps are conducted. This problem is not only related to the process itself but also to the missing detailed knowledge of how digital innovation is developed. Therefore, interview participants suggested developing ***new structures for screening digital innovation opportunities and fostering knowledge transfer.***

"If I look at the current development digital innovation is approached in various ways, but all of them are not structured." (#5)

On the individual level, the participants overall explained the importance of the capability to correctly ***understand customer needs for digital products***. As stated in one of the interviews there is an ambiguity of how customers rate the importance of digital innovation.

"Customer has been asked in focus groups in regard with one of the small ideas we want to introduce. And a pilot is running with the customer. – digitally enabled service." (#3)

"For the customer was important first the physical product and then potentially the digital solution. The digital solution is seen as a complimentary." (#9)

As there are some good practices of managing the customer demand and focusing on its importance for the success of digital innovation, there are still many open questions about the nature of the digital

innovation as such and the related development process. That might prove to be a barrier to sensing activities and proper opportunity identification. Hence, one of the emerging core categories was related to the ***understanding of the technology of digital innovation***. This microfoundation is important not only for the sensing activities but also extends to any follow-up process steps in the development of digital innovation.

To identify a specific scope for new market activities manufacturing firms constantly try to comprehend the information related to the customer needs, the external development of emerging technology and make sense of the fast-paced changes in their industries. In this context, it is vital to embrace the ***capability to challenge the status quo***, i.e., as one of the participants stated " *to ask the right questions*".

"*… challenging us on a high level and high level of know-how has a great impact. All people on all levels through the whole chain have been challenged to think in a new way***."** *(#3)*"

This microfoundation is particularly crucial for manufacturing firms in the sensing phase for two reasons. Firstly, competing in a new environment mainly driven by technology trends is difficult to recognize new business opportunities if employees are looking through the lens of pure product development. Secondly, asking the right questions helps to better understand the customer demand, the competitors, and at a later stage to develop a digital mindset in the organization.

4.2 Microfoundations for Seizing of Digital Innovation

While sensing addresses the process of screening and identifying new market opportunities, seizing focuses on the ability of the organization to foster related potentials by resource mobilization. To seize opportunities in the digital space product-centric firms need to build new digital teams and acquire external digital knowledge. This process requires a high degree of integration and change management to align the organization towards digital innovation. That becomes obvious by the following quote:

"*First, it took quite long (more than 2 years) to set up the department and start developing digital innovation or software solutions. It required a lot of external knowhow but also knowhow from internal people to ensure the integration of the new people in the company." (#9)* Therefore, on the organizational level, the ***creation of a dedicated digital innovation stream*** is seen as an important step towards seizing digital innovation and it impacts the whole organization.

"…, a new department has been set up and external know-how has been acquired. I think on purpose at this moment the integration was not in focus. The idea was to let the new team work on a digital solution not getting disturbed from existing processes" (#9)

A logical next step is the development of digital know-how in the organization by adding new resources with a digital background. In most of the cases, the participants stated that the first digital innovation projects have been led by people with no digital background with main knowledge in physical product development. As the first results showed that the success rate of such projects is rather low the firms started to hire experts in digital innovation. Hence, if the firms manage to develop the competence to ***attract digital experts*** will support the further development of digital innovation. Interestingly, the dedicated teams with digital experts have not been integrated into the existing organizational structure but rather kept independent.

"We changed the digital innovation team. New employees who are coming from the digital world. … a tailor-made process for DI can be established if we put people in charge who have a digital innovation background. They have a different approach to developing digital innovation." (#4)

The next consequent step in the development of digital innovation has been identified by the practitioners as the definition of a dedicated digital innovation process that differs from the traditional product development by its pace and iteration cycles. The relevant microfoundation is to establish ***a digital development process.***

"Three years back the software development process has been developed following the agility project management framework" (#9)

"Our department started using the new development process and it was further developed towards the standards for software development" (#3)

The participants addressed as an important point the technology readiness to develop digital innovation. Coded as the competence to develop, source, and maintain digital architecture, this microfoundation plays a critical role in the success of digital innovation. It is seen as an enabler considering technology platforms for the scalability of the digital solutions, and the role of the IT organization as a provider of services supporting digital innovation.

