Industrial Marketing Management 111 (2023) 158–172

Contents lists available at ScienceDirect

Industrial Marketing Management

journal homepage: www.elsevier.com/locate/indmarman

Capabilities for data-driven innovation in B2B industrial companies

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ARTICLE INFO

Keywords:
Data-driven innovation
Capabilities
Industrial company
B2B

ABSTRACT

Industrial companies are increasingly interested in innovating through data to develop solutions for customers' current and future needs. This study examines organizational capabilities for data-driven innovation (DDI) in the context of established industrial companies. Building on the prior innovation literature, resource-based view, and dynamic capabilities view, we conduct a qualitative study of technological and marketing capabilities in relation to DDI. Based on interview data from six multinational B2B companies, we find that even though technological capabilities are vital to DDI, five of the six examined companies struggle more with marketing capabilities in developing DDI. The research findings underline the central role of customer understanding and involvement in DDI, as well as the significance of the ability to articulate the DDI value proposition in a form that potential customers can grasp. The study contributes to our understanding of DDI as a phenomenon in the context of established manufacturing companies, and identifies key challenges for intangible data-driven innovations in this context.

1. Introduction

In this era of intense global competition and highly dynamic operating environments, innovations are widely considered a necessary precondition for firm survival and indeed success (Seidler-de Alwis & Hartmann, 2008). Innovations that utilize data as a core ingredient, that is, data-driven innovations (DDI), are expected to be crucial to business competitiveness in the near future (European Commission, 2020). There is evidence of data driving productivity and resource-efficiency gains (Brynjolfsson, Hitt, & Kim, 2011; Hemerly, 2013), a development anticipated to spread across all industry sectors and enable companies to innovate new products and services (European Commission, 2020). Indeed, nearly all companies accumulate a wide array of data nowadays, such as financial and CRM data, operations data, and environmental data. Yet, few industrial companies have been capable of leveraging these vast amounts of data for improved products or services (Babu, Rahman, Alam, & Day, 2021; Dubey, Gunasekaran, Childe, Blome, & Papadopoulos, 2019; Zhong, Newman, Huang, & Lan, 2016; Zillner et al., 2016).

In this study, we focus on organizational capabilities central to innovating through data. Capability refers to an organization's capacity to deploy resources using organizational processes to achieve a desired end (Amit & Schoemaker, 1993). Organizational capabilities enable the firm to make use of its resources (Penrose, 1959), and they are essential factors for a firm's competitive advantage (Barney, 1991). According to Jetzek (2013), capabilities are one of the four critical factors (capabilities, openness, resource governance, technical connectivity) enhancing value creation from open government data (Jetzek, 2013), which demonstrates the significance of capabilities for DDI. Moreover, Lafiti, Bouwman, and Nikou (2021) showed that when companies are innovating new data-driven business models, organizational capabilities have a strong mediating role in improving firm performance. Most recently, Sultana, Akter, and Kyriazis (2022) found DDI capabilities have a significant impact on performance, and the relationship is mediated by strategic market agility.

Despite the aforementioned potential for value creation, surprisingly little is known about DDI in the industrial context or with regard to research-based knowledge on the capabilities of industrial firms. For example, Hossain, Agnihotri, Rushan, Rahman, and Sumi (2022) put forward a long list of future research topics related to DDI in the industrial context, focusing particularly on the marketing analytics capability. Also, Morgan, Miočević, and Herhausen (2019) argued that the capabilities-based view of industrial firms calls for further development. In particular, they argued for the need to develop the understanding of the interfaces between capabilities and other organizational phenomena. This study addresses these calls by focusing on the interface between organizational capabilities and DDI.

Also, there is a need for deeper understanding on the capabilities

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https://doi.org/10.1016/j.indmarman.2023.04.005
Received 9 September 2021; Received in revised form 29 December 2022; Accepted 6 April 2023
Available online 15 April 2023

industrial companies leverage in pursuing DDI. To succeed in DDI, the company needs to emphasize the development also of its organizational capabilities. Yet, there is limited research examining what the focal organizational capabilities look like in the context of DDI. The extant literature indicates that both marketing and technological capabilities play a key role in organizational innovation in general (Eng & Okten, 2011; López-Cabarcos, Srinivasan, Göttling-Oliveira-Monteiro, & Vazquez-Rodriguez, 2019), and in DDI in particular (Sultana et al., 2022). In line with this research, we aim to uncover the nature of these two focal capabilities in the DDI domain, and what kind of challenges industrial companies need to overcome in relation to these capabilities when they start pursuing DDI. In this paper, we address the following research questions:

1. What are the key elements of technological and marketing capabilities in the context of data-driven innovation?
2. What kind of capability deficiencies do the industrial companies face?

We seek answers to these questions by analyzing DDI in six manufacturing companies operating in business-to-business (B2B) markets. This study contributes to the literature on organizational innovation capabilities, and the growing body of research on data as an ingredient of innovation (Trabucchi & Buganza, 2019). We advance the resource-based view of the firm (e.g., Barney, 1991) and the dynamic capabilities approach (e.g., Teece, 2007), which strive to explain companies' competitive advantage. Moreover, we build on the focal assumption that a firm's internal capabilities influence its ability to innovate (Verona, 1999). Our study makes a further important contribution by adding to the understanding on the details of the two aforementioned focal organizational capabilities. The few extant studies have established the importance of capabilities for DDI, reinforcing that of technological and marketing capabilities in particular. However, the earlier studies appear to build on the assumption that the focal organizational capabilities are independent of the context.

Capabilities are developed over time and become embedded in the organization, which makes them difficult to imitate (Grewal & Slotegraaf, 2007). This also implies that capabilities are not identical across contexts, highlighting the importance of context-specific examination. In addition to the significant role played by the internal organizational context, the external context is also important. By scrutinizing the capabilities of relatively similar companies engaging in similar DDI initiatives, this study identifies patterns in how the capabilities are manifested in the companies, and, thus, contributes to the academic literature and managerial practice. The study also identifies the most significant challenges the companies tackle in DDI capabilities, which further adds to the understanding of the preconditions for DDI.

In sum, we draw on the strategic management literature on organizational capabilities in general, and investigate the marketing and technological capabilities research in particular. Combining these with research on innovation, and more specifically data-driven innovation, positions our contribution at the intersection of the industrial marketing tradition and strategic management (Martínez-López, Merigó, Gázquez-Abad, & Ruiz-Real, 2020).

Next, we present ideas on the concept of DDI based on earlier research. Thereafter, we draw insights from the prior knowledge on technological and marketing capabilities to form a theory-based framework. After building the framework for DDI capabilities, we describe the research methods and empirical data, followed by the empirical findings. The paper concludes with implications from the analyses and directions for future research.

2. Literature review

2.1. Data-driven innovation

Schumpeter's seminal writings on the innovation-driven business cycle have impacted innovation research since the 1930s (Dekkers, Talbot, Thomson, & Whittam, 2014; Schumpeter, 1934). He described innovations as new combinations, where untried technology is used for 1) producing a new commodity, 2) producing an old commodity in a new way, 3) a new source of materials supply, 4) a new outlet for products, or 5) where, for instance, the industry is being reorganized. Then again, the OECD defines innovation as "*the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations*" (OECD, 2005, p. 46).

Here, DDI refers to innovation that utilizes data as a core ingredient. The academic literature describes it as business innovation, based to a large degree on exploiting data, and capable of generating positive economic and social impacts (Jetzek, Avital, & Bjorn-Andersen, 2014). Companies are looking for new ways to use data and analytics to inform their decision-making, improve organizational processes, or create new methodologies to resolve challenges and create customer value (Brynjolfsson et al., 2011).

In general, companies engage in innovating because they expect to obtain economic benefits from the resulting innovation (Hippel, 1988). Digitalization has led to many companies accumulating vast amounts of data every day.

However, one of the major challenges in building DDIs is figuring out what can be done with all the data that are available, and defining what kind of data are needed to create value-added. The data can be acquired from internal sources, such as manufacturers' own databases (e.g., development and test data), or external sources, such as customer sites (e.g., machine or process data) or data marketplaces (e.g., market analyses, weather data) (Azkan, Iggena, Gür, Möller, & Otto, 2020). DDI often necessitates combining various different kinds of data. The companies most successful in DDI have been able to capitalize on analytics and consider data a core asset (Kiron, Prentice, & Ferguson, 2014). Koski (2012) on the use of data and knowledge for innovation in Finnish firms[1] found that there are differences between sectors in the frequency of DDI. ICT intensive firms produce the most DDIs and demonstrate the greatest scope of data use in service and product innovation (Koski, 2012).

The academic discussion on DDI has recently focused increasingly on utilizing big data, that is, data characterized by high volumes, variety and velocity. Some research emphasizes the analysis requirements, and other scholars the real-time information or unstructured data that can be obtained, for example, from social media (Akter & Wamba, 2016; Babu et al., 2021; Schroeck, Shockley, Smart, Romero-Morales, & Tufano, 2012). Big data has been found to constitute an infrastructural resource, because it can be used in various ways to produce different services or products (Zillner et al., 2016). At the same time, there are researchers who remind us of the importance of small data, such as frontline employees' information on customers and markets (Lam, Sleep, Hennig-Thurau, Sridhar, & Saboo, 2017). Regardless of data size, DDI still involves collection, analysis and new ways of interpreting data to add value through innovations (Hemerly, 2013).

DDI has to date been most visible, and thus mainly examined, in the domain of consumer markets, and how it is leveraged to create new business or better serve customers (Babu et al., 2021). Nonetheless, manufacturing firms in B2B markets are also increasingly emphasizing innovating through data. The ongoing digitalization of industry, termed "Industry 4.0", describes data and IT driven changes in manufacturing

[1] The focus was on the use of publicly available data such as spatial data, meteorological data, demographic data, business data, and traffic data, but any other types of data relevant to the firm could also be reported.

systems (Kumar & Bhatia, 2021; Rad et al., 2022). These developments are expected to have versatile organizational and business implications (Lasi, Fettke, Kemper, Feld, & Hoffmann, 2014), where data may, for example, enable reducing lot size without losing production process efficiencies (Zillner et al., 2016), and thus increase flexibility in manufacturing.

Ultimately, the use of data has the potential to change even the underlying mechanisms of value creation, and thus have a significant impact on business models (Huberty, 2015). The earlier research has identified three different value capture mechanisms for DDI: improving existing mechanisms, understanding current customers more profoundly, and finding new kinds of customer who can see a broader value in the data (Trabucchi & Buganza, 2019; Trabucchi, Buganza, & Pellizzoni, 2017). These mechanisms are not exclusive and can exist simultaneously (Trabucchi et al., 2017). To benefit from the value-creating mechanisms, the firm needs the capabilities to innovate on data.

