

Digital transformation: What we have learned (thus far) and what is next

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There is certainly a lot of discussion about digital technologies, their transformative nature, and their potentially disruptive impact on business and society. The number of publications on digital technologies and their impact on business and management have risen dramatically. This paper's main objective is to draw attention to practical and research-related views on what we know and what we still need to learn about business and management in the digital era. We do so by combining the insights obtained from interviews with senior managers in charge of their firm's digital transformation activities in 2017 with the results of a systematic literature review covering a decade of practice-oriented, academic literature on the impact of digital technologies. We identify the challenges that firms face at the beginning of their digital transformation efforts and summarize the managerial guidance offered by 242 publications over the years, 133 of which have been published since 2017. Based on the analysis conducted, we discuss the emerging solutions for a number of the key challenges identified in 2017, flag the remaining ones, and identify new themes that require attention. This leads us to propose an agenda for future, practice-oriented research on digital transformation.

KEYWORDS

digital transformation, literature review, qualitative research, research agenda

1 | INTRODUCTION

This paper's main objective is to combine practical and research-related views on what we know and what we still need to learn about business and management in the digital era. Undoubtedly, digital technologies have become omnipresent and play a growing role in our lives (Colbert, Yee, & George, 2016). The option scope that digital technologies offer and, with this, the impact digital technologies have on individuals, business, and society, have grown ever since the diffusion of the Internet around the turn of the millennium. Throughout this time, the nature of the digital technologies has changed. For 2005, Gartner proposed technologies such as instant messaging, a wider use of wireless local area networks (WLANs), and Internet

Protocol telephony (IP telephony) among the top strategic technologies (Farber, 2004). In 2010, the same list included technologies such as cloud computing, advanced analytics, and mobile applications (Cable, 2009). For 2015, Gartner identified three themes across its top 10 strategy technology trends: intelligence everywhere, merging of the real and the virtual world, and the emerging new information technology (IT) reality (Spender, 2015). Around the same time, a new stage of information and communication technology—ubiquitous computing, characterized by pervasive technologies that help physical and electronic spaces unify—began (Cascio & Monteaegre, 2016). For 2020, Gartner's top 10 strategic technology trends include hyper-automation, blockchain, and human augmentation (Panetta, 2019).

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Driven by efficiency and growth ambitions, we expect firms' focus on digital technologies to continue increasing by two-digit annual growth rates (World Economic Forum, 2018). The digital transformation's central paradigm has emerged owing to the variety of digital technologies over the years, which enabled constant connectivity between objects and people and allowed generating and processing data in new manners (Iansiti & Lakhani, 2014; Lyytinen, Yoo, & Boland, 2016; Rindfleisch, O'Hern, & Sachdev, 2017). Digital transformation thereby refers to the "process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies" (Vial, 2019, p. 118). Digital technologies create unprecedented replication opportunities at almost zero marginal cost once the required infrastructure has been established (Iansiti & Lakhani, 2014). These advances change the rules of competition and collaboration, requiring all actors to adapt in order to retain or regain their competitiveness (e.g., Dodgson, Gann, Wladawsky-Berger, Sultan, & George, 2015; Pigni, Piccoli, & Watson, 2016; Weill & Woerner, 2018). Furthermore, individuals, companies, and governments have gained new forms of access to data and information, thus transforming social interactions and facilitating the emergence of new business opportunities (Greenstein, Lerner, & Stern, 2013). Moreover, digital technologies have transformed the behaviours of market participants and the manners in which firms and markets interact (Lamberton & Stephen, 2016; Verhoef et al., 2017). While digital technologies are now present in all management areas ranging from finance to marketing, a rapidly increasing number of companies have appointed an executive leader, often called the firm's chief digital officer, to lead their digital agenda (Peladeau, Herzog, & Acker, 2017).

In recent years, the number of academic publications in the field of business and management as well as information systems that emphasizes the impact of digital technologies has risen sharply. Particularly, the high level of attention that practice-oriented management literature, such as *Harvard Business Review*, the *MIT Sloan Management Review*, *California Management Review*, and *MIS Quarterly Executives*, pays to the digital phenomenon is not surprising. However, for many businesses, their digital transformation efforts represent one of their biggest risks (NC State University's ERM Initiative & Protiviti, 2019) and as much as 70 per cent of digital transformation programs fail (Bucy, Finlayson, Kelly, & Moye, 2016).

The fast and fundamental, often unprecedented changes caused by the increasing diffusion of digital technologies paired with the apparent challenges that businesses face serve as the motivation for this study, which aims at understanding what we know and what we still need to learn about business and management in the digital era. In 2017, the urgency to accept and respond to the increasing digitalized world had become undeniable; however, many firms were still searching for the right approach to tackle this challenge. During this time, we interviewed senior managers in charge of designing and leading their firm's digital transformation activities, many of them being appointed as the firms' chief digital officers. Our objective was to learn from their early-stage experiences, to understand their challenges, and to identify relevant and unanswered questions as a practice-driven

inspiration for future research. We combined the results obtained from these interviews with the findings of a systematic literature review covering a decade of practice-oriented, academic literature about the impact of digital technologies on business and management and particularly the managerial guidance provided.