"IT shall be able to provide the platforms and the know-how to use existing technologies." (#5)

"In our case, the role of IT is to provide the infrastructure for our systems and to ensure also integrated into the existing processes from an IT perspective." (#9)

So far, these microfoundations enabling seizing capabilities have been identified on the organizational level. However, we can report two on the individual level. The first is the ***ability to manage digital innovation projects*** as participants suggested there are significant differences in managing physical product development and digital innovation projects. Changing requirements for digital innovation development require a higher level of flexibility and new processes.

"For digital innovation, the waterfall project management approach is not applicable…, digital innovation is developed with agile Scrum methods based on prototypes." (#8)

The second microfoundation in this context is related to digital innovation awareness. It can be seen as closely related to the previous one and reflects a major notion in the data. A recurrent topic in the interviews was a sense amongst interviewees that increased awareness about digital innovation among all members of the organization is required to support further development of digital innovation.

"There is awareness of digital innovation in the company. However, it is still considered as something relevant in the future." (#5)
As one of the participants stated that the new digital innovation practices "*created tension since not everybody in the organization understands the agile software development" (#9).*

There were other examples of conflicts in the organization due to different characters of the digital innovation activities. Therefore, the suggested activity was to constantly communicate and create awareness of the nature of digital innovation across the organization.

4.3 Microfoundations for Transforming Towards Digital Innovation

Transformation DCs address the long-term competitiveness of the firm by allowing for reconfiguration and realignment of the internal resources (Teece 2007). The interviewees explained that in their company transformation activities are taking place to re-align internal processes and practices to better foster the potential of digital innovation, as one of the participants stated "*…we are just at the beginning of the digital innovation journey…".* As learning emerges over time, two critical microfoundation have been identified on the organizational level. The first is related to the ability to ***steer digital innovation*** activities. In one of the cases, it was indicated that after introducing a dedicated task force and attention given by the top management the quality of work has increased.

"We establish a group, business unit heads, who are regularly meeting. …. We turned these meetings into a constant process of steering the digital transformation. Owned by members of the board of directors and one of the CEOs…." (#3)

The second microfoundation was identified to be the integration of digital output in the existing processes and defined as ***MF digital organizational integration.***

"For me, integration plays a major role it starts with the processes and ends with the integration for our customers. A successful digital solution would meet the goals we set and will create a seamless experience for the customer" (#9)

Interviewees suggested transformation must happen on the individual level which resonates with the number of microfoundations identified on the individual level of analysis.

The quotes related to how individuals perceive and deal with the divergence of digital innovation in the organizational contexts have been coded into the category of ***digital mindset.*** It was seen as an important microfoundation for the success of digital innovation:

"And of course when we move from mechanical solution to electronic solutions in a field we are not aware of there it also needs to be a change of the mindset" (#6)

As a related yet different transformational microfoundation, ***digital know-how*** has been discovered. One of the interviewees stated that skills are equally important as the right mindset to develop digital innovation.

"It is a question not only on mindset but also on skills. If you don't have digital skills, you need to develop them" (#4)

5 Discussion

The growing relevance of digital innovation forces incumbent firms to seek new ways of sustaining their market position and ensuring long-term success. The extant literature offers a limited view on how incumbents address or should address the digital innovation challenge (Nambisan et al., 2017). The goal of this study was to identify the underlying processes, practices, and cognitive competencies (microfoundations) required to build DC in product-centric incumbents. By empirically identifying microfoundations, the study adds to the existing research on digital innovation and DC. In what follows we will discuss main contributions for IS research and managerial practices.

The following major points are to be considered. Firstly, we set out with the aim to gain detailed insights of microfoundations on individual and organizational levels for DC considering the role of human agency in the process of digital innovation. Further, we wanted to address one criticism of much of the literature on DC about the framework only providing high-level claims while neglecting the role of the actors involved in building those DC (Fallon-Byrne and Harney, 2017; Nylén et al., 2015). Secondly, the findings naturally raise the questions of the criteria used for microfoundation categorization. As the study subscribes to the interpretative philosophical stance and is exploratory, no clear criteria have been set at the begging. The delimitation of microfoundations evolved during the research process. We based our categorization on the multi-level microfoundations approach proposed by Felin et al. (2012) that considers sub-entities of organizational microfoundations, e.g., people, processes, and structures. The importance of the lower-level entities building organizational microfoundations is also recognized by Teece (2007). Further, we have not neglected the importance of individuals and their skills impacting the process of development of digital innovation specifically on leadership positions (Teece, 2012). Hence, we assigned microfoundations to the organizational level in cases where the represented capabilities can be rooted in the organization while being accessible by a wide range of actors. For example, microfoundations embody a structure, process, or reflect interactions among individuals. On the contrary, any capabilities based on personal motivation or skills of an individual were seen as individual microfoundations.