2.2. Capabilities for data-driven innovation

Organizational capabilities are in practice information-based processes, and typically develop in specific functional areas. Yet, they may also develop through various combinations of resources at the organizational level (Amit & Schoemaker, 1993). Along the lines noted above, earlier research indicates that a firm's capabilities are a focal factor influencing innovation in general (Verona, 1999).

Innovations arise from knowledge-creation processes that combine internal R&D activities with knowledge from internal and external sources (e.g., Belderbos, Carree, & Lokshin, 2004). In addition, capabilities are critical to how an organization creates new knowledge based on earlier knowledge, that is, moves from using knowledge to creating knowledge (Malerba & Orsenigo, 2000). This section of the paper synthesizes the prior research on the two function-based capabilities explained in the introduction: technological and marketing capabilities.

In the same vein as Sultana et al. (2022), we argue that the organizational capability for DDI is multidimensional. Based on the earlier literature, technological and marketing capabilities are found to be focal for DDI capability, and both comprised several elements. In addition to marketing and technological capabilities, Sultana et al. (2022) defined people's innovation talent as a dimension of DDI capability. Our approach conceptualizes innovation talent as cutting across the two examined dimensions. This and the elements are explained in the following sections.

2.2.1. Technological capabilities

The core of technological capabilities is the organization's capacity to leverage existing technologies, and to develop or integrate new technologies to create value. Earlier research has defined technological capability as "*the capability to make effective use of technical knowledge and skills, not only in an effort to improve and develop products and processes, but also to improve existing technology and to generate new knowledge and skills in response to the competitive business environment*" (Jin & von Zedtwitz, 2008 p.328).

The prior research has found that technological capabilities are connected to a firm's abilities to utilize data for innovation (Koski, 2012), because they are linked to how well the firm is able to leverage data and knowledge for innovation. DDI requires not only the availability of data but also specific technical skills to work with and extract insights from those data (Gupta & George, 2016; Sultana et al., 2022). Nonetheless, technological capability is an abstract concept, and difficult to observe as it is highly intangible. It can, however, be examined by analyzing a bundle of indicators. Some studies have measured technological capability through R&D input measures, such as R&D spending, while others have measured it with R&D output measures, such as the number of patents or scientific publications. (Coombs & Bierly III, 2006) In this study, it is necessary to adopt a more holistic approach, and to understand the elements of technological capability and their role in DDI (cf. Prencipe, 2000).

On a more nuanced level, technological capabilities have been examined, for instance, in terms of production department efficiency and effectiveness, economies of scale, and technological experience, as well as technological skills and equipment (López-Cabarcos et al., 2019). Building on the specific characteristics of DDI discussed above, Zillner et al. (2016), and Cao, Duan, and Cadden (2019), the technological capability for DDI calls for the

- ability to obtain the necessary data,
- ability to combine data from different sources, and
- ability to analyze the data.

The first two elements may refer to company internal data, but more often in today's networked world data from external sources, too, thus highlighting external integrative capacity (cf. Habermann, Sprenger, & Abdel-Jaber, 2006), which refers to the firm's ability to interact with various actors to create and integrate knowledge. On the one hand, it builds on internal R&D efforts that develop the firm's absorptive capacity, and on the other, on the communication infrastructure with external actors (Cohen & Levinthal, 1990; Tripsas, 1997). In other words, the firm must be able to identify which data help advance initiatives, and have sufficient command of the domain to evaluate the data's value and potential outcomes when linked to internally created knowledge (Cohen & Levinthal, 1990).

The third element noted above refers to the data's utilization. The capacity to analyze volumes of data builds on some tangible resources, human skills, and intangible resources (Su et al., 2021). First, the tangible resources include the equipment employed in data analysis, and financial support for the tasks. Second, human skills include both the technical and managerial skills to drive the initiatives (Prescott, 2014). Finally, the intangible resources focus on the organization's data-driven culture and how it enables, for example, the development of processes to support DDI (Mikalef, Bouram, & Krogstie, 2019).

2.2.2. Marketing capabilities

According to the prior research, also firm marketing capabilities are tightly associated with innovation (Merrilees, Rundle-Thiele, & Lye, 2011). This era of increasingly complex markets and interactions between a firm and its customers has spotlighted the importance of marketing capabilities (Day, 2011).

In this study, we build on the conceptualization of marketing capabilities as strategy supporting marketing processes (Felin, Foss, Heimeriks, & Madsen, 2012), including for instance marketing mix processes, but also more complex abilities in managing customer relationships (Merrilees et al., 2011; Vorhies & Morgan, 2005). Due to the novelty in the B2B context, as well as the complexities involved, the more complex capacities of the organization in marketing are influential in DDI (Sultana et al., 2022).

On the strategic level, marketing capabilities comprise three elements:

- ability to innovate and deliver superior customer value,
- ability to capitalize on the customer as an asset, and
- ability to capitalize on the brand as an asset (cf. Day, 2011).

First, delivering and innovating superior customer value entails firm capacity to help customers solve their problems in a satisfying way, at the same time looking to future innovation of new value (Day, 2011). Marketing capabilities are thus associated with understanding customer needs (Saeed, Yousafzai, Paladino, & De Luca, 2015), which calls for knowledge thereof. The firm also requires the ability to convert said knowledge into an offering that solves the customers' problems. This, in turn, necessitates the ability to offer superior customer value (Saeed et al., 2015). Creating value for the customer, but also for the firm itself,

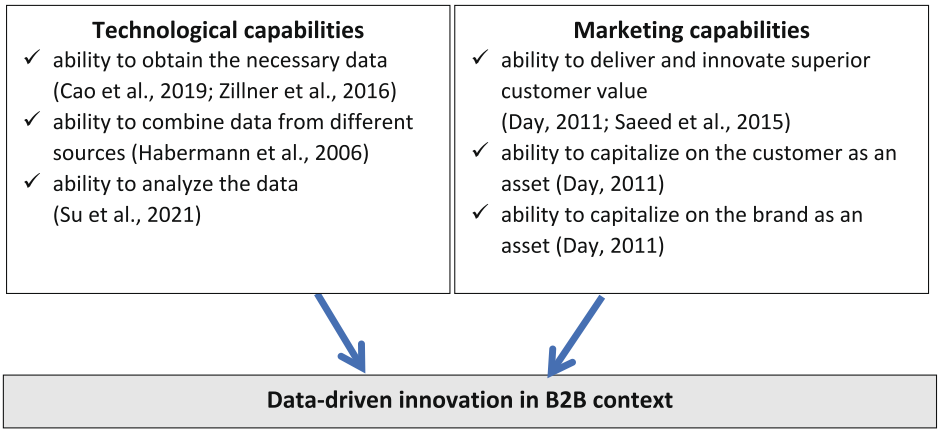

Fig. 1. Theory-based framework.

builds on value creation logic that may in the DDI context be very different to what an established company is accustomed (cf. Huberty, 2015;Trabucchi et al., 2017; Trabucchi & Buganza, 2019).

In addition to offering value today, the firm needs to innovate new value to stay current and competitive. New value can be innovated to meet presently unmet customer needs and/or future needs. Both paths call for the ability to renew knowledge on customer needs (cf. Danneels, 2002; López-Cabarcos et al., 2019). The prior research has found that a strong focus on marketing capabilities advances knowledge-based innovation, and innovation overall in high-tech sectors (Drucker, 1985; Im & Workman, 2004).

Second, capitalizing on the customer as an asset refers to the relationship the firm develops with its customers, and how that relationship is maintained and renewed (Day, 2011). This is also connected to the novel value creation and capture logics pertaining to DDI. In fact, in the context of data-driven innovation, the customer relationship is an important consideration, since the data that are the basis for innovation can also contribute to the kind of customer relationship that is created. For example, Lafferty (2019) found that slightly over half (56%) of the examined industrial companies already used big data analytics to improve their customer relationships. Despite this, the emphasis on the use of data in manufacturing firms has been strongly within, for example, their manufacturing facilities, whereas integrating the customer (or even more broadly the value chain) into the picture is lagging (Zillner et al., 2016). One way of bringing the customer into the frame is by involving them in the innovation process. This has been found to impact DDI positively (Koski, 2012). All in all, the relationship with the customer is a critical facet of marketing capabilities (Merrilees et al., 2011), and essential to DDI (Trabucchi et al., 2017; Trabucchi & Buganza, 2019).

Finally, capitalizing on brand as an asset refers to explicitly managing the brand and strengthening it with coherent investments (Day, 2011). Brand names are used extensively in B2B markets, conferring many benefits on firms (Michell, King, & Reast, 2001). In the B2B context, the relevance of the brand in the purchasing decision has been found to comprise risk-reducing and information search-reducing effects (Backhaus, Steiner, & Lügger, 2011). Overall, branding has proven a differentiating factor in B2B markets, and brands can even contribute to company performance (Michell et al., 2001). Strong brands can both attract and retain customers (Day, 2011).

Drawing on our literature review, we constructed a theory-based framework on DDI in the B2B context. It consists of two groups of capabilities that will impact DDI, namely technological and marketing. This framework was utilized in the empirical part of the study to recognize the most critical capabilities for DDI.

3. Empirical data collection and analysis

Given the exploratory nature of our research, an inductive, qualitative approach seemed appropriate (Edmondson & McManus, 2007). We chose to conduct a multiple-case study which enables investigation of the research topic and analysis of the phenomenon in its contextual setting (Eisenhardt, Graebner, & Sonenshein, 2016).

Case selection constitutes a crucial decision in the research process, which should therefore be made after careful consideration and a critical evaluation of the alternatives. Random selection is neither necessary nor desirable, and theoretical sampling is recommended (Eisenhardt et al., 2016) where special attention should be paid to theoretical relevance and the purpose of the study (Fletcher, Zhao, Plakoyiannaki, & Buck, 2018). In this study, we ensured the relevance of the sampling by maintaining similarity for a) nature of company, b) company operations, and c) substantive area addressed, that is, DDI development. The studied cases are all a) large, established companies, with a long history in offering physical products for industrial customers; b) industrial companies operating internationally in B2B markets that change slowly; and, c) active in the development of data sharing and data-based innovation, evidenced by ongoing R&D projects focusing on the area.

We collected empirical data from our six case companies via semi-structured qualitative research interviews. From each organization, the researchers contacted first one person who was familiar with company's ongoing R&D projects. This contact person agreed to select and invite for interview the persons in their company with the most relevant knowledge. The key criteria were that the interviewees were involved in ongoing data-based innovation in their organization and, to ensure multiple perspectives, worked in different business areas, units or functional areas. Also the contact person was interviewed, except at one company (Beta) where he did not play an active role in the examined data-driven initiative. After the interviews in each company, the authors reviewed the interviews and if any research topic remained unclear, we conducted additional interviews.

Altogether 20 online interviews were conducted (via Zoom or Microsoft Teams) between May and October 2020. Table 1 shows the lists the interviewees by company, the duration of each interview in minutes, and information on each interviewee's work experience in years. All interviews were conducted by the authors, where first author was mainly responsible for asking questions, and the second author was taking notes, but also asking clarifying questions and making sure that all the essential topics were covered.