The contribution of this paper is twofold. First, we summarize what we know about the digital technologies' impact on business and management and what we know about how to cope with this. By reviewing the guidance and advice provided in 242 practitioner-oriented research publications, we identify and summarize the key findings along five thematic themes: the impact of digital technologies on business and strategy; on marketing and customers; on management, organization, and governance; on employees and leadership; and on how to manage the transformation. We show how the interest in particular digital technologies, such as artificial intelligence (AI) and blockchain, has drastically increased since 2017 and how the interest in all thematic fields has grown over time. Second, we derive an agenda for future research that tackles the remaining challenges and addresses the emerging white spots. Combining the results of the systematic literature review with the practice perspective gained through the interviews allows us to identify and prioritize the remaining, open questions. Compared with 2017, we have gained a better understanding of what the digital transformation means, how to organize and approach it, and how firms can design their engagements in novel forms of inter-firm collaborations. Other challenges identified in 2017, such as the measurement of success and performance of digital transformation initiatives, how to develop the relevant skills and capabilities for the digital era, and how to cope with the negative social impact of digital technologies, remain widely unanswered. Furthermore, new discussions have emerged that will require further consideration, such as the role and potential agency of digital technologies, novel forms of organization and regulation, how to fuse the physical and digital worlds, the implications of multiple digital technologies in combination, and the unavoidable incorporation of inter-disciplinary views, such as ethics or legal.

Following this introduction, we first present the empirical results of our qualitative interviews before providing an analysis of a decade of practitioner-oriented management literature on business and management in the digital era. Thereafter, we combine both perspectives to reflect upon the major challenges and the guidance and recommendations provided by the literature thus far. This discussion allows us to identify the unanswered questions and to derive an agenda for future research, which is followed by a brief conclusion.

2 | PRACTITIONER VIEW ON THE DIGITAL TRANSFORMATION CHALLENGES IN 2017

2.1 | Method and approach

Digital transformation is a practice-driven phenomenon. Obtaining in-depth insights from the corporate practice perspective is crucial to

#	Industry	Country	Position	Duration
11	Technology	Germany	Chief digital officer	53:25
12	Media	Germany	Chief digital officer	38:20
13	Automotive	Germany	Chief digital officer	37:40
14	Construction	Germany	Chief digital venturing officer	23:17
15	Maritime	Denmark	Chief digital officer	35:04
16	Construction	Finland	Corporate vice president	59:31
17	Consulting	France	Digital manager	31:03

TABLE 1 Overview of interviews

gain a full understanding of the state-of-art of the topic. This study's first objective was therefore to explore practitioners' perception of the digital transformation. In mid-2017, when the need to respond to the increasing digital ubiquity in corporate environments had reached firms of all industries and sizes, we interviewed senior experts in charge of their firm's digital transformation strategies and activities. For this, we applied a qualitative approach, using semi-structured interviews with senior experts from the industry. The interviews emphasized the informants' experience with the digital transformation journey to date, their accomplishments, approaches, and challenges. Overall, we interviewed seven managers responsible for a firm's digital transformation and disruption journey at the top executive level of large-sized industrial or service companies across Europe (see Table 1). The interviews lasted an average of 40 min and took place, whenever possible, on-site in the managers' working environment. We transcribed all the interviews and followed an open coding procedure to identify the relevant concepts from the practitioners' point of view. Based on the initial list of codes and the memos of the researchers involved, we aggregated the data into themes and categories (see Appendix A for an overview).

2.2 | Empirical insights on digital transformation challenges in 2017

2.2.1 | Awareness and understanding of the increasingly digital environment

All managers interviewed in 2017 emphasized an increasing attention to digital transformation in their firms. Yet, they struggled to define what digital entails:

The term digital is rather washed-out. It is a synonym for many terms and only a few people can tell you what it means. (I3)

Despite early definitions focusing on the technology itself, practitioners incorporated transformational aspects, strategies, and business models:

... from gluing technologies together to designing new business models so that new markets can be created using digital technology. (I6)

Similar to the academic duality of understanding digital innovation and transformation as a process and an outcome, our interviewees' views of the terms also differed. However, the managers did not perceive the variety of definitions as a barrier, as long as key stakeholders have a shared understanding and goals and consider digital transformation as a continuous process.

Their incumbent organizations' digital transformation endeavours are perceived differently from the ventures that are considered digitally native and the key motivations in engaging in digital transformation were mostly driven by demands of clients or threats of market disruption.

2.2.2 | Responding to the increasingly digital environment and managing digital transformation

In order to approach the digital journey successfully, firms need to understand how they are affected and where their individual transformation journey starts:

Customized transformation means finding those methods and tools that fit the company and that enable the company to make the transformative moves that fit and need to be done. (I3)

Managers stressed the necessity of a clear strategy to guide their strategic initiatives:

I'm afraid that most companies... do not have a real strategy. And I do not mean a digital strategy. I would not know what a digital strategy is - that would somehow imply that there is a core strategy and a digital strategy - that is just nonsense. But I need to have a strategy regarding how I want to use the digital opportunities, just as I needed a strategy for using the automation potentials in the 70s. (I4)

Digital leaders increasingly expand the scope of their business activities. They simultaneously consider their core business's digital transformation and the exploration of new digital business opportunities:

It is all about developing new business fields; not only by building on today's core business areas but also by building completely outside today's key business areas. (I4)

In order to excel in digital transformation, companies need to understand what they are good at, what their core competencies are, and how they can complement them. It is not surprising that a decision to engage in digital transformation often comes from the top, and chief digital officers are often regarded as orchestrators and enablers. As orchestrators, they must negotiate with the current business units and deal with organizational change on a daily basis. As enablers, our interviewees should be aware of threats that digital transformation creates for the existing business units and they have to find win-win situations for everyone.