We observed an uneven distribution of microfoundations across the three DCs sensing, seizing, and transformation in terms of these levels of analysis. For example, building sensing dynamic capabilities for digital innovation requires focusing on individual microfoundations, while seizing focuses more on organizational capabilities. This is an interesting finding supported by the data as the interviewees stated that digital innovation activities are started by individuals or a small group in the product-centric firms, with no or very limited organizational support and lack of dedicated DI structures. As a

logical consequence, it could be concluded that those individual microfoundations result in sensing organizational microfoundations. Related to seizing DCs, organizational microfoundations seem to drive individual microfoundations. This is supported by the feedback of the participants who stated that in this phase already certain organizational structures should be in place to support DI seizing activities. This view offers an avenue for further analysis of the interconnectedness between individual and organizational microfoundations and their fluidity for building DCs.

5.1 Contributions for Managerial Practice

On the level of sensing, the main finding is that a structured process for screening digital initiatives is an essential microfoundation to increase the sensing capabilities of the firm. Next, it is about understanding the convergence and generativity of digital technologies and the requirements they create for manufacturing firms. Lastly, the involvement of employees in these activities has been considered an important step towards a better understanding of digital innovation.

Our research provides further context on situations in which seizing digital innovation opportunities constitutes a challenge for the firms. Because seizing activities haven't been supported by major organizational or process changes, the digital innovation development process is tied to traditional product development. The result is organizational tension since product dominance and digital innovation regimes differ. Therefore, the interview participants suggested that a dedicated digital innovation development process managed by externally sourced digital experts shall have a positive impact on digital innovation activities. Once the foundation is built, detailed microfoundations to manage digital projects are required. Taking into consideration that the context under investigation is not transformational, the microfoundations supporting the integration of digital innovation output into the main business stream seem to be vital for the further success of the digital innovation activities. In general, it was proposed that digital innovation activities must be managed by dedicated organizational units, though, their integration in the core firms' processes remains key for further success.

Relating to our cases, the transformational capabilities and their respective microfoundations were the least developed considering that the firms have not yet undertaken any major business model or organizational adjustment to manage digital innovation activities. However, it was suggested that the transformation activities should be incremental and follow a certain sequence. As a first step, cross-functional teams with digital knowledge should be formed. In an ideal scenario, members of the team should be able to handle both digital and traditional product development. The second stage of development is twofold. Some companies suggested appointing special roles, such as a dedicated Chief Digitalization Officer, others recommended building on digital units relying on external resources. At the third stage with progress on digital innovation already reached, alignment issues emerged as not all organizational units have been aligned with a digital innovation strategy. Consequently, realignment and integration activities should take place to adjust the organization, especially to match the different paces of physical product and digital innovation.

5.2 Contributions for IS Research

Our results show that there is a set of individual and organizational microfoundations underpinning the dynamic capability framework (Figure 1), which can be aligned with selected prior literature (Table 1). Adding to these studies, we provide a selection and classification of relevant microfoundations for successful digital innovation from the dynamic capability perspectives on sensing, seizing, and transforming (Helfat et al., 2007) in the context of incumbent product-centric firms. By empirically identifying microfoundations and mapping those to DC theory, our findings address the widely discussed limitation of DCs related to their practical adoption (Barreto, 2010; Helfat and Peteraf, 2009), especially in terms of providing detailed descriptions of microfoundations and the indifference of the role of employees (Abell et al., 2008; Eisenhardt et al., 2010; Felin et al., 2012).