The interviews comprised semi-structured questions on capabilities within the company to develop and introduce DDI. Specifically, we asked about different elements of technological and marketing capabilities. The semi-structured interview questions are presented in Appendix1.

Table 1
List of interviews.

Company	Headquarters	Size	Established	Industry	Description	Interviews and durations (min)	Years in working life/ company/current position
Alpha	Finland	12,500 employees in 100+ countries Turnover EUR 3.7 billion	1940	Material handling solutions	World-leading provider of lifting solutions	Manager, new earnings logic 60 Manager, market & business intelligence 60 Director, digitalization 60 Director, data-driven services 60	20/2.5/2.5 6/6/0.5 20/3/2 24/11/2.5
Beta	Denmark	28,000 employees in 100+ countries, Turnover EUR 6.3 billion	1933	Automation	Provider of engineering products and solutions	Senior vice president (of a business unit) 60 Senior director of program management 40 Senior project director 60	24/5/1.5 33/26/6 26/26/3
Gamma	Finland	450 employees in 11 countries Turnover EUR 0.1 billion	1901	Automation	Provider of Intelligent factory automation solutions.	Head of product management 55 Chief digital officer, VP 55 Product manager, digital products 55	14/12/2 22/4/1 9/7/1
Delta	Finland	18,000 employees in 50 countries Turnover EUR 3.3 billion	1910	Material handling solutions	Leading provider of cargo and load handling solutions	Director, business development & digitalization 85 Product manager, remote services 60 Innovation specialist 60 Product development, data science 60 IT enterprise data architect 75 Product manager, digital services 60	23/10/6 19/12/5 14/8/8 ? /5.5/2 21/5/5 2/0.5/0.5
Epsilon	Italy	1800 employees in 80 countries Turnover EUR 0.4 billion	1969	Metal machine tools	Leading specialist in laser and sheet metal working technology	R&D manager 45 Digital solutions and strategy developer 50	37/33/33 6/6/6
Zeta	Sweden	14,500 people in 50+ countries Turnover EUR 7.6 billion	1899	Specialized steel	Highly-specialized global steel company	Director, digital business development 55 Digital business developer 50	9/9/3 13/2/2

The interviews yielded a total of 19 h and 25 min of qualitative material. Most of the interviews were video recorded. One company opted out of recording and our contact person joined the interviews to assist in writing notes. Thus, our research database comprised detailed interview notes and recordings, which were stored in a secure file-hosting service provided by the University. The data were analyzed and coded using NVivo 12, a qualitative data analysis computer software package. We employed directive qualitative content analysis, where the theoretical framework served as the analysis frame (Hsieh & Shannon, 2005). In addition to the theory-based codes, the researchers allowed for emergent codes that arose from the data in the pilot phase, to further add to our extant understanding of the phenomenon (Schreier, 2014). The coding frame (see Appendix 2) was developed to meet the requirements of unidimensionality, exclusiveness and exhaustiveness (Schreier, 2014).

Data analysis proceeded from data reduction (interview notes supplemented with recordings) through data reorganization (coding) to data representation and conclusions (Roulston, 2014). The analysis did not necessitate verbatim transcripts, since the conversation is not analyzed per se, merely the content the interviewees bring forward (Barbour, 2014). Hence, we coded on interview notes supported by the recordings.

The coding was tested on one interview prior to the coding phase. Both authors coded the interview, and the coding was compared for consistency (Barbour, 2014). The differences were discussed and resolved to define the coding frame. The first author then coded all of the data, and the other checked to see whether they agreed on the coding. If not, both authors returned to the original data to see what the interviewees had said about the topic in question. The authors then discussed their interpretations of the data, and wrote their joint interpretation. Intercoder reliability was 95% (calculated as number of agreements divided by the sum of number of agreements and disagreements. See e.g., O'Connor & Joffe, 2020).

Moreover, as part of the data analysis process, the authors discussed and identified from the data the biggest challenges in each case company. The main challenge was chosen on the basis that either the interviewees explicitly mentioned it as the biggest challenge, or several of the company interviewees mentioned the same challenge.

The trustworthiness of the study was advanced with multiple means. First of all, the researchers strove for transparency in reporting the research process (Roulston, 2014). In addition, both data collection and analysis benefited from investigator triangulation (Archibald, 2016). Particularly, a collaborative approach to data analysis can, on the one hand, confirm the view built by one researcher, or, on the other, bring a diversity of perspectives into the process (Cornish, Gillespie, & Zittoun, 2013). In this study, the emphasis lay on confirming the coding by one researcher. The means of ensuring the validity of the inference drawn from the data are summarized in Table 2 (Maxwell, 2012).

The empirical findings and analyses based on the data are presented in the following sections.

4. Companies' approach to data-driven innovation

In the examination of our empirical findings, we first looked at what kinds of DDI the case companies were developing. Based on the interview data (Section 1 of the coding frame in Appendix 2), Table 3

Table 2
Validity criteria and their application in this study.

Validity criteria	Explanation of application in this study
Descriptive validity	The degree of accuracy of the collected data was ensured by recording almost all interviews, and, where recording was not possible, a second interviewer made detailed notes. The interpretations were discussed with company contact person. The researchers also attended several meetings with the contact persons and thus developed broader understanding of the companies' situation.
Interpretive validity	To capture subjectivity in the interviewees' accounts, the researchers asked each interviewee about their background, position and responsibilities in the company. Additional clarifying questions about the interviewee's position/relation to the discussed topics were asked when considered necessary. Company websites were examined for supporting secondary materials.
Theoretical validity	To ensure the account in this paper is valid as a theory of the examined phenomenon, that the concepts used to describe the phenomenon and the relationships between them are valid, the researchers interviewed persons who were highly knowledgeable about the topic, but also represented different organizational levels and business areas. Thus, it was possible to gain both breadth and depth of perspectives.
External validity & generalizability	Ensuring the external validity of research findings means, in this study, that the researchers acknowledged the special characteristics of the study context, and reflected the interviewees' accounts and their own interpretations against the contextual characteristics. In addition, this paper includes detailed descriptions of the study context, which enable the reader to evaluate generalizability to other contexts.
Evaluative validity	To ensure that the account is not distorted by the researchers' evaluations, the research process included discussion and debate between the researchers, and exposing the inferences to the case companies. In addition, the paper strives to describe the research process transparently.

summarizes the role of DDI in each company's innovation strategy, and the company's goals through DDI. It also describes the case companies' extant DDI initiative(s), as well as what the interviewees considered the basis for value creation and value capture therein.

The first three columns are intended to paint a picture of the DDIs as a contextualized phenomenon in the case companies. The role of DDI in strategy and the goals elucidate the organizational expectations on DDI, whereas the description of DDI initiatives shows what the companies are doing in practice. The columns on value creation and value capture further explain the kind of DDI the companies are developing, but also builds the foundation for better understanding the aspects of technological and marketing capabilities critical to the case companies DDI.

There was some variation in how the companies' innovation strategies incorporated DDI. In Gamma, DDI had a central role in the strategy, explorative approach was allowed, and the company applied different impact criteria to exploratory DDI than to more traditional exploitative initiatives. Beta related that the role of data in their innovation strategy was still somewhat vague, all innovation initiatives were expected to meet the same requirements, and, for instance, the strict repayment time applied to all innovations. The other companies' approaches lay somewhere in between these two extremes, geared more towards an exploitative than exploratory approach.

The focus on improving existing value capture mechanisms through DDI signals a rather conservative approach to innovating through data, but may also be linked to a lack of experience. All six companies saw that data enabled them to provide improved services to their existing customers. That involved greater value-added for the customer, for instance in the form of predictive services that help prevent production interruptions, or more reliable and convenient information exchange. The companies were expecting to charge for the data-driven services, which is one important element of value capture. In addition, at least three of the case companies expected the more systematic or comprehensive use of data to improve internal operations (Gamma, Epsilon & Zeta), which further enforces value capture.

It was also important to Beta and Gamma to develop a more profound customer understanding. Their employment of data in DDI looked to build a better picture of how customers actually used their products, and of their types of need. The use of data to deepen customer understanding is more typical to B2C markets, where customer numbers tend to be significantly higher, so the data are easily accumulated. In B2B markets, the number of customers is more limited. However, for example, equipment manufacturers accumulate data on equipment utilization, and collect different kinds of data compared to companies serving consumers.

Epsilon was the only case company looking to extend value capture by reaching a new customer segment. It was building a platform where data could be exchanged between industrial buyers and sellers. In addition to offering the service to their immediate customers (metal handling workshops), Epsilon could potentially serve also upstream and downstream actors, that is, the raw materials providers and the customers buying the processed metal products.

DDI is a relatively new challenge for companies in B2B markets, especially for manufacturing companies that typically have a strong history in physical products, but are increasingly interested in leveraging extant data as well as what can be created with additional sensors (see e.g., Paschou, Rapaccini, Adrodegari, & Saccani, 2020). This held for the manufacturing firms examined in this study, which had only recently given DDI a central role in their innovation strategy, though Epsilon had longer experience. It was reflected in interviewees' spontaneous replies when asked about innovation strategy and the role of DDI therein; they hoped for more concrete top management support for DDI. Thus, the empirical findings of this study attest to manufacturing companies being in the early stages of DDI development.

In sum, in this early phase the companies appear to build primarily on proven value creation logics (Azkan et al., 2020) and value capture mechanisms (Trabucchi et al., 2017; Trabucchi & Buganza, 2019). Adopting the kind of moderate approach to DDI that prevailed in the case companies illustrates an incremental take on innovating through data, even though the potential exists to radically change, even revolutionize, manufacturing industries (Paschou et al., 2020). The novelty of data as an input for innovation may be one factor increasing the firms' cautiousness. Moreover, data must be processed for use (Hemerly, 2013), and DDI often calls for combining data from various sources (Azkan et al., 2020). It is a new challenge for incumbents to meet, and therefore the risks potentially carry greater weight.

Following this overview of the status of DDI in the case companies, we focus next on the organizational capabilities that play a role in enabling the companies to innovate on data.

5. The capabilities for data-driven innovation

This study has analyzed interviewees' views on key elements of technological and marketing capabilities for data-driven innovation in six case companies (see Section 2 of coding frame in Appendix 2). Next, section 5.1 presents the findings on technological capabilities, especially how the interviewees saw their company's ability to a) obtain necessary data, b) combine data from different sources, and c) analyze data. In section 5.2, we present the findings on marketing capabilities, particularly how the interviewees saw their company's ability to a) innovate and deliver superior customer value, b) capitalize on the customer as an asset, and c) capitalize on the brand as an asset. Section 5.3 synthesizes the findings and reveals the most demanding challenge of the case companies as identified by the researchers.

Table 3
Case companies' data-driven innovation objectives and initiatives.