Digital strategies require inter-organization collaboration, working at the systematic level. One of the organizations was established to set up

... digital projects across different organizations to challenge the barriers between different actors. We are facilitators that drive digitalization with our members and share their knowledge of the maritime industry. (I5)

There is a need to align multiple stakeholders from all parts of the firm resulting in an increased complexity:

We have so many interfaces within and beyond all types of company boundaries to which we have to go. That does not work anymore.... (I1)

The important component of digital leadership is to break silos and ensure cross-discipline work within and outside the organization. One of the interviewees from the automotive industry argued:

Digital is a topic that can only work across disciplines. None of the models that I develop works just in silos 1, 2, or 3. I always have all of them involved to some extent. I orchestrate all of this.... (I3)

There is a need for more efficient inter-organizational settings to help avoid concentrating digital power in the hands of just a few actors, and there is a call for more insights on how to cope with the emerging digital powers:

Think about Facebook. There is no ethics commission. It is basically a one-man show. It's like a dictatorship – one person determines what is on the agenda and what is not. (I2)

Furthermore, experienced digital leaders emphasize the need to approach digital transformation simultaneously with explorative approaches and well-defined, even measurable, targets. These leaders distinguish themselves very clearly by their focus on ensuring tangible outputs and implementing and spreading new methods within the organization.

2.2.3 | Changing work and collaboration

Digital technologies cause important implications for the workforce, for the capabilities they require, and for the potential design of future work. First, decision makers should privilege an evidence-based approach and the need to be trained in order to fully understand and embrace the digital transformation's potential for their business:

...need to develop a much stronger sense of data economics. We need the technology to execute this. It also requires skilled professionals, such as data scientists or data engineers, to drive this. (I3).

Second, blending more agile and flexible approaches with more traditional processes and accustomed behaviours should be taken into account when transforming the existing workforce or bringing new digital talent into the workforce:

My concern is that we bring them to our classical (stage gate) way of working, while they come from a totally different environment. (I6)

Lastly, emerging technologies resulted in an increasing fear of being replaced by technologies and managers indicate the need:

... to eradicate the fears and anxiety about the digital future, the fear that the Internet – this dangerous thing – will do something harmful, will threaten my working pace, etc.... You need to talk to people and explain – both the chances and the risks. You need to make clear that risks exist, but also that there are more opportunities. (I1)

Managers call for more transparency, open dialogue, and education. Yet, at the same time they express their concerns related to digital vulnerabilities and social responsibilities linked to a number of the jobs being replaced:

What are we supposed to do with all these people? That is a topic that bothers me, that worries me a lot... All of these technological developments will most certainly emerge, but nobody has thus far been able to provide an answer to the question of what we should

do with all these people? And I do not have an answer either. (I2)

3 | REVIEW OF THE PRACTICE-ORIENTED, ACADEMIC LITERATURE: 2010–2020

3.1 | Method and overview of the data

We searched for relevant literature in the leading, peer-reviewed, practitioner-oriented journals, namely, *Harvard Business Review* (HBR), *California Management Review* (CMR), the *MIT Sloan Management Review* (MITSMR), and *MIS Quarterly Executive* (MISQE). We limited our search to papers published between January 2010 and March 2020, thereby covering a full decade of academic literature for a managerial audience. Our intention was to include all papers published in this timeframe that provide managerial guidance on how to approach, understand, master, transform, and manage businesses in the digital era. As even a long list of top-down, pre-defined search terms could not guarantee to capture all relevant papers, we decided to comprehensively screen all papers published in the defined journals and timeframe. Therefore, instead of using a wide variety of top-down search terms, we screened the titles and abstracts of all papers published in the relevant period to identify all papers that provide any form of guidance for managers on how to master the digital transformation. For this, we initially screened a total of 4,187 publications of which 2,842 were published in HBR, 771 in the MITSMR, 303 in CMR, and 270 in MISQE. During this initial screening phase, we deliberately included papers about any type of digital technology and the impact of digital technologies on any management discipline. This was followed by a second screening of the full papers to sort out any articles that did not provide any form of managerial guidance, as well as publications that did not build on research, for example, interviews or short commentaries. This led to a final sample of 242 papers consisting of 61 HBR papers, 14 CMR papers, 92 MITSMR papers, and 75 MISQE papers (see Figure 1 for an overview) that contribute to five key themes: the management of the transformation and *implications for strategy and business models, customers and marketing, organization and governance, leadership and employees*. Furthermore, we grouped 27 papers that discuss the potential of the digital technologies but without a dedicated contribution to one of the topics that resort under the theme *demystifying the potential of digital technologies*.

Figures 2 and 3 provide an overview of the split of the final sample of 242 publications over the years with regard to the technologies

emphasized and the themes addressed. Noticeably, while in the first half of the period, the interest focused majorly on specific technologies, we observe a rising interest from 2015 in themes that are not specific to one particular technology. Figure 3 further illustrates how the attention is distributed among all thematic categories, which reveals the widespread implications across all disciplines. Below, we summarize the key findings derived from the 242 papers by first providing an overview of the discussion on the technologies' potentials before examining each of the five themes. Appendix B complements this by providing an overview of the references per theme and digital technology.

3.2 | Demystifying the potential of digital technologies

Digital technologies function as an enabler for more global, collaborative, and open activities (Bogers, Chesbrough, & Moedas, 2018). While expectations concerning the overall potential of digital technologies are high, measuring the digital economy's size and impact is challenging (Brynjolfsson & Collis, 2019). In the digital world, firms face an environment in which constant connectivity allows for and demands more interactions and involvement of customers and collaborators and in which access to resources has often replaced their ownership (McGrath, 2020). However, the myth that digital needs to be disruptive is a false assumption—in reality, digital is often about using digital tools to serve known customers better, to combine digital and physical worlds, and to focus on the customer, not the technology (Furr & Shipilov, 2019). Furthermore, not every firm, process, or business model requires a digital transformation, and many executives—particularly in public companies—show limited interest in fundamentally transforming their organizations (Andriole, 2017).