Microfoundations enabling digital innovation (O.. Organizational level, I...Individual level)	**DC**	**Selected references**
MF engage employees in digital innovation activities (O)	1. Sensing	Digital mindset crafting; Digital scouting; Digital scenario planning (Warner and Wäger, 2019)
MF new structures for screening opportunities (O)		
MF challenging the status quo (I)		Shift from physical product paradigm to software logic (Andreasson and Henfridsson, 2009)
MF understanding the nature of digital innovation (I)		The new logic of digital innovation; homogeneity and convergence (Boland et al., 2007)
MF understanding the technology for digital innovation (I)		Promote the use of digital technology (Orth et al., 2021)
MF creation of a dedicated digital innovation stream (O)	2. Seizing	Strategic agility; Balancing digital portfolios; Rapid prototyping (Warner and Wäger, 2019)
MF attract digital experts (O)		Recruit digital talents (Orth et al., 2021)
MF establish a digital development process (O)		Different organizational focus on digital innovation (Porter and Heppelmann, 2015)
MF digital architecture (O)		
MF ability to manage digital innovation projects (I)		Dynamic of the digital innovation process (Tuomi, 2004)
MF create digital innovation awareness (I)		
MF steering digital innovation (O)	3.Transforming	Improving digital maturity; Navigating innovation ecosystems; Redesigning internal structures talent and to enhance internal and external collaboration; Improving digital maturity balancing traditional ownership with mobility services; Redesigning internal structures (Warner and Wäger, 2019)
MF digital organizational integration (O)		
MF new quality standards for digital innovation (O)		
MF digital knowhow (I)		Developing and optimizing a digital organization (Orth et al., 2021)
MF digital mindset (I)		Requirements on new digital knowledge (Henfridsson et al., 2009a)

Table 1 Microfoundations enabling digital innovation and selected associated literature

Our mapping of microfoundations to DC theory and the level on which they are observed aids to expose a time sequence of activities within which individuals and organizations are involved during the overall digital innovation development process. Considering that sensing, seizing, and transformation follow a certain logic, the importance of specific microfoundations at different stages of digital innovation development also becomes distinct. For example, our data showed that the development of digital knowhow undergoes various stages, starting with individuals, primarily in leadership positions, followed by a broader increase of digital skills in the organization. This finding is consistent with other studies (Orth et al., 2021; Warner and Wäger, 2019) which recognize the importance of digital knowhow and its impact on organizations. However, we understand the process of developing digital skills as a long-lasting procedure determined by the constant reciprocal influence of microfoundations during the DC stages.

Another key point emphasized in most interviews was related to the integration of digital innovation practices in the existing processes. The interviewees expressed the view that it is crucial for the firm to build microfoundations allowing for the organizational integration of DI and a dedicated DI development process. As the digital innovation process and output are tightly integrated (Mendling et al., 2020), business process management takes an important role to help to better integrate digital innovation process and output into the incumbent's processes (Grisold et al., 2021).

Further, our work contributes to the existing knowledge of innovation and DC, and their underlying microfoundations in particular by addressing existing criticism on the ability of the DC framework to cover issues related to the complex relationships between organizational and individual needs in building innovation (Boxall, 2013). It appears that digital innovation firstly requires the development of individual microfoundations, which enable organizational microfoundations. However, this is a misleading assumption, especially in the context of incumbents as the organizational inertia and history determine the microfoundations on the organizational level. That leads to tensions in the organization between the competencies and processes, digital versus physical product-driven teams.

6 Limitations and Future Research

The efforts of this study should be observed as an attempt to understand digital innovation microfoundations relevant for product-centric incumbents. While the study provides meaningful insights for our sample, the results have several limitations. Along with the common shortcomings of qualitative research based on the GT approach, a limitation of our study is that we cannot rule out missing relevant microfoundations. We tried to limit this possibility by using the core capability of GT during the interview process, e.g., constant data collection and analysis which steered the direction of the research. Besides, Teece (2007) already advised that it is hard to identify all relevant microfoundations. The examined context includes globally operating firms; however, the observations are mainly provided from the perspectives of managers operating in their headquarters. Further, no consideration was given to external factors such as the dynamics of the industry, the cultural habits of customers and vendors, or any country-specific characteristics. External factors might play a relevant role in building capabilities supporting digital innovation development. Due to the fast pace of development of technologies and industries, the study should be interpreted as a snapshot of a constantly changing environment. With a small sample size, caution must be applied, as the findings might not be transferable to other industries. However, the study showed similarities of the challenges and development of digital innovation across firms and industries and might be relevant for firms at the same or similar stage of digital innovation development. Therefore, further research might build on reviewing the status of development of manufacturing firms in other countries or regions and by building a comparison between different industries or types of manufacturing firms (incumbent versus newcomers) to understand better the dynamics of digital innovation. More, it might be interesting to investigate, how other companies are developing microfoundations and evaluate the benefits of those. In general, this study offers a departing point for further evaluation of digital innovation enablement in manufacturing firms.