Company	DDI in company innovation strategy	Company goal in DDI	Description of DDI initiative(s)	Basis for value creation (cf. Azkan et al., 2020)	Basis for value capture
Alpha	Digitalization and automation at the heart of strategy; data employment focal	Data-sharing models and business models for data-driven concepts	1) System-to-system interface between the customer and an online store, 2) Utilizing data from new equipment data to optimize maintenance, 3) Tracking raw materials.	Using industrial equipment data to improve monitoring, maintenance, and predictive services	Data leveraged to improve remote monitoring of installed equipment and to efficiently provide better maintenance services
Beta	Role of data in innovation strategy vague. Strict 3-year repayment requirement for innovations	Leveraging equipment sensoring in more varied ways. Learning to leverage data across business units to help the customer	Collecting and utilizing equipment operating data in e.g. predicting malfunctions. Status: Early phase; need to learn more about customer needs.	Improved quality and novel predictive maintenance based on equipment data	Data used for quality improvements, efficient predictive maintenance; improved customer understanding
Gamma	DDI central to the innovation strategy; initiatives well-prioritized; exploration allowed	Finding mutually beneficial ways of leveraging shared data with customers. Learning to leverage common data spaces	Developing solutions to enable data flows between the customer's automation solutions; business models that enable monetizing the data. Status: Pilots ongoing.	Improved transactions and data flows in the value chain, better fit with customer needs	Developing better customer understanding via data and helping customers operate better. More efficient information flow in the value chain.
Delta	Innovation a central element in the company strategy. Shared view of the importance of DDI	Discovering how to leverage past and future equipment data to solve customers' problems	Developing solutions for remote monitoring of installed equipment and enabling customer access to equipment data through one interface. Status: Pilots ongoing.	Data-based remote monitoring, offer customers easier access to data that is scattered	Data leveraged to improve remote monitoring of installed equipment and provide better maintenance services
Epsilon	Wants the most innovative portfolio. DDI forms the core of the strategy. All the latest products are data driven	Learning how to motivate customers to change their operations to derive more value-added from the solution	Cloud-based platform to serve both customers and suppliers to enable seamless data exchange in the value chain from a customer need to a ready product. Status: User interface under development; customer pilots completed.	Improve transactions and the data flow in the value chain	Platform solution enhances more efficient data flow in the value chain
Zeta	Digitalization strategy in place but its clarity varies between business areas	Learning how to make customers' production easier with data-based services	Developing a solution for sharing data with the customer, e.g. inventories, to make transactions in the value chain more predictable. Status: Limited pilots ongoing.	Improve transactions and the data flow in the value chain	More efficient data exchanges in the value chain, and e.g. tracking materials and inventory levels; new business models

5.1. Technological capabilities

The most compelling message from the interviewees on technological capabilities was that their firm's ability to innovate on data was not constrained by technology and related know-how. To put this in context, the industries in which the case companies operate are not the most technologically advanced. An interviewee from Zeta captured this well by stating that the company is typically less technologically advanced than its customers, which have had to adopt technologies to improve efficiency, for example, for small lot sizes that challenge industrial production.

Obtaining data (#1 element of technological capabilities), was identified in the theory-based model as one of the critical elements for the specific requirements of DDI. In the context of the industrial companies examined here, obtaining data from newly installed equipment was said to be technologically relatively easy. However, older equipment tended to pose more technological challenges. Yet, Gamma interviewees reported they also encountered new equipment from which it was technically impossible to export data, for instance due to very low frequency vibration that is hard to measure.

Delta interviewees noted that sensor technology presents a significant challenge in obtaining data. The high-quality sensors required for equipment used in demanding conditions may be so expensive that the price of the solution becomes too high. Perhaps even more importantly, some data cannot be obtained due to a lack of common interfaces:

> "*We don't have any standard for API interfaces in manufacturing industry, and now because everyone publishes their own interface the situation is not improving. This is maybe the most significant and concrete obstacle.*"
>
> (Zeta)

Epsilon interviewees noted the importance of data security as a technical aspect related to obtaining data, more in the nature a hygiene factor that needs to be taken into account in everything that relates to DDI.

Nonetheless, based on the interview data, it seems that obtaining the data for DDI is not essentially a technological challenge for the case companies. When asked about the challenges of shared data, an Alpha interviewee listed all but technological issues:

> "*There are the legal aspects, what kind of data can be exchanged and how data collected in different parts of the world can be transferred… then there are the contracts we have with our customers… Overall this is a very delicate topic for our customers, and not all of them want to share their data with us, any of it, even though we can justify the benefits to them.*"
>
> (Alpha)

More importantly, obtaining the data is a challenge in terms of the customer's mindset, what the existing contracts state about data use rights (Alpha, Beta, Delta, Zeta), and how to govern a large volume of contracts related to the platform with multidirectional data flows (Epsilon).

> "*We'd often like to have at least a periodic if not continuous data flow, but this is challenging because we have contracts with customers to access the data mainly during maintenance.*"
>
> (Beta)

According to the interviewees, customers' cautiousness in sharing their data must be tackled with transparency and an ethical code of conduct. A Gamma interviewee saw a good customer relationship here as a critical enabling factor, which links to marketing capabilities.

In terms of **combining data** (#2 element of technological

capabilities), interviewees from many of the companies reported that it was relatively easy to bring data in from external sources, but truly integrating data from different sources into the company's solution was much more challenging. Delta interviewees emphasized the lack of standards as a notable factor making it technologically challenging to combine different datasets:

> "*An interesting detail in data-service and ecosystems is that there are no existing standards for the major ecosystems. This is important because required scaling of the markets does not happen without standards.*"
>
> (Delta)

For the most part, the case companies have experience of combining data from various internal sources. For instance, in Gamma, the data that have been combined were primarily internal, and only some external data had been used at the time of the interviews. Zeta has experience of working with only internal data, but even that had proven quite challenging. Therefore, Zeta focuses on enabling the integration of data from numerous legacy systems that are the result of multiple mergers and acquisitions in the company's history. When asked if the legacy load is the most important obstacle, the Zeta interviewee responded:

> "*Yes. Yes it is the biggest challenge, and we're resolving that at the moment… We have a 3 to 4 year target architecture and we're building project by project, piece by piece towards it. But in this kind of quarter-based public-company world it's extremely difficult to say that could I please get 30 million euros just for cleaning our data and organizing the data models. So, it doesn't work, but we need to take it stagewise.*"
>
> (Zeta)

The challenge of legacy systems is highly relevant also to Alpha, Gamma and Delta. Moreover, Zeta emphasized that it is relatively easy to pilot solutions to address the challenges, but much harder to turn them into established and scalable solutions. Beta has experience of combining data from different sources for a digital twin that was part of the product development process. However, the company recognizes the challenge of structuring the data so that it is usable. Delta interviewees reported that the firm has to some degree a track record in integrating a small number of different data sources into a service offered to the customers. Yet, the integration solution is not yet very advanced. Nevertheless, the interviewees perceived that their firm has the ability to combine data also from external sources when needed.

Finally, **analyzing the data** (#3 element of technological capabilities) seems to be the technological capability that requires the most development effort on the part of the case firms. The majority of the companies told us about their need to acquire some very specific data processing skills, such as advanced big data analytics skills, from partners. For example, Gamma interviewees explained that their company lacked advanced analytics capabilities, and therefore had partners in analytics. Epsilon collaborates with selected SMEs in analytics, but also with consulting companies and universities.

> *"If we think about advanced analytics, AI [artificial intelligence], ML [machine learning] and the like, we don't have the internal capabilities, and we're performing some analyses there as to how we could analyze and process the data to produce information."*
>
> (Gamma)

> *"We work quite a lot internally, but we always have to improve our skills… we're co-operating with different companies, SMEs… so we can basically gain from them new expertise on artificial intelligence, or machine learning, different cloud simulation technologies."*
>
> (Epsilon)

Zeta also reported a lack of analysis capabilities, as well as lack of good tools for data analysis.

> "*Even if we could get external data, we don't really have any other tools than email and Excel to process that data. We'd like to know for instance how our products perform when they're attached to customers' equipment, but we don't have the tools to handle the data, and I'd even argue that we're not able to understand what business benefits these analyzes could produce for us.*"
>
> (Zeta)

5.2. Marketing capabilities

The first aspect of marketing capabilities for DDI in the theory-based model is the **ability to innovate and deliver superior customer value** (#1 element of marketing capabilities). Good customer understanding is an integral part of this capability. All of the case companies have at least some direct contacts to their customers, that is, there are no intermediaries between the firm and the user of its products or solutions, creating the opportunity to get direct customer feedback. Thus, they can more easily develop their understanding of the customers compared to companies operating only through, for instance, a sales partner network.

Nevertheless, only two of the case firms (Epsilon and Zeta) felt they have the desired level of customer understanding in their organization. The interviewees said that they understand the customers' needs and pain points that could be solved with DDI:

> "*We co-operate closely with our customers and for example get an understanding of what they need based on the discussions our sales managers have with them. So, because the managers visit our customers' factories, they see the manufacturing process, and what can be done in a better way. So, they provide our R&D department with some ideas, such as what the customer complaints are. Or perhaps we could add this new feature to our machines or to our software.*"
>
> (Epsilon)

> "*We found that using the right tools and techniques with customers it's actually quite easy to get into a very deep dialogue with them and get a lot of good data on their preferences… so how do you then capture that in a way that it can be leveraged more broadly? That's definitely one thing we never solved.*"
>
> (Beta)

The other firms felt that they still have work to do in deepening their knowledge of the customers' problems, so that they can find more compelling ways to leverage data.

Bearing in mind that DDI is novel in the case companies' markets, there is great potential to innovate new kinds of value for customers. However, all of the case companies reported some form of resistance to change on the part of their customers, manifested in various ways. Primarily, customers may be very hesitant to connect thus far unconnected equipment to the Internet, or move to an always-on connection (instead of opening the connection only when e.g. support is needed).

> "*One challenge has been how to motivate the customer to turn on the data collection function, and that they plug our connectivity solution into an always-on internet line. There the problem is how to motivate the customer; what do we offer them so that they consent to the data collection.*"
>
> (Gamma)

In addition, challenges appear in how well the customer knowledge spreads within the organization, especially how it reaches the product/service developers. In particular, Alpha and Delta interviewees pondered this:

> "*If we do customer interviews for a particular development, it remains disordered there and too often the information is buried within that development project… the customer data collected for development, there's no common way of documentation.*"
>
> (Alpha)

"*For example, Delta IT is good at developing new solutions, but the downside is that they're very far away from the customer and business areas. Staying close to the customer with an agile development process would do a lot.*"

(Delta)

"Currently the need is defined by product owners: they introduce some innovation as the basis of the work or project, and after that there's an attempt to study a possible customer need in the background. So, the situation is still that the customer focus is not known too well when running development."