The range of digital technologies is wide, and like the technologies' potentials, it continues to expand over time. Robotic process automation (RPA) can perform back-office routines faster and more accurately (Lacity & Willcocks, 2016a, 2016b). Extended reality (XR) reality-blending solutions, such as augmented reality, allow firms to speed up processes by putting information into the applied context as well as to unlock emerging business opportunities in the virtual worlds (Morvan, Hintermann, & Ovanessoff, 2020; Nevo, Nevo, & Carmel, 2011; Porter & Heppelmann, 2017). Additive manufacturing technologies or 3D printing—after recent technological progress that allowed to overcome a number of the overblown near-term expectations (Bonnín Roca, Vaishnav, Mendonca, & Morgan, 2017; D'Aveni, 2018)—offer high flexibility for customization of products

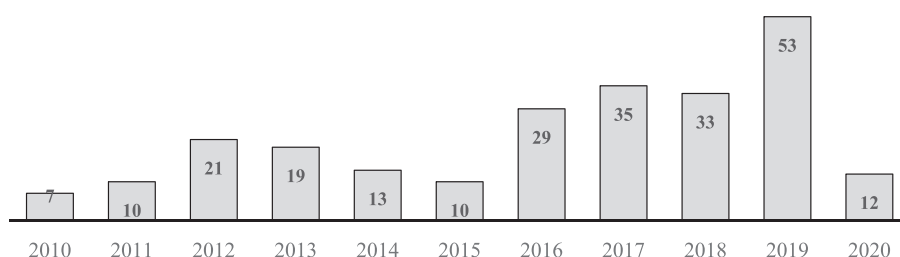


FIGURE 1 Overview of publications over the years

FIGURE 2 Emphasis on technologies over the years

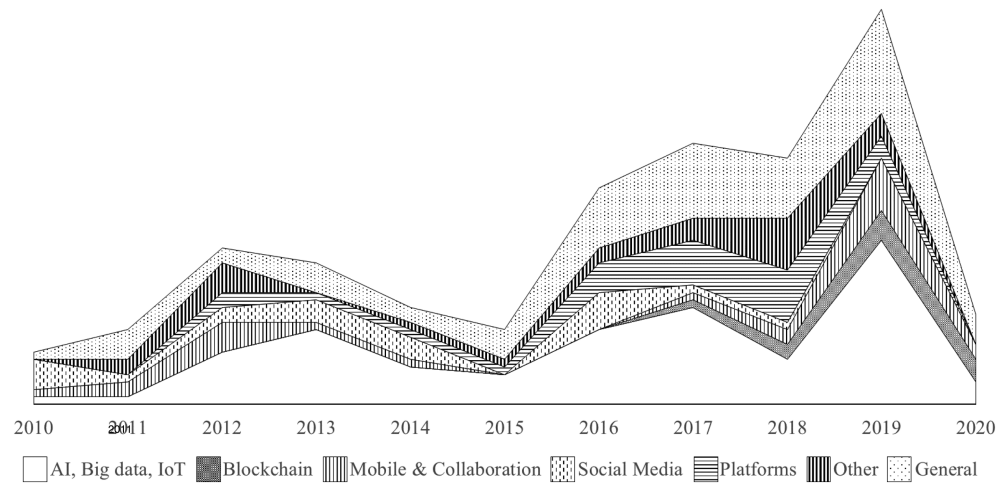
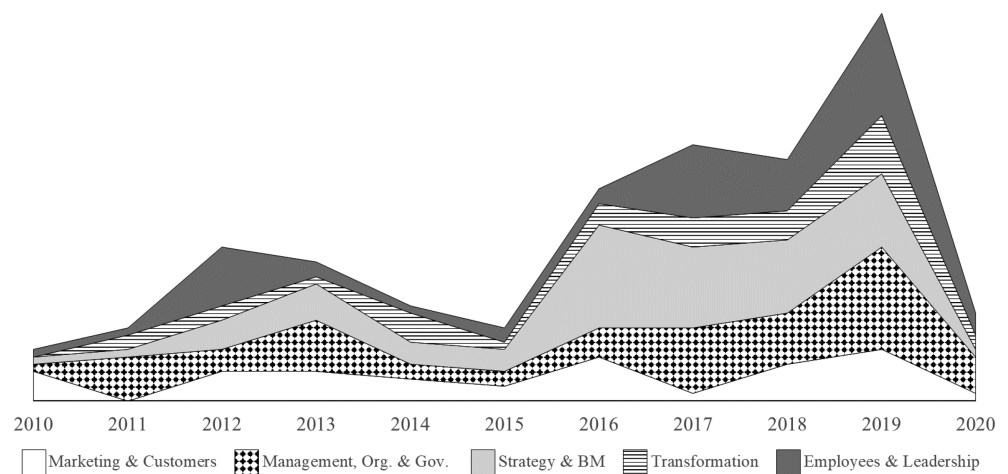


FIGURE 3 Emphasis on themes over the years



and manufacturing locations, potentially resulting in shifts in the design of supply chains (Ben-Ner & Siemsen, 2017; D'Aveni, 2015). The blockchain—building on unique characteristics, such as its distributed database and the irreversibility of records—has the potential to reduce transaction costs, to facilitate access to outside resources, or to enable the effective management and exchange of property rights (Felin & Lakhani, 2018; Pedersen, Risius, & Beck, 2019; Tapscott & Tapscott, 2017). Cloud solutions offer to manage firms' IT infrastructure cost-effectively, which is often a viable alternative to providing in-house IT in small- and medium-sized enterprises (SMEs) (Lacity & Reynolds, 2014; McAfee, 2011). With the rising availability of data and information, data analytics and data-enabled learning emerge as a competitive asset for many firms (Barton & Court, 2012; Hagiú & Wright, 2020). The Internet of Things (IoT) enables firms—supported by smart, connected products and devices—to generate real-time data with contextual information (Gandhi & Gervet, 2016). This enables new forms of relationships and interactions, enhanced coordination possibilities of complex processes, and new cross-functional collaboration opportunities (Porter & Heppelmann, 2014, 2015). AI further enhances this effect, offering firms unprecedented opportunities to automate processes, derive cognitive insights, and create cognitive enhancement (Tarafadar, Beath, & Ross, 2019; Watson, 2017).