7 Conclusion

This research set out to determine microfoundations enabling the digital innovation activities in incumbent product-centric firms. It extends our understanding of the dynamics of digital innovation development in manufacturing firms, by taking the perspective of DC and its underlying microfoundations. The study takes an interpretative stance and GT has been used to collect the data reflecting the experience of the actors in the field of digital innovation. The semi-structured interviews helped to get a close perspective on the processes and dynamics ongoing in incumbent firms when they try to develop digital innovation. The study has identified leading microfoundations on organizational and individual levels seen as key drivers for digital innovation enablement by the participants. The study provides practical insights and can be used as guidance by incumbent manufacturing firms on their digital innovation journey. The findings offer a starting point to deepen the subject in similar or related areas and to extend the knowledge on the complex dynamics of digital innovation. Last, but not least, the study promotes the usage of qualitative methods in the domain of IS by extending the understanding of the implications of digital innovation in the socio-economical context in the substantive area of inquiry.

References

Abell, P., Felin, T., Foss, N., 2008. Building Micro-Foundations for the Routines, Capabilities, and Performance Links. Manag. Decis. Econ. 29, 489–502.

Adner, R., Helfat, C.E., 2003. Corporate effects and dynamic managerial capabilities. Strateg. Manag. J.

Andreasson, L., Henfridsson, O., 2009. Digital differentiation, software product lines, and the challenge of isomorphism in innovation: A case study, in: 17th European Conference on Information Systems. pp. 3027-3039 ST-Digital differentiation, software.

Barreto, I., 2010. Dynamic Capabilities: A review of past research and an agenda for the future. J. Manage. 36, 256–280.

Baygi, R.M., Introna, L.D., Hultin, L., 2021. Everything flows: Studying continuous sociotechnological transformation in a fluid and dynamic digital world. MIS Q. Manag. Inf. Syst. 45, 423–452.

Boland, R.J., Lyytinen, K., Yoo, Y., 2007. Wakes of Innovation in Project Networks: The Case of Digital 3-D Representations in Architecture, Engineering, and Construction. Organ. Sci. 18, 631–647.

Boxall, P., 2013. Mutuality in the management of human resources: Assessing the quality of alignment in employment relationships. Hum. Resour. Manag. J.

Charmaz, K., 2008. Grounded Theory as an Emergent Method. Handb. Emergent Methods 155–170.

Chew, E., 2012. Value Co - Creation in the Organizations of the Future 16–24.

Crossan, M.M., Apaydin, M., 2010. A Multi-Dimensional Framework of Organizational Innovation: A Systematic Review of the Literature. J. Manag. Stud. 47, 1154–1191.

Eisenhardt, K.M., Furr, N.R., Bingham, C.B., 2010. Microfoundations of performance: Balancing efficiency and flexibility in dynamic environments. Organ. Sci.

Eisenhardt, K.M., Martin, J.A., 2000. Dynamic capabilities: What are they? Strateg. Manag. J.

Fallon-Byrne, L., Harney, B., 2017. Microfoundations of dynamic capabilities for innovation: a review and research agenda. Irish J. Manag. 36, 21–31.

Faulkner, P., Runde, J., 2019. Theorizing the digital object. MIS Q. Manag. Inf. Syst. 43, 1278–1302.

Felin, T., Foss, N.J., Heimeriks, K.H., Madsen, T.L., 2012. Microfoundations of Routines and Capabilities: Individuals, Processes, and Structure. J. Manag. Stud. 49, 1351–1374.

Fernández, W.D., 2004. The grounded theory method and case study data in IS research : issues and design. Inf. Syst. Found. Constr. Crit. Work. Aust. Natl. Univ. 43–59.

Fichman, R.G.R.G., Dos Santos, B.L., Zheng, Z., Santos, Brian L Dos, 2014. Digital Innovation as a Fundamental And Powerfull Concept In the Information Systems Curriculum. MIS Q. 38, 1–15.

Glaser, B.G., 2001. The grounded theory perspective: Conceptualization contrasted with description. Mill Valley, CA: Sociology Press.

Glaser, B.G., 1998. Doing grounded theory: Issues and discussion. Recherche.

Glaser, B.G., 1992. Basics of grounded theory analysis: emergence vs forcing, Recherche.

Grisold, T., vom Brocke, J., Gross, S., Mendling, J., Röglinger, M., Stelzl, K., 2021. Digital Innovation and Business Process Management : Opportunities and Challenges as Perceived by Practitioners. Commun. Assoc. Inf. Syst.