(Delta)

Second, **the ability to capitalize on the customer as an asset** (#2 element of marketing capabilities) revolves around the kind of relationship the firm establishes with its customers. As mentioned above, all of the case companies have at least some direct contacts to their customers, and thus can accumulate knowledge of the customers also directly. The companies that have practices in place to involve customers in the DDI process described a variety of involvement methods.

"*…here on the customer service side when we develop new services, so we engage in a kind of mini-conceptualization. Even when we're developing a relatively trivial service, we at least pressure test it with a customer group before we develop it further. If it's anything larger, we try to find a customer to collaborate with.*"

(Alpha)

"*…at exhibitions and customer events, so that's actually where we can discuss with our customers what's their situation, what's happening, and then we hold an internal meeting where we basically discuss what can be done better inside our company, what new we can offer our customers.*"

(Epsilon)

"*One of the reasons we're doing it through pilots and through customer value is also to prove that there's a real value there, so that we could kind of make sure to invest in serving such a purpose*."

(Zeta)

Customer involvement is expected to improve the understanding of customer needs, and potentially lower the customer's barriers to sharing the data accumulated by their operations and/or equipment for the DDI. Involving the customer in the development process constitutes an avenue to capitalize on the customer as an asset. Nevertheless, interviewees from Beta, Gamma and Delta recognized that they were not integrating customers sufficiently into their DDI processes, as illustrated by the following quote from a Delta interviewee:

"*[Delta] listens to the customers well and we're keeping an eye on customer pain points, but the approach is that detected problems are solved without involving customers in the internal development. Ideas from the customers are not reaching business units but their problems and challenges are heard. I see that co-creation would be a much better approach.*"

(Delta)

Finally, the third capability in the marketing capabilities domain, **capitalizing on the brand as an asset** (#3 element of marketing capabilities), appears somewhat challenging in the examined context. The primary concern in this respect is that the firms are so well established with their product offering that existing customers may be unable to perceive them as data-driven service providers:

"*Our people are perceived to sell equipment or traditional services, and [customers] don't see that we'd be the ones with whom to start discussing more innovative possibilities to utilize data. And this applies the other way around also, so I've been involved in a discussion myself [the interviewee talked about one innovative service the company has developed] … so the discussion is very easily drawn back to the scope that customers perceive as ours. They don't understand, they say that's an interesting idea, and then return to talking about the equipment.*"

(Alpha)

In contrast, Gamma and Delta interviewees reported that their customers are expecting data-driven services from them.

Additionally, most of the case companies noted their insufficient capabilities in selling data-driven services, exemplified by Alpha whose interviewees reported that their company is not particularly good at communicating the expected benefits of DDI to the customers.

"*Our organization is not ready for it yet. The salespeople sell equipment. It's clear and concrete and what we've always sold. These [data-driven services] are difficult and even slightly scary, because you don't have the skills to talk about them… it's really a huge change and a bottleneck for us.*"

(Alpha)

"Our challenge is that we lack the vision and understanding on how to "package" and sell data so that it generates income."

(Delta)

Building further on the responses above, interviewees from five of the six case companies (Alpha, Beta, Gamma, Delta & Zeta) reported that the business models are among the most critical challenges. Legal issues, data ownership, and the contracts, for instance, are important and challenging pieces of the puzzle and need to be in place, but figuring out how to make money by leveraging the data so that it is also perceived as fair by the stakeholders is an even more difficult issue to resolve.

"The digital accelerator team has something to give but it's only a technical perspective: what's required is business models for data services and clear roles for who would implement and own the concepts."

(Delta)

"Data is commonplace locally in customers' systems, and it can be seen as a business that the customer buys a Delta solution, because we have the intelligent software that uses the data. But then we'd be able to collect data in a centralized manner from customers' different systems and create value based on that, so we're only just getting started. We have some basic building blocks, but now we need to work on especially the business model."

(Delta)

5.3. Synthesized findings

The results are summarized in Table 4, where the bold script denotes each company's most demanding challenge as identified by the researchers.

Only one company, Zeta, experiences technological capability as a compelling challenge. The company is working hard on the potential, and the capability to combine data from various internal sources. All the other case companies face the most compelling challenges on the marketing capability side. Beta and Gamma struggle with the value added by DDI for the customer. The complexity of DDI combined with its newness to the companies challenges their capacity to turn customer understanding into a value-adding solution. Delta and Epsilon are challenged by customer involvement in the DDI process. Even though Beta and Gamma were also found to insufficiently involve customers in the DDI process, Delta and Epsilon see it as the most critical bottleneck impairing DDI in the company. They are unable to tap into customer relationships to truly involve the customer in innovating. Finally, DDI in Alpha is constrained by the legacy of the strong brand. A track record in equipment and traditional services hinders customers' and potential customers' ability to perceive the company as a data-driven solutions provider.

Thus, our empirical findings show that even though technological capabilities are necessary, they are not, with the exception of one of our

Table 4
Summary of the findings on case companies' capabilities for DDI.

Capability		Alpha	Beta	Gamma	Delta	Epsilon	Zeta
Technological	#1 Ability to obtain necessary data	No technological hurdles to obtaining data.	No technological hurdles to obtaining data.	Challenges to obtaining data from specific equipment.	Sensor technology and lack of interfaces limit obtaining data.	No technological hurdles to obtaining data.	Lack of interfaces limits data exchanges.
	#2 Ability to combine data from different sources	Sufficient capabilities to integrate data from different sources, yet somewhat challenged by own legacy systems.	Sufficient capabilities to integrate external data with internal. Challenges in structuring the data to be useful.	Capabilities to combine data, but data quality challenges integration. Yet, own data is scattered in legacy systems.	Good technical readiness to combine data, but lack of standards hinders progress. Own data scattered in legacy systems.	Company operates its own platform through which all necessary data can be integrated.	**Own data scattered in legacy systems. Has piloted combining data from different sources.**
	#3 Ability to analyze data	Collaborates on analytics with partners.	Need to strengthen advanced analytics skills.	Acquires advanced analytics from partners.	Good analytics capabilities (but too few people).	Collaborates on analytics with partners.	Lacks tools and capabilities for data analysis.
Marketing	#1 Ability to innovate & deliver superior customer value	Customer understanding enables building a solid value proposition, but lacks skills in communicating value-added to customers.	**Customer understanding insufficient or too scattered for coherent value proposition.**	**Lacking capabilities to develop strong customer value.**	Lack of productization in DDI that shows e.g. in pricing challenges.	Direct contact with customers is utilized to deepen customer understanding.	Sufficient customer understanding, and used in DDI.
	#2 Ability to capitalize on the customer as an asset	Customers are involved in conceptualizations.	Insufficient customer involvement in DDI; DDI should be more systematically infused with customer needs.	Insufficient customer involvement in the DDI process.	**Needs to involve customers more in the DDI process.**	**Routinely tests ideas with customers in presentations etc. Yet, customer involvement remains shallow.**	Routinely pilots initiatives with customers using a systematic process.
	3# Ability to capitalize on the brand as an asset	**Customers do not perceive the firm as a potential data-driven service provider. New sales capabilities needed.**	Lacks capabilities in selling data-driven services/solutions.	Track record in bringing novel offerings to market.	Rigidities in sales due to product sales tradition.	Company has an established position as a platform operator in the value chain.	Has sufficient sales capabilities. Builds on the established brand image that is aligned with high value-added.

case companies, the constraining factors in DDI. This may be because the companies have made strategic investment in data analytics R&D, and also are often building on technologies that have been developed and applied earlier in other fields, and their DDIs are novel to their market. In this context, the key hurdle for DDI is not the technology per se, but finding meaningful and value-adding applications. Overall, the case companies perceive that they have sufficient technological capabilities to collect, combine and analyze data so that they are able to make use of them. Still, DDI may be constrained by an organization's inability to combine internal data due to legacy Thus, technological and information systems capabilities are necessary but not alone sufficient to materialize DDI.

The major challenge in DDI was found to be insufficient marketing capabilities. Though all companies had direct contact to customers and some involved them in the innovation process through different forms of pilot (cf. Saeed et al., 2015), two of the case companies noted that customer involvement remained too shallow to gain a proper understanding of customer needs. Moreover, while the marketing department or salespeople may have good knowledge on customers and their needs, it appeared to be very difficult to share it internally so that it reached the technology developers. This reflects the difficulty of distributing knowledge and activities between organizational units, and there appears to be a specific need for boundary-spanning roles. In two other companies, the main obstacle was their limited ability to formulate and also articulate the value-added to the customers, as it for instance called for a different kind of value-based selling than they traditionally exercised (Töytäri & Rajala, 2015). The third examined area of marketing capabilities, namely capitalizing on the brand as an asset, appeared to be challenging for the companies in general, and the biggest obstacle for one of them. Incumbent manufacturing companies may face challenges in leveraging their established brand in DDI. This finding enforces the critical importance of the company and brand image that prevails in the market (cf. Baines & Lightfoot, 2014).

Finally, scrutinizing the findings on technological and marketing capabilities against those on the role of DDI in the companies' innovation strategies confirms that all but one (Epsilon) are at the very early phases of DDI development. Either the role of DDI in the strategy has not yet been clarified or has yet to be actioned. Epsilon seemed to have the most experience in DDI, and also the most clearly defined DDI initiative. A clear focus most probably makes it easier to tackle the challenges, and to advance the innovation. Whereas Epsilon needs to put effort into deeper integration of the customers into the DDI process, the other companies, with challenges on the marketing capabilities side (Alpha, Beta, Gamma and Delta), apparently need to address more than one area of marketing capabilities to effectively advance DDI.

6. Discussion

6.1. Criticality of technological and marketing capabilities for DDI

The study at hand sheds light on the organizational capabilities linked to DDI. Based on earlier literature, those examined here are conceptualized under technological and marketing capabilities. The empirical results demonstrate the importance of both to DDI, and that industrial companies face challenges in both domains.

First, the findings on technological capabilities demonstrate the significance of legacy load in data accumulation systems, which is particularly pressing in large and established industrial organizations. The lack of data commensurability due to the lack of standards is a challenge that the early movers need to tackle. Even though Ghasemaghaei (2021) found that data variety has positive performance outcomes, the data need to be accessible and potentially combined for use. Their large size combined with complex organizational structures challenges industrial companies in seizing the data to which they have

access and could leverage for customer value-added. The technological capabilities for DDI demonstrate the boundary-spanning potential of organizational capabilities to add value. In the same vein as Mamédio, Rocha, Szczepanik, and Kato (2019) found in their systematic literature review, this study indicates that some of the specific data analytics capabilities needed in DDI can be accessed through partners.

Moreover, the findings indicate that marketing capabilities have a key role in DDI, as they help in creating attractive value propositions for the innovations, engaging the customer and selling DDI as part of a solid brand. However, the examined industrial companies seem to struggle with the introduction of DDI into their portfolios, particularly due to insufficiencies in marketing capabilities.