Despite its expected revolutionary and transformative impact (Brock & von Wangenheim, 2019; Iansiti & Lakhani, 2020), at least thus far, most AI-related initiatives focus on using AI within the existing business (Brock & von Wangenheim, 2019) and concerns the potentially overblown expectations about the technology's capabilities that emerge (Gerbert & Spira, 2019). As customers are continuously connected using mobile technologies, firms need to respond with connected strategies to improve their customers' experience (Siggelkow & Terwiesch, 2019; Stieglitz & Brockmann, 2012). Furthermore, social media as tools for social networking and accessing digital content increasingly compete with other technologies for time and attention and provide a new source for business value (Culnan, McHugh, & Zubilaga, 2010; Kane, 2015).

3.3 | Managing the transformation

When it comes to technology adoption and diffusion, digital technologies are no exception from other technologies—this is not a straightforward process, and it is specific to the technology and the context. For instance, to enhance the use of AI, building trust by establishing a sense of fairness, transparency, and accountability as well as a realistic

perspective on the technology's capabilities have emerged as crucial to foster the technology adoption (Davenport, 2019). This might also require senior leadership involvement in conveying the urgency of working with AI and investments in AI-related education of employees and leaders (Fountaine, McCarthy, & Saleh, 2019). For the blockchain, which requires high levels of complex and unknown coordination, experts foresee a similar adoption behaviour over time from single use to localization, substitution, and eventual transformation similar to the diffusion of the Internet (Iansiti & Lakhani, 2017a). For technologies, such as RPA, even though most of the technology diffusion challenges are less complex, addressing concerns about potential job losses is essential to RPA adoption (Hallikainen, Bekhus, & Pan, 2018; Lacity & Willcocks, 2016b).

Digital transformation is generally an iterative process that often requires rapid adaptation through a participatory approach (Hansen, Kraemmergaard, & Mathiasen, 2011; Smith & Watson, 2019). Furthermore, the process is often more incremental, as firms initially focus on a few selected projects before scaling up (Davenport & Ronanki, 2018). Leonardi (2020) recently proposed six interlinked phases that are essential for a successful digital transformation: the leadership sells the transformation, the employees adopt the transformation, the employees choose how to use the technology, data change employee behaviour, local performance improves, and local performance aligns with corporate goals. Digital transformation at its core is a business transformation focusing on increasing customer experience and operational efficiency (Weill & Woerner, 2018). While there is no commonly agreed understanding of the digital transformation's elements, most studies list business models, performance management, the workplace, mindset and skills, and a firm's IT function as relevant elements in addition to customer experience and operational processes (El Sawy, Kraemmergaard, Amsinck, & Lerbech Vinther, 2016; Gurbaxani & Dunkle, 2019; Matt, Hess, Benlian, & Wiesbock, 2016; Westerman, Bonnet, & McAfee, 2014).

The successful navigation of a digital transformation starts with a clear strategy combined with the operational backbone and organizational culture (Iansiti & Lakhani, 2020; Sebastian et al., 2017). As the speed of change is extremely high, firms need to be alert and responsive, even to weak signals in their environment (Venkatraman, 2019). Successful responses to digital disruption include those firms that focus on serving additional customer segments instead of only continuing to service existing customers or focusing on cutting costs (Bughin & van Zeebroeck, 2017). A suggestion on how to approach digital initiatives is to apply the digital lens to the firm's existing product and service offering (Iansiti & Lakhani, 2014). Many successful digitalization initiatives are digital-physical mashups that allow a firm's customers to benefit from the advantages of both the digital (e.g., rich product information, online reviews, and price comparison) and the physical space (event/experience, testing/trying on, and personal help) (Rigby, 2011; Rigby, 2014). Often, hybrid product offerings that combine emerging with existing technologies help firms learn about and deal with the uncertainty attached to the new technology smartly (Furr & Snow, 2015). Beyond the firm's boundaries, the firm needs to understand who in their ecosystem they need to involve to create

new value-added services (Vaia, Carmel, Trautsch, DeLone, & Menichetti, 2012). Internally within the firms, the required cultural shift towards interdisciplinary collaboration in a fast-moving, agile, and experimentation-friendly environment is often the most difficult part in digital transformation (Ibarra, 2019; Westerman, Soule, & Eswaran, 2019). Particularly, the challenging collaboration of IT and business should be seamless (Dremel, Herterich, Wulf, Waizmann, & Brenner, 2017). In the context of industrialized digital transformation, a template and business-driven approach with a matrix organization, tight steering of suppliers, and cascaded planning proved to be successful (Winkler & Kettunen, 2018). Furthermore, consistent standardization and access to easy-to-use analytic tools as well as thinking in code and making code to be business as usual within the firm are likely to increase the positive outcomes and to ease the digital transformation process (Barton & Court, 2012; Walter, 2019; Wixom, Yen, & Rellich, 2013). From an operational perspective, firms might be capable of leveraging digital technologies to reduce complexity inherent to their product and service offering, thereby potentially increasing the variety of their offering without surpassing the complexity sweet spot (Mocker, Weill, & Woerner, 2014).