Helfat, C.E., Finkelstein, S., Mitchell, W., Peteraf, M.A., Singh, H., Teece, D.J., Winter, S.G., 2007. Dynamic capabilities: Understanding strategic change in organizations, Strategic Management Journal.

Helfat, C.E., Peteraf, M.A., 2015. Managerial cognitive capabilities and the microfoundations of dynamic capabilities. Strateg. Manag. J. 36, 831–850.

Helfat, C.E., Peteraf, M.A., 2009. Understanding dynamic capabilities: Progress along a developmental path. Strateg. Organ.

Henfridsson, O., Mathiassen, L., Svahn, F., 2009a. Reconfiguring Modularity : Closing Capability Gaps in Digital Innovation.

Henfridsson, O., Yoo, Y., Svahn, F., 2009b. Path Creation in Innovation Design : a Multi - Layered Perspective 1–32.

Hund, A., Wagner, H.T., Beimborn, D., Weitzel, T., 2021. Digital innovation: Review and novel perspective. J. Strateg. Inf. Syst. 30, 101695.

Kindström, D., Kowalkowski, C., 2014. Service innovation in product-centric firms: a multidimensional business model perspective. J. Bus. Ind. Mark. 29, 96–111.

Lansiti, M., Lakhani, K.R., 2014. Digital ubiquity: How connections, sensors, and data are revolutionizing business. Harv. Bus. Rev. 92, 90–99.

Liu, Y., Dong, J., Mei, L., Shen, R., 2022. Digital innovation and performance of manufacturing firms: An affordance perspective. Technovation 102458.

Magnusson, J., Holmström, J., Magnusson, J., Mähring, M., 2021. Orchestrating digital innovation: The case of the swedish center for digital innovation. Commun. Assoc. Inf. Syst. 48, 248–264.

Matavire, R., Brown, I., 2013. Profiling grounded theory approaches in information systems research. Eur. J. Inf. Syst.

Mendling, J., Pentland, B.T., Recker, J., 2020. Building a complementary agenda for business process management and digital innovation. Eur. J. Inf. Syst. 29, 208–219.

Mueller, S.K., Mendling, J., Bernroider, E.W.N., 2019. The roles of social identity and dynamic salient group formations for ERP program management success in a postmerger context. Inf. Syst. J. 29, 609–640.

Nambisan, S., Lyytinen, K., Majchrzak, A., Song, M., 2017. Digital Innovation Management: Reinventing Innovation Management in a Digital World. MIS Q. 41 No. 1, 223–238.

Nylén, D., Holmström, J., Holmstro, J., Nyle, D., 2015. Digital innovation strategy: A framework for diagnosing and improving digital product and service innovation. Bus. Horiz. 58, 57–67.

Orlikowski, W.J., 1993. CASE Tools as Organizational Change: Investigating Incremental and Radical Changes in Systems Development. Misq 17, 309.

Orth, P., Piller, G., Rothlauf, F., B, P.O., Rothlauf, F., 2021. How Companies Develop a Culture for Digital Innovation: A Multiple-Case Study, Lecture Notes in Business Information Processing. Springer International Publishing.

Parviainen, P., Tihinen, M., Kääriäinen, J., Teppola, S., 2017. Tackling the digitalization challenge: how to benefit from digitalization in practice. Int. J. Inf. Syst. Proj. Man agement 5, 63–77.

Porter, M.J., Heppelmann, J.E., 2014. How Smart, Connected Products Are Transforming Competition. Harv. Bus. Rev.

Porter, M.J.E., Heppelmann, J.E., 2015. How smart connected products are transforming companies. Harv. Bus. Rev. 1.

Salter, A., Alexy, O., 2013. The Nature of Innovation.

Sandberg, J., Holmström, J., Lyytinen, K., 2020. Digitization and phase transitions in platform organizing logics: Evidence from the process automation industry. MIS Q. Manag. Inf. Syst. 44, 129–153.

Sarker, S., Lau, F., 2001. Using an Adapted Grounded Theory Approach for Inductive Theory Building About Virtual Team Development 32, 38–56.

Seidel, S., Urquhart, C., 2013. On emergence and forcing in information systems grounded theory studies: the case of Strauss and Corbin. J. Inf. Technol. 28, 237–260.

Suddaby, R.O.Y., 2006. From the Editors : What Grounded Theory is not. Acad. Manag. J. 49, 633–642.