The challenges at the customer interface appear to be largely associated with the inability to develop strong customer value propositions. This may be linked to the depth and breadth of customer understanding in the industrial organizations, and especially their abilities in imagining how to solve customers' problems through data utilization, since there is no such tradition in the company. In fact, Rapaccini and Adrodegari (2022) found that especially the interface between service design and value creation mechanisms is an underexplored area; this seems to be where industrial firms need more know-how in DDI.

On the other hand, companies may conceptualize the customer value proposition as a one-sided concept, where the provider delivers value predetermined by the customer (see Kowalkowski, 2011). This may be connected to the perceived challenges of involving the customer in an iterative innovation process. Instead of involving customers in the development process, the company builds on the premise of customer needs they have at the initial stages of the innovation process.

Also, the inability of customers to perceive an equipment provider as a potential data-based services provider can be seen to result from deficiencies in the company's ability to effectively communicate the DDI-based value proposition (cf. Payne, Frow, & Eggert, 2017). Moreover, the customers appear to be attaching attributes to the brand that are not compatible with those they expect from a data-based services provider (cf. Campbell, Papania, Parent, & Cyr, 2010; Wilkinson, Young, & Freytag, 2005). Our study supports Payne et al. (2017) proposition that brand reputation is a moderating factor that strengthens the customer value proposition's impact on the customer, because brand reputation is an indication of ability to deliver. This is particularly important in the case of innovative customer value propositions.

Our findings on the technological and marketing capabilities are not only consistent with the prior studies but offer new insights into the association between them in making DDI possible. In the following section we highlight the contributions to the literature, and offer actionable managerial implications.

6.2. Implications for research

This study has several theoretical implications for research on organizational capabilities and DDI. First and foremost, our study adds to the contextualized understanding of organizational capabilities for DDI in large industrial companies. As we noted in the introduction, it is highly relevant to take a contextualized look into the organizational capabilities for DDI. First, because of the particular nature of data (Zillner et al., 2016), the capabilities for DDI need to be distinguished from generic innovation capabilities. Especially the ways in which technological capabilities manifest themselves is noteworthy. The conceptualization of DDI through three elements of technological capabilities (obtaining, combining and analyzing data) and three elements of marketing capabilities (deliver and innovate customer value, capitalize on the customer as an asset, and capitalize on the brand as an asset) contributes clarity to the discussion on DDI in the B2B context.

Second, the nature of the industrial manufacturing companies is also significant for DDI. Whereas companies serving consumers tend to accumulate slivers of data from a very large number of individuals, companies in B2B markets may accumulate a mass of repetitive data on the operations of one particular machine per customer; or the customer accumulates the data and the equipment provider needs to negotiate access to the data in the first place.

Even more importantly, this study adds to the thus far scant body of knowledge on DDI as a phenomenon that is considerably broader than technological know-how. This is an important notion for the future examination of organizational capabilities, and is comparable to the recommendations by Babu et al. (2021).

Considering the unpredictability of data-driven technologies and their business applications that Sultana et al. (2022) refer to, our study further emphasizes the necessity for industrial organizations to find a balanced position between the opportunities stemming from fast-advancing technologies and the much more slowly changing customer needs. From another perspective, the combinations of marketing and technological capabilities enable meaningful value-adding applications from data, which is in line with Kogut and Zander (1992) suggestion that firms innovate (create new knowledge) by recombining their current capabilities. Based on these notions, we propose that the ability to strike a balance between marketing and technological capabilities is an important organizational dynamic capability (cf. Teece, 2007). Our study contributes also beyond deepening the understanding of organizational capabilities for DDI. By applying a theory-based framework to qualitatively explore how the organizational capability for DDI appears in the context of examination, this study takes a step towards bridging the reductionist approach to B2B marketing with the extreme contextualization along the lines drawn by Möller and Halinen (2022). Even though this study leans towards the extreme contextualization end of the spectrum, we draw insight from the earlier reductionist research and shed light on the contextual aspects that appear to be the most influential, to enhance analytical generalization.

Our focus on DDI in industrial companies also contributes to the nascent stream of research on digital servitization in this context, by extending the understanding on organizational capabilities (Paschou et al., 2020).

6.3. Managerial implications

Although capabilities play an important role in advancing firm innovativeness (Eng & Okten, 2011; López-Cabarcos et al., 2019), the empirical evidence to illuminate how and in which ways DDI occurs is incomplete. Our study contributes to the understanding on which specific technological and marketing capabilities can improve firms' ability to innovate based on data. The results show that even if a company masters all the technological capabilities, including strong data analytics capabilities as suggested by the prior literature (Gupta & George, 2016), DDI is unlikely to flourish unless marketing capabilities are also in place. In practice, all levels of management need to attend to the balance between marketing and technological capabilities in the organization. Particularly in industrial organizations with a strong track record in technologies, managerial understanding of the marketing capabilities for DDI is critical to foster DDI in the organization.

Naturally, it is necessary for the decision-makers to recognize the different data-related capabilities that are relevant to DDI. They are then better able to decide in which areas the company should invest its internal development efforts, and where partners are needed.

In the B2B context, where the potential customer segment is not as vast as in consumer business, it is critical to have an in-depth understanding of customer needs. Only then may the company be able to develop DDI that provides new value-added to the customers. Information on customer needs should therefore be assimilated across the firm. The practical implication for industrial companies is to develop processes and structures that support and even enhance information sharing across different organizational units, to build a collective understanding of customer needs and the firms' possibilities in responding to those needs.

Moreover, the findings highlight the importance of involving the

customer in the innovation process, because DDI in manufacturing industry quite often builds on data acquired from customers' equipment and processes. For the DDI to deliver value-added, it is essential to involve customers as early as the development phase, as well as during the production phase. Obtaining valuable information from their customers and markets helps companies understand the current state of the business and, more importantly, recognize business threats and opportunities (Ashrafi, Ravasan, Trkman, & Afshari, 2019).

Finally, especially how the top management evaluates and prioritizes various initiatives and activities in the organization is highly influential for DDI. Due to the novelty of the DDI initiatives, the industrial companies may not yet have found well-functioning metrics to evaluate DDI's potential. This combined with some deficiencies in capabilities made it difficult to advance DDI. If an industrial company is serious about engaging in DDI, the top management must attend to the prerequisites. The developers need legitimization, top management support, and diverse capabilities.

6.4. Future research

Our findings indicate some interesting avenues for future research. First, we suggest looking into the co-existence of technological and marketing capabilities in industrial organizations, and for DDI in particular. The areas where the capabilities overlap merit further clarification, both conceptual and empirical. Second, the development or co-evolution of these capabilities is also an interesting area for research. What kind of dynamic capabilities (cf. Teece, 2007) play a role in the development of industrial companies' marketing and technological capabilities for DDI?

Moreover, the DDI initiatives examined in this study follow the traditional logic where the digital tools are used to record or replicate physical reality. Future research could go a step further and begin to examine what DDI in manufacturing companies is in the digital-first world that is being seen already in some other contexts (Baskerville, Myers, & Youngjin, 2020). It would be important to better understand the obstacles that industrial companies need to overcome before digital-first applications are possible, but also what kinds of business case might apply.

7. Conclusions

The concluding section looks into the study's learnings and limitations. The conceptualization of technological capability in the DDI context adds to our understanding on the specific requirements DDI imposes on industrial companies. This is extremely important as industrial companies enter a new phase where digitalization and innovating through data become more common. Instead of looking into generic technological capability, the present study scrutinizes it specifically from the starting point of DDI. The three elements of technological capability for DDI, identified based on the prior literature and examined empirically, add to the emerging picture of organizational capabilities for DDI. The study illustrates the context-specificity of the technological capabilities that stems from the nature of data as an input for innovation.

Moreover, building on Day (2011) marketing capabilities conceptualization, we have examined the nature of marketing capabilities in the DDI context. The findings suggest that the marketing capabilities are considerably less context specific compared to the technological capabilities. Nevertheless, marketing capabilities were found to require more work in the industrial companies. Thus, it is evident that both the technological and marketing capabilities need attention; the former because they are manifested in a highly context specific manner, and the latter due to industrial companies' potential deficiencies therein.

All in all, our study adds to the understanding on DDI as a phenomenon in the context of established manufacturing companies that have a strong track record in physical products and possibly also accompanying maintenance services. The conceptualization of DDI in this context brings forth the key challenges for intangible innovations that leverage intangible inputs (data) from physical equipment. Despite the technology being proven in other contexts, there are considerable hurdles for industrial companies to overcome.

As noted above, the technology is an important yet not limiting factor in DDI initiatives in this context. Companies are able to leverage their existing technological capabilities to process data, and when needed access complementary analytics capabilities through partners. With regard to firm marketing capabilities, the firms' solid basis in customer understanding is critical for the DDI initiatives to deliver and innovate customer value. However, the firms face the challenge of renewing both the knowledge of the customer needs, and the customers' perception of the value-added the company can help to create. In addition, the organizations need to internally ensure that the renewed understanding of customer needs is combined with technological knowledge on DDI, so that it serves as the basis for value creation.

This study demonstrates the value of examining a set of various capability domains that are not separate from one another, but overlap and form a broader constellation. Especially the interfaces between the capability domains are of interest and value, since they are highly relevant to businesses. The findings are also linked to organizational structure and further reinforce the importance of paying attention to the areas where the responsibility of one unit/function ends and that of another begins. This is actually a valuable notion from the managerial perspective, too.

The study also has its limitations. It focuses on manufacturing companies operating in the B2B markets and mainly delivering physical products to their customers. The findings are contextual, and therefore the context and the companies are carefully described above. As the aim of the study is to provide contextualized knowledge, the research findings are not generalizable (Ghauri, 2004). The study examines large industrial organizations headquartered in Europe. Therefore, we recommend prudence in applying the findings beyond these boundaries. The companies' size, nature of operations, and their location all influence the findings. Finally, the study relies on empirical data that constitute a snapshot from 2020, and, thus, is not able to investigate the development of DDI initiatives into capabilities. Finally, we interviewed only managerial level informants in the case companies. Thus, we have been able to capture only the managerial perspective. The results may have been somewhat different had we collected empirical insights also from the shop floor.

Declaration of Competing Interest

The research project was conducted in collaboration with a consortium of companies that received R&D funding from national innovation funding agency.

Data availability

The authors do not have permission to share data.

Appendix 1. The semi-structured interview questions

Date:
Company:
Name:
Title/position:
How long has been working in this position & in the company:
DDI Strategy:

- What is the role of data-based innovation in the company's strategy?
- Why is the company interested in data-driven innovation?

The data-driven business cases:

- Describe what is the focus or business case(s) you are working on in your company?
- What kind of data-driven innovations are pursued?

Technological Capabilities, key elements (categorized according to the theoretical framework in Fig. 1).

#1 Ability to obtain the necessary data

- Are there any particular bottlenecks in accessing or utilizing external data or company internal data?
- How would you evaluate the abilities of your company to make use of external and in-house knowledge?