3.4 | Implications for strategy and business models

A digital business strategy demands strong leadership, an agile and scalable core, and a clear focus on either a customer engagement or a digitized solutions strategy (Ross, Sebastian, & Beath, 2017). As shown by DBS Bank in Singapore, a digital business strategy exploits information abundance to create new value for customers and requires the continuous navigation of the dynamic and emerging digital landscape (Sia, Soh, & Weill, 2016). Grover, Kohli, and Ramanlal (2018) suggest that managers should carry out a thorough sociotechnical, strategic assessment for every digitization initiative to determine the firm's readiness for digital offerings and the potential consequences for customers. To be successful in the digital environment, firms need to overcome legacy IT infrastructure challenges quickly, as everything their competitors do with data is scalable, defensible, and reinforceable (Wessel, Levie, & Siegel, 2016). AI-enabled algorithms have a great potential to help firms fine-tune their digital strategies. Alibaba, for example, uses an algorithmic self-tuning approach to discover what works and to adjust and shape their strategy (Reeves, Zeng, & Venjara, 2015). However, even though technologies might provide relevant insights, managers cannot rely on algorithms only. Instead, managers need to remain focused on how they use the information derived from the data that are provided to the technology in alignment with their strategic objectives and by considering the long-term implications of the data (Luca, Kleinberg, & Mullainathan, 2016).

Despite the potential of big data, only few firms know how to exploit the data already embedded in their operating systems (Parmar, Mackenzie, Cohn, & Gann, 2014). To exploit data, firms have to change their decision-making culture; senior managers have to embrace evidence-based decision-making (Ross, Beath, &

Quaadgras, 2013) and combine data management approaches to shape new analytics-focused roles and to set guidelines for responding to challenges posed by digital transformation (Davenport, 2013). Leadership at multiple levels has to be aligned and focus should be given to human dimensions of analytics (Davenport, 2014). Firms should consider developing a coherent strategy when it comes to striking a balance between two types of data management—defensive (e.g., security and governance) and offensive (e.g., predictive analytics)—and understanding what is the real value of data that it disposes (DalleMule & Davenport, 2017). Short and Todd (2017) define data value as the composite of three sources of value: the asset or stock value, the activity value, and the expected or future value. To capitalize on big data, companies should pay attention to data flows as opposed to stocks and rely on data scientists as well as product and process developers instead of data analysts (Davenport, Barth, & Bean, 2012). When sharing data, managers should monitor benefits versus drawbacks and remain agile (Krämer, Schnurr, & Wohlfarth, 2019). Moreover, digital data streams (DDS) offer possibilities to extract value from data—this requires awareness of existing DDS (Herterich, Uebernickel, & Brenner, 2016) as well as the identification of value drivers and value archetypes (Piccoli & Pigni, 2013; Pigni et al., 2016). Firms can improve the value realization from DDS when the agility of the resource allocation process is appropriate for the levels of both DDS platform maturity and commitment from data-driven top management (Anand, Sharma, & Coltman, 2016). Generally, firms take three approaches to monetizing their data: improving internal business processes and decisions, wrapping information around core products and services, and selling information offerings to new and existing markets (Wixom & Ross, 2017). For example, Watson, Boudreau, Li, and Levis (2010) demonstrate how UPS improved safety, reduce mileage, cause lower emissions, and cut maintenance costs by gathering information through proprietary firmware in its trucks. To create value from blockchain, firms like TradLens focused on key shipping documents, such as the packing list, the certificate of origin, or the commercial invoice to develop a blockchain prototype for inter-organizational operations (Jensen, Hedman, & Henningsson, 2019). Najjar and Kettinger (2013) argue that selling data to suppliers can be risky in terms of losing competitive advantage, and the companies should consider the costs of making the data available in the first place when building their pricing models. To monetize value from data, BBVA balanced short-term project goals and long-term capability creation; invested in social-good projects; assessed the value and impact of data science projects; and trained all employees about data science (Alfaro et al., 2019). Blockchain can help companies monetize the content (Dutra, Tumasjan, & Welp, 2018) where content creators can gain more control over their work and a greater share of the content revenue and content aggregators can leverage blockchain technology to handle certain processes more efficiently.

Managers should consider the continuum between a pure reseller and a pure multisided platform and assess which model will allow the firm to exploit scale and aggregation effects, offer a better buyer or seller experience, and resolve market uncertainties (Hagiu &