Susman, D.G., Warren, D.A., Ding, D.M., 2006. Product and Service Innovation in Small and Medium-Sized Enterprises, Current.

Svahn, F., Henfridsson, O., 2011. The dual regimes of digital innovation management, in: Proceedings of the Annual Hawaii International Conference on System Sciences. pp. 3347–3356.

Svahn, F., Henfridsson, O., Yoo, Y., 2009. A Threesome Dance of Agency: Mangling the Sociomateriality of Technological Regimes in Digital Innovation. Int. Conf. Inf. Syst. 1–18.

Svahn, F., Mathiassen, L., Lindgren, R., 2017. Embracing Digital Innovation in Incumbent Firms: How Volvo Cars Managed Competing Concerns. MIS Q. 41, 239–253.

Tan, J., 2010. Grounded theory in practice: issues and discussion for new qualitative researchers. J. Doc. 66, 93–112.

Teece, D.J., 2018. Profiting from innovation in the digital economy: Enabling technologies, standards, and licensing models in the wireless world. Res. Policy 47, 1367–1387.
Teece, D.J., 2017. Dynamic Capabilities and (Digital) Platform Lifecycles. Entrep. Innov. Platforms 211–225.
Teece, D.J., 2016. Dynamic capabilities and entrepreneurial management in large organizations: Toward a theory of the (entrepreneurial) firm. Eur. Econ. Rev.
Teece, D.J., 2014a. The Foundations of Enterprise Performance: Dynamic and Ordinary Capabilities in an (Economic) Theory of Firms. Acad. Manag. Perspect. 28, 328–352.
Teece, D.J., 2014b. A dynamic capabilities-based entrepreneurial theory of the multinational enterprise. J. Int. Bus. Stud. 45, 8–37.
Teece, D.J., 2012. Dynamic Capabilities: Routines versus Entrepreneurial Action. J. Manag. Stud. 49, 1395–1401.
Teece, D.J., 2007. Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. Strateg. Manag. J. 298, 1319–1350.
Teece, D.J., Pisano, G., Shuen, A., 1997. Dynamic Capabilities and Strategic Management. Strateg. Manag. J. 18, 77–115.
Tuomi, I., 2004. Networks of innovation: Change and meaning in the age of the Internet. Res. Policy 32, 251.
Tushman, M., Anderson, P., O'Reilly, C., 1997. Technology cycles, innovation streams, and ambidextrous organizations: organization renewal through innovation streams and strategic change, in: Managing Strategic Innovation and Change. pp. 3–23.
Urquhart, C., Fernandez, W., 2006. Grounded Theory Method : The Researcher as Blank Slate and Other Myths. Inf. Syst. 12, 456–464.
Urquhart, C., Lehmann, H., Myers, M.D., 2010. Putting the "theory" back into grounded theory: Guidelines for grounded theory studies in information systems. Inf. Syst. J. 20, 357–381.
Warner, K.S.R., Wäger, M., 2019. Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal. Long Range Plann. 52, 326–349.
Wilden, R., Devinney, T.M., Dowling, G.R., 2016. The Architecture of Dynamic Capability Research Identifying the Building Blocks of a Configurational Approach. Acad. Manag. Ann.
William J. Wales, Vinit Parida, Patel, P.C., 2013. Too much of a good thing? absorptive capacity, firm performance, and the moderating role of entrepreneurial orientation. Strateg. Manag. J. 1350, 12.
Yoo, Y., 2013. The Tables Have Turned: How Can the Information Systems Field Contribute to Technology and Innovation Management Research? J. Assoc. Inf. Syst. 14, 227–236.
Yoo, Y., Boland, R.J., Lyytinen, K., Majchrzak, A., 2012. Organizing for Innovation in the Digitized World. Organ. Sci. 23, 1398–1408.
Yoo, Y., Henfridsson, O., Lyytinen, K., Tiwana, A., Konsynski, B., Bush, A.A., 2010a. Research Commentary —The New Organizing Logic of Digital Innovation: An Agenda for Information Systems Research. Inf. Syst. Res. 21, 724–735.
Yoo, Y., Lyytinen, K.J., Boland, R.J., Berente, N., 2010b. The Next Wave of Digital Innovation: Opportunities and Challenges: A Report on the Research Workshop "Digital Challenges in Innovation Research," SSRN.
Zahra, S.A., Sapienza, H.J., Davidsson, P., 2006. Entrepreneurship and dynamic capabilities: A review, model and research agenda. J. Manag. Stud.