#2 Ability to combine data from different sources

- How well is your company able to integrate data from different sources? Which factors enhance it? Which factors hinder it?
- How would you evaluate your company's skills in combining and processing data?

#3 Ability to analyze the data

- Are there sufficient (data analytics) resources for data-diven innovation?
- Does your company have sufficient technological skills to innovate on shared data? Why?
- How would you evaluate your company's skills in analyzing and refining data?

Marketing Capabilities, key elements (categorized according to the theoretical framework in Fig. 1).

#1 Ability to deliver and innovate superior customer value

- How clear is the process from an idea to an innovation in the company?
- Does your company strive for creating change in the market? How?
- How would you evaluate the readiness to deliver and innovate new value from data?

#2 Ability to capitalize on the customer as an asset

- How does your company accumulate knowledge of what the customers need and want?
- How does your company examine the markets for new opportunities? (e.g. unmet customer needs)
- How would you evaluate the abilities of your company to bring the market knowledge to the R&D process?

#3 Ability to capitalize on the brand as an asset

- How does company's brand image support data-based innovation?

Appendix 2. The coding frame

Section 1: Case companies' data-driven innovation objectives and initiatives (findings summarized in Table 3)

- DDI in Company Innovation Strategy
- Company goal in DDI
- Description of DDI initiative(s)
- Basis for value creation
- Basis for value capture

Section 2: Case companies' capabilities for DDI (findings summarized in Table 4).

Technological capabilities

- #T1 Ability to obtain necessary data
- #T2 Ability to combine data from different sources
- #T3 Ability to analyze data

Marketing capabilities

- #M1 Ability to innovate & deliver superior customer value
- #M2 Ability to capitalize on the customer as an asset
- #M3 Ability to capitalize on the brand as an asset

Other.

References

Akter, S., & Wamba, S. F. (2016). Big data analytics in E-commerce: A systematic review and agenda for future research. *Electronic Markets, 26*(2), 173–194.

Amit, R., & Schoemaker, P. J. H. (1993). Strategic assets and organizational rent. *Strategic Management Journal, 14*(1), 33–46. https://www.jstor.org/stable/2486548.

Archibald, M. M. (2016). Investigator triangulation. *Journal of Mixed Methods Research, 10*(3), 228–250. https://doi.org/10.1177/1558689815570092

Ashrafi, A., Ravasan, A. Z., Trkman, P., & Afshari, S. (2019). The role of business analytics capabilities in bolstering firms' agility and performance. *International Journal of Information Management, 47*(2019), 1–15. https://doi.org/10.1016/j.ijinfomgt.2018.12.005

Azkan, C., Iggena, L., Gür, I., Möller, F., & Otto, B. (2020). A taxonomy for data-driven services in manufacturing industries. In , *184*. *PACIS*.

Babu, M. M., Rahman, M., Alam, A., & Day, B. L. (2021). Exploring big data-driven innovation in the manufacturing sector: Evidence from UK firms. *Ann. Oper. Res.*. https://doi.org/10.1007/s10479-021-04077-1. published online 21 April 2021.

Backhaus, K., Steiner, M., & Lügger, K. (2011). To invest, or not to invest, in brands? Drivers of brand relevance in B2B markets. *Industrial Marketing Management, 40*(7), 1082–1092. https://doi.org/10.1016/j.indmarman.2011.09.002

Baines, T., & Lightfoot, H. W. (2014). Servitization of the manufacturing firm. *International Journal of Operations & Production Management, 34*(1), 2–35. https://doi.org/10.1108/IJOPM-02-2012-0086

Barbour, R. S. (2014). Quality of data analysis. In U. Flick, K. Metzler, & W. Scott (Eds.), *The SAGE handbook of qualitative data analysis* (pp. 496–509). London: SAGE Publications Ltd.. https://doi.org/10.4135/9781446282243.n34

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management, 17*(1), 99–120. https://doi.org/10.1177/014920639101700108

Baskerville, R. L., Myers, M. D., & Youngjin, Y. (2020). Digital first: The ontological reversal and new challenges for information systems research. *MIS Quarterly, 44*(2), 509–523. https://doi.org/10.25300/MISQ/2020/14418

Belderbos, R., Carree, M., & Lokshin, B. (2004). Cooperative R&D and firm performance. *Research Policy, 33*(10), 1477–1492. https://doi.org/10.1016/j.respol.2004.07.003

Brynjolfsson, E., Hitt, L. M., & Kim, H. H. (2011). Strength in numbers: How does data-driven decision making affect firm performance? *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1819486

Campbell, C., Papania, L., Parent, M., & Cyr, D. (2010). An exploratory study into brand alignment in B2B relationships. *Industrial Marketing Management, 39*(5), 712–720. https://doi.org/10.1016/j.indmarman.2010.02.009

Cao, G., Duan, Y., & Cadden, T. (2019). The link between information processing capability and competitive advantage mediated through decision-making effectiveness. *International Journal of Information Management, 44*(February 2019), 121–131. https://doi.org/10.1016/j.ijinfomgt.2018.10.003

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly, 35*(1), 128–152. https://doi.org/10.2307/2393553

Coombs, J. E., & Bierly, P. E., III (2006). Measuring technological capability and performance. *R&D Management, 36*, 421–438. https://doi.org/10.1111/j.1467-9310.2006.00444.x

Cornish, F., Gillespie, A., & Zittoun, T. (2013). Collaborative analysis of qualitative data. In U. Flick, K. Metzler, & W. Scott (Eds.), *The SAGE handbook of qualitative data analysis* (pp. 79–93). Retrieved from https://search.credoreference.com/content/entry/sageukqda/collaborative_analysis_of_qualitative_data/0.

Danneels, E. (2002). The dynamics of product innovation and firm competences. *Strategic Management Journal, 23*(12), 1095–1121. https://doi.org/10.1002/smj.275

Day, G. S. (2011). Closing the marketing capabilities gap. *Journal of Marketing, 75*(4), 183–195. https://doi.org/10.1509/jmkg.75.4.183

Dekkers, R., Talbot, S., Thomson, J., & Whittam, G. (2014). Does Schumpeter still rule? Reflections on the current epoch. *Journal of Innovation Economics and Management, 13*(1), 7–36. https://doi.org/10.3917/jie.013.0007

Drucker, P. F. (1985). *Innovation and entrepreneurship: Practice and principles*. New York: Harper & Row.

Dubey, R., Gunasekaran, A., Childe, S. J., Blome, C., & Papadopoulos, T. (2019). Big data and predictive analytics and manufacturing performance: Integrating institutional theory, resource-based view and big data culture. *Brit J Manage, 30*, 341–361. https://doi.org/10.1111/1467-8551.12355

Edmondson, A. C., & McManus, S. E. (2007). Methodological fit in management field research. *The Academy of Management Review, 32*(4), 1246–1264.

Eisenhardt, K. M., Graebner, M. E., & Sonenshein, S. (2016). Grand challenges and inductive methods: Rigor without rigor mortis. *The Academy of Management Journal, 59*(4), 1113–1123.

Eng, T.-Y., & Okten, D. (2011). Exploring a dynamic framework of innovative capability: A theoretical integration of technological and marketing capabilities. *Technology Analysis & Strategic Management, 23*(9), 1001–1013. https://doi.org/10.1080/09537325.2011.616700

European Commission. (2020). *A european strategy for data*. Brussels: European Commission. Retrieved from http://www.econis.eu/PPNSET?PPN=1691285641.

Felin, T., Foss, N. J., Heimeriks, K. H., & Madsen, T. L. (2012). Microfoundations of routines and capabilities: Individuals, processes, and structure. *Journal of Management Studies, 49*(8), 1351–1374.

Fletcher, M., Zhao, Y., Plakoyiannaki, E., & Buck, T. (2018). Three pathways to case selection in international business: A twenty–year review, analysis and synthesis. *International Business Review, 27*(4), 755–766.

Ghasemaghaei, M. (2021). Understanding the impact of big data on firm performance: The necessity of conceptually differentiating among big data characteristics. *International Journal of Information Management, 57*(2021), Article 102055. https://doi.org/10.1016/j.ijinfomgt.2019.102055

Ghauri, P. (2004). Designing and conducting case studies in international business. In R. Marschan-Piekkari, & C. Welch (Eds.), *Handbook of qualitative research methods for international business* (pp. 109–124). Cheltenham: Edward Elgar.

Grewal, R., & Slotegraaf, R. J. (2007). Embeddedness of organizational capabilities. *Decision Sciences, 38*, 451–488. https://doi.org/10.1111/j.1540-5915.2007.00166.x

Gupta, M., & George, J. F. (2016). Toward the development of a big data analytics capability. *Information Management, 53*(8), 1049–1064.

Habermann, F., Sprenger, P., & Abdel-Jaber, T. (2006). From E-learning to integrated learning architectures. *International Journal of Computer and Information Sciences, 4*(1), 50–57.

Hemerly, J. (2013). Public policy considerations for data-driven innovation. *Computer, 46*(6), 25–31. https://doi.org/10.1109/MC.2013.186

Hippel, E. V. (1988). *The sources of innovation*. New York, NY: Oxford University Press. Retrieved from http://bvbr.bib-bvb.de:8991/F?func=service&doc_library=BVB01&local_base=BVB01&doc_number=000505051&sequence=000002&line_number=0001&func_code=DB_RECORDS&service_type=MEDIA.

Hossain, M. A., Agnihotri, R., Rushan, M. R. I., Rahman, M. S., & Sumi, S. F. (2022). Marketing analytics capability, artificial intelligence adoption, and firms' competitive advantage: Evidence from the manufacturing industry. *Industrial Marketing Management, 106*, 240–255. https://doi.org/10.1016/j.indmarman.2022.08.017

Hsieh, H., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research, 15*(9), 1277–1288. https://doi.org/10.1177/1049732305276687

Huberty, M. (2015). Awaiting the second big data revolution: From digital noise to value creation. *Journal of Industry, Competition and Trade, 15*, 35–47. https://doi.org/10.1007/s10842-014-0190-4

Im, S., & Workman, J. P. (2004). Market orientation, creativity, and new product performance in high-technology firms. *Journal of Marketing, 68*(2), 114–132. https://doi.org/10.1509/jmkg.68.2.114.27788

Jetzek, T. (2013). The value generating mechanisms of open government data. *Geoforum Perspektiv, 12*(23), 47–56. https://doi.org/10.5278/ojs.persk..v12i23.489

Jetzek, T., Avital, M., & Bjorn-Andersen, N. (2014). Data-driven innovation through open government data. *Journal of Theoretical and Applied Electronic Commerce Research, 9*(2), 15–16. https://doi.org/10.4067/S0718-18762014000200008

Jin, J., & von Zedtwitz, M. (2008). Technological capability development in China's mobile phone industry. *Technovation, 28*(2008), 327–334.

Kiron, D., Prentice, P. K., & Ferguson, R. B. (2014). The analytics mandate. *MIT Sloan Management Review, 55*(4), 1–25. https://sloanreview.mit.edu/projects/analytics-mandate/.