Wright, 2013). Drawing on examples from eBay, Lending Club, and Airbnb, Hagiu and Rothman (2016) discuss hurdles when building and scaling online marketplaces, such as challenges to sustain business models, ensuring trust, managing disintermediation, and engaging early enough with regulators. To reveal platform value, companies can consider becoming a multisided platform provider by opening the door to the third parties, connecting customers, and connecting products to customers, or supplying a multi-sided platform (Hagiu & Altman, 2017). Reeves, Lotan, Legrand, and Jacobides (2019) argue that platforms have several development paths: never took off, that is, Microsoft's Windows phone; won it temporarily, that is, Netscape browser, Symbian, and OS; created a fork in the road, that is, Uber, Seamless, and GitHub; or became sustainable, that is, Windows and Amazon. For a platform to be successful, it needs multiple types of users that are interested in both sides of the offering (Edelman, 2015), and to become sustainable, companies need to seize the opportunity to capture a large proportion of the market, evolve the model to avoid losing momentum in the face of market saturation and competition, and lock in market leadership to maintain their position over the longer term (Reeves et al., 2019). Platform managers rely on five fundamental properties of networks to be successful: network effects, clustering, risk of disintermediation, vulnerability to multi-homing, and bridging to multiple networks (Zhu & Iansiti, 2019). To compete with rising platforms, incumbents can take legal action to try and have the current laws enforced and leverage what they do best (Edelman & Geradin, 2016). The other concern is that only a few digital superpowers capture a disproportional and growing share of the value being created (Iansiti & Lakhani, 2017b). Successful platform dethroners can achieve a powerful type of differentiation by focusing on what the platform dethroner does better than its competitors (Suarez & Kirtley, 2012). Sampler (2018) discusses risks of running matchmaking platforms. Generally, platform competition should be adopted to the local context: To compete in China's digital market, companies must adopt strategies that are customized to China's unique conditions (Li, Candelon, & Reeves, 2018). Platform-based strategy requires managing three shifts: from resource control to resource orchestration, from internal optimization to external interaction, and from a focus on customer value to a focus on ecosystem value (Van Alstyne, Parker, & Choudary, 2016). Success depends on many others in the ecosystem, as often the weakest actor determines the potential of the joint endeavour (Adner & Kapoor, 2016; Furr, O'Keefe, & Dyer, 2016). Jacobides (2019) argue that the importance of ecosystems is linked to three structural changes: a rollback of regulatory protections, a blurring of the separation between products and services, and technology that revolutionizes how firms can serve customers. Value drivers of network effects are defined as the minimum market share at which the network can achieve financial breakeven, the nature and durability of the customer relationships spawned by the network, and the extent to which the data generated by the network facilitates product and pricing optimization (Knee, 2018). An example of a similar network is a pan-industrial company proposed by D'Aveni (2017) where different stakeholders are centred around 3D printing.

An incumbent entering the sharing economy should consider the scope of the target market, the capabilities to gain competitive advantage, and the means to earn money (Mocker & Fonstad, 2017). Frey, Trenz, and Veit (2019) describe sharing economy differentiation strategies based on technology partnerships and user experience. Incumbents can potentially respond to sharing economy platforms by strengthening business-as-usual; invest-learn-act; step-out-and-partner; hybrid; and expand-and-compete (Zhang, Kettinger, Kolte, & Yoo, 2018). Particularly, the hybrid model focused on creating and sharing new value, drive rapid conversion to the new platform, and identify and act on opportunities to deter competitive imitation from gaining increasing attention (Zhu & Furr, 2016). For instance, Tauscher and Kietzmann (2017) showed that a hybrid business model can significantly reduce the inherent risks and lead to sustainable growth in the sharing economy. By analysing 37 sharing economy platforms, Constantiou, Marton, and Tuunainen (2017) identified that sharing economy models are based on tight or loose control over participants and high or low rivalry between participants. Sharing businesses fail when there is a lack of providers, insufficient analysis of the sharing market, trust and safety, hidden resource requirements, an unsalable technical design, an unclear legal environment, or a business termination through acquisition (Chasin, von Hoffen, Hoffmeister, & Becker, 2018).

To transform an industry, any technology needs to link the industry to an emerging market need through a business model (Kavadias, Ladas, & Loch, 2016). For example, when transitioning to a cloud-based business model, a software vendor found a new manner of consuming computer resources that provide advantages, such as low installation costs, no need for in-house servers, pay-as-you-go, great flexibility, and scalability (Xiao & Hedman, 2019). Online retailers can search for areas where traditional retail does not meet the needs of potential customers (Bell, Choi, & Lodish, 2012). Furthermore, online retailers might benefit from a well-aligned omnichannel strategy (Hansen & Kien, 2015). However, firms should be aware that despite the global nature of digital offerings, for example, in e-commerce, they need to adapt their business models to their markets' cultural particularities (Wang & Ren, 2012). Garmulewicz, Holweg, Veldhuis, and Yang (2018) discuss how 3D printing can enable circular economy solutions. D'Aveni (2018) points out mass customization, mass variety, mass segmentation, mass modularization, and mass standardization as relevant business models for 3D printing. Kavadias et al. (2016) point out that transformative business models require personalization, a closed-loop process, asset sharing, usage-based pricing, a collaborative ecosystem, and an agile and adaptive organization. Mass customization business models require firms to leverage the potential of involving many users in co-creation, yet with the efficiency associated with mass production (Gruel & Piller, 2016). To create digital offerings, firms should use an iterative approach involving customer-driven experiments and cross-functional teams (Ross, Beath, & Mocker, 2019). Moreover, firms need to respond to their competitors' business model changes, such as the rising threat of free online offerings (Bryce, Dyer, & Hatch, 2011). McGrath (2020) discusses digital to consumer business models driven by digital technologies, algorithms,

data analytics, and new forms of connectivity based on access to assets, co-creation with customers, always-on and mobile, and capital-light ecosystem business models. When developing a product-service business model like Go Get, companies should prioritize pro-social objectives over business objectives, establish a viable long-term business model, and reconcile business and social logics if business growth dilutes the initial pro-social identity (Tan, Cahalane, Tan, & Englert, 2017). With respect to AI, Bughin (2018) argues that companies should pursue AI adoption at scale as soon as feasible, focus on applications that yield product and service innovation to capture the technology's top-line benefits, and complete digitization efforts as the backbone for AI applications. Start-ups can use different business model archetypes, such as assisted intelligence (i.e., image scans analysis), augmented intelligence (i.e., precision medicine), and autonomous intelligence (i.e., doctorless hospitals) to bring AI to the market (Garbuio & Lin, 2019). Mandviwalla and Watson (2014) suggest that firms can generate capital through social media by learning from and engaging with what drives human, social, and symbolic capital generation; data-driven analysis and decision-making; and knowledge generation and dissemination to create and develop human and organizational capital.

3.5 | Implications for customers and marketing

In the digital era, customers connect with brands in fundamentally new manners, often through media channels that are beyond manufacturers' and retailers' control, which implies that firms' marketing strategies must adapt to the changes in brand relationships and consumer decision journeys (Edelman, 2010). Brands are increasingly tied to experiences (Lewnes & Keller, 2019). Furthermore, employees are increasingly involved in brand management—as brand ambassadors on social media, by encouraging younger employees to share their social media skills with more senior colleagues, and by training employees on the importance of having a social media presence (Cervellon & Lirio, 2017). Social media plays an important role in brand building, and companies should privilege activities that support a brand's reputation over sales in the short term (Barwise & Meehan, 2010). Traditional brands can be rejuvenated in social media by scanning and mapping the social space around the brand and its competitors, by engaging with consumers on social networks, and by learning from consumers' interactions (Mount & Martinez, 2014). Moreover, Twitter can serve to build new connections to the brand (Sashittal, Hodis, & Sriramachandramurth, 2014). For instance, one of the early adopters of social media, Infosys, used social media to sense and seize ideas to build thought leadership, manage their brands, inform overall market directions, and guide their strategy (Heath, Singh, Ganesh, & Taube, 2013). Cultural branding where brands collaborate with crowds and champion their ideologies in the marketplace has emerged as a complementary approach to conventional branding (Holt, 2016). To make the best of social media efforts, companies should combine push and pull marketing, supporting likes with branded content (John, Mochon, Emrich, & Schwartz, 2017) and connecting with customers

online and offline (Lewnes & Keller, 2019). De, Hu, and Rahman (2018) discuss mistakes of online retail practices, such as letting a consumer become lost in a sea of products, recommending only popular products, fostering unrealistic customer expectations, focusing on sales rather than net sales retail, and not keeping pace with technology advances. Hoffman and Fodor (2010) indicate the importance of revisiting the return on investment (ROI) of online marketing to assess consumer motivations and measure the social media investments customers make while engaging with the marketers' brands. Zalmanson and Oestreicher-Singer (2016) explore how to convert website visitors into paying customers and introduce the concept of the ladder of participation—a framework for strategic thinking about using site engagement to improve conversion.

Firms need to understand how the changing mode of communication affects the content of human communication, that is, the impact of posting on the length, timing, and tone of user-generated content: visual or short burst communication. (Piccoli & Ott, 2014). Furthermore, Gupta (2013) argues that firms should adapt their marketing strategies to the communication channels that the customers use; that is, banner ads do not work on mobile devices. The language used to communicate can enhance customer satisfaction and purchase behaviour (McFerran, Moore, & Packard, 2018). Companies should improve their social communication (Adjei, Noble, & Noble, 2012) by focusing on the timeliness of information and its relevance. Firms can explore various approaches to increase possibilities of re-tweeting like humanizing the brand and keeping the messages short (Malhotra & Malhotra, 2016; Malhotra, Malhotra, & See, 2012; Shore, Baek, & Dellarcas, 2018). Adomavicius, Bockstedt, Curley, Zhang, and Ransbotham (2019) argue that recommendations online shape consumer preferences and call for the importance of reducing bias in online recommendation systems.

The rising availability of data and tools for data analytics have fundamentally changed marketing analytics. Nichols (2013) argues that the days of correlating sales data with a few dozen discrete advertising variables are over, as many firms deploy advertising analytics that include activities, such as attribution to quantify each advertising element's contribution, optimization to use predictive analytics tools to run scenarios for business planning, and allocation to redistribute resources across marketing activities in real time. Firms should focus on their brand identity when leveraging data for sales (Robert, 2015), as any form of perceived online surveillance may create consumer backlashes. Marketers need to understand when personalized ads will be met with acceptance or annoyance (John, Kim, & Barasz, 2018). With the emergence of AI, marketing analytics have started to change even further. Urban, Timoshenko, Dhillon, and Hauser (2020) argue that deep learning encourages experimentation and enables real-time adaptability of A/B experiments. Recent research contributions have provided an integrative framework for understanding the role of AI in personalized engagement marketing and offer recommendations for firms based on time and place (Kumar, Rajan, Venkatesan, & Lecinski, 2019; Overgoor, Chica, Rand, & Weishampel, 2019).

Digital technologies also fundamentally change customer engagement and experiences. Customer experiences can be enhanced when organizations leverage data from IoT and communities of users throughout customer service lifecycles (Ives, Rodriguez, & Palese, 2016) and derive value from unstructured data (Müller, Junglas, Debortoli, & vom Brocke, 2016). AI can further help retailers identify which customers to cultivate and which experience to provide to them (Latinovic & Chatterjee, 2019). Social media greatly enriches traditional customer and firm interaction, and it enables the firm and customers to monitor what other customers say about the firm (Ransbotham & Gallagher, 2010). User-centred and open innovation communities appear to be a great means to foster customer engagement (Dong & Zhang, 2016). Overall, digital technologies allow firms to build stronger ties with customers (Siggelkow & Terwiesch, 2019) and be strategic about their offerings to build relationships with new customers, for example, through social coupons (Kumar & Rajan, 2012). Firms increasingly compete in customer journeys that feature automation, personalization, context-based interaction, and ongoing innovation (Edelman, 2015). Thereby, firms need to cultivate empathy and emotional connections with customers (Agarwal & Weill, 2