Kogut, B., & Zander, U. (1992). Knowledge of the firm, combinative capabilities, and the replication of technology. *Organization Science, 3*(3), 383–397.

Koski, H. (2012). *The role of data and knowledge in firms' service and product innovation* (Vol. 1272). Helsinki: The Research Institute of the Finnish Economy (ETLA). Retrieved from https://www.econstor.eu/handle/10419/87792. Retrieved from.

Kowalkowski, C. (2011). Dynamics of value propositions: Insights from service-dominant logic. *European Journal of Marketing, 45*(1/2), 277–294.

Kumar, S., & Bhatia, M. S. (2021). Environmental dynamism, industry 4.0 and performance: Mediating role of organizational and technological factors. *Industrial Marketing Management, 95*, 54–64.

Lafferty, C. (2019). Sustainable industry 4.0: Product decision-making information systems, data-driven innovation, and smart industrial value creation. *Journal of Self-Governance and Management Economics, 7*(2), 19–24. https://doi.org/10.22381/JSME7220193

Lafiti, M.-A., Bouwman, H., & Nikou, S. (2021). ICT-driven business model innovation in SMEs: The role of organizational capabilities, firm size and age. In *The 34th Bled e-conference*. https://doi.org/10.18690/978-961-286-485-9.28

Lam, S. K., Sleep, S., Hennig-Thurau, T., Sridhar, S., & Saboo, A. R. (2017). Leveraging frontline employees' small data and firm-level big data in frontline management: An absorptive capacity perspective. *Journal of Service Research, 20*(1), 12–28.

Lasi, H., Fettke, P., Kemper, H. G., Feld, T., & Hoffmann, M. (2014). Industry 4.0. *Business and Information Systems Engineering, 6*(4), 239–242.

López-Cabarcos, M.Á., Srinivasan, S., Göttling-Oliveira-Monteiro, S., & Vazquez-Rodriguez, P. (2019). Tacit knowledge and firm performance relationship. *Journal of Business Economics and Management, 20*(2), 330–350. https://doi.org/10.3846/jbem.2019.9590

Malerba, F., & Orsenigo, L. (2000). Knowledge, innovative activities and industrial evolution. *Industrial and Corporate Change, 9*(2), 289–314. https://doi.org/10.1093/icc/9.2.289

Mamédio, D., Rocha, C., Szczepanik, D., & Kato, H. (2019). Strategic alliances and dynamic capabilities: A systematic review. *Journal of Strategy and Management, 12*(1), 83–102. https://doi.org/10.1108/JSMA-08-2018-0089

Martínez-López, F. J., Merigó, J. M., Gázquez-Abad, J. C., & Ruiz-Real, J. L. (2020). Industrial marketing management: Bibliometric overview since its foundation. *Industrial Marketing Management, 84*(2020), 19–38. https://doi.org/10.1016/j.indmarman.2019.07.014

Maxwell, J. A. (2012). *A realist approach for qualitative research*. SAGE: Los Angeles. Retrieved from http://bvbr.bib-bvb.de:8991/F?func=service&doc_library=BVB01&local_base=BVB01&doc_number=028854519&sequence=000001&line_number=0001&func_code=DB_RECORDS&service_type=MEDIA. Retrieved from.

Merrilees, B., Rundle-Thiele, S., & Lye, A. (2011). Marketing capabilities: Antecedents and implications for B2B SME performance. *Industrial Marketing Management, 40*(3), 368–375. https://doi.org/10.1016/j.indmarman.2010.08.005

Michell, P., King, J., & Reast, J. (2001). Brand values related to industrial products. *Industrial Marketing Management, 30(5*,)415–425. https://doi.org/10.1016/S0019-8501(99)00097-8

Mikalef, P., Bouram, L. G., & Krogstie, J. (2019). Big data analytics capabilities and innovation: The mediating role of dynamic capabilities and moderating effect of the environment. *British Journal of Management, 30*(2), 272–298.

Möller, K., & Halinen, A. (2022). Clearing the paradigmatic fog — How to move forward in business marketing research. *Industrial Marketing Management, 102*(2022), 280–300. https://doi.org/10.1016/j.indmarman.2022.01.021

Morgan, R. E., Miočević, D., & Herhausen, D. (2019). Capability-driven industrial firms: Considering resources, capabilities, and competencies for marketing developments. *Industrial Marketing Management, 83*, 1–7. https://doi.org/10.1016/j.indmarman.2019.08.007

O'Connor, C., & Joffe, H. (2020). Intercoder reliability in qualitative research: Debates and practical guidelines. *International Journal of Qualitative Methods, 19*. https://doi.org/10.1177/1609406919899220

OECD. (2005). *Measurement of scientific and technological activities, Oslo manual*. Paris: Organization for Economic Cooperation & Development. Retrieved from https://ebookcentral.proquest.com/lib/[SITE_ID]/detail.action?docID=514749.

Paschou, T., Rapaccini, M., Adrodegari, F., & Saccani, N. (2020). Digital servitization in manufacturing: A systematic literature review and research agenda. *Industrial Marketing Management, 89*(2020), 278–292. https://doi.org/10.1016/j.indmarman.2020.02.012

Payne, A., Frow, P., & Eggert, A. (2017). The customer value proposition: Evolution, development, and application in marketing. *Journal of the Academy of Marketing Science, 45*, 467–489. https://doi.org/10.1007/s11747-017-0523-z

Penrose, E. (1959). *The theory of the growth of the firm (reprinted 1995 ed.)*. Oxford: Oxford University Press. https://doi.org/10.1093/0198289774.001.0001/acprof-9780198289777-chapter-1. Retrieved from.

Prencipe, A. (2000). Breadth and depth of technological capabilities in CoPS: The case of the aircraft engine control system. *Research Policy, 29*(7–8), 895–911. https://doi.org/10.1016/S0048-7333(00)00111-6

Prescott, M. (2014). Big data and competitive advantage at Nielsen. *Management Decision, 52*, 573–601.

Rad, F. F., Oghazi, P., Palmié, M., Chirumalla, K., Pashkevich, N., Patel, P. C., & Sattari, S. (2022). Industry 4.0 and supply chain performance: A systematic literature review of the benefits, challenges, and critical success factors of 11 core technologies. *Industrial Marketing Management, 105*, 268–293.

Rapaccini, M., & Adrodegari, F. (2022). Conceptualizing customer value in data-driven services and smart PSS. *Computers in Industry, 137*(2022), Article 103607. https://doi.org/10.1016/j.compind.2022.103607

Roulston, K. (2014). Analysing interviews. In U. Flick, K. Metzler, & W. Scott (Eds.), *The SAGE handbook of qualitative data analysis* (pp. 297–312). London: SAGE. Retrieved from https://search.credoreference.com/content/entry/sageukqda/analysing_interviews/0.

Saeed, S., Yousafzai, S., Paladino, A., & De Luca, L. M. (2015). Inside-out and outside-in orientations: A meta-analysis of orientation's effects on innovation and firm performance. *Industrial Marketing Management, 47*, 121–133. https://doi.org/10.1016/j.indmarman.2015.02.037

Schreier, M. (2014). Qualitative content analysis. In U. Flick, K. Metzler, & W. Scott (Eds.), *The SAGE handbook of qualitative data analysis* (pp. 170–183). London: SAGE.

Schroeck, M., Shockley, R., Smart, J., Romero-Morales, D., & Tufano, P. (2012). Analytics: The real-world use of big data. *IBM Global Business Services, 12*(2012), 1–20. Retrieved from https://www.bdvc.nl/images/Rapporten/GBE03519USEN.PDF.

Schumpeter, J. A. (1934). *The theory of economic development*. Cambridge, MA: Harvard University Press. Retrieved from http://search.credoreference.com/content/entry/ultimatebusiness/the_theory_of_economic_development/0. Retrieved from.

Seidler-de Alwis, R., & Hartmann, E. (2008). The use of tacit knowledge within innovative companies: Knowledge management in innovative enterprises. *Journal of Knowledge Management, 12*(1), 133–147. https://doi.org/10.1108/13673270810852449

Su, X., Zeng, W., Zheng, M., Jiang, X., Lin, W., & Xu, A. (2021). Big data analytics capabilities and organizational performance: The mediating effect of dual innovations. *European Journal of Innovation Management, 25*(4), 1142–1160. https://doi.org/10.1108/EJIM-10-2020-0431

Sultana, S., Akter, S., & Kyriazis, E. (2022). How data-driven innovation capability is shaping the future of market agility and competitive performance? *Technological*

Forecasting and Social Change, 174(2022), Article 121260. https://doi.org/10.1016/j.techfore.2021.121260

Teece, D. J. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal, 28*, 1319–1350. https://doi.org/10.1002/smj.640

Töytäri, P., & Rajala, R. (2015). Value-based selling: An organizational capability perspective. *Industrial Marketing Management, 45*, 101–112. https://doi.org/10.1016/j.indmarman.2015.02.009

Trabucchi, D., & Buganza, T. (2019). Data-driven innovation: Switching the perspective on big data. *European Journal of Innovation Management, 22*(1), 23–40. https://doi.org/10.1108/EJIM-01-2018-0017

Trabucchi, D., Buganza, T., & Pellizzoni, E. (2017). Give away your digital services: Leveraging big data to capture value. *Research-Technology Management, 60*(2), 43–52. https://doi.org/10.1080/08956308.2017.1276390

Tripsas, M. (1997). Surviving radical technological change through dynamic capability: Evidence from the typesetter industry. *Industrial and Corporate Change, 6*(2), 341–377.

Verona, G. (1999). A resource-based view of product development. *The Academy of Management Review, 24*(1), 132–142. https://doi.org/10.2307/259041

Vorhies, D. W., & Morgan, N. A. (2005). Benchmarking marketing capabilities for sustainable competitive advantage. *Journal of Marketing, 69*(1), 80–94.

Wilkinson, I., Young, L., & Freytag, P. V. (2005). Business mating: Who chooses and who gets chosen? *Industrial Marketing Management, 34*(7), 669–680. https://doi.org/10.1016/j.indmarman.2005.06.003

Zhong, R. Y., Newman, S. T., Huang, G. Q., & Lan, S. (2016). Big data for supply chain management in the service and manufacturing sectors: Challenges, opportunities, and future perspectives. *Computers and Industrial Engineering, 101*(2016), 572–591. https://doi.org/10.1016/j.cie.2016.07.013

Zillner, S., Becker, T., Munné, R., Hussain, K., Rusitschka, S., Lippell, H., … Ojo, A. (2016). Big data-driven innovation in industrial sectors. In J. M. Cavanillas, E. Curry, & W. Wahlster (Eds.), *New horizons for a data-driven economy – A roadmap for usage and exploitation of big data in Europe* (pp. 169–178). Springer Open. https://doi.org/10.1007/978-3-319-21569-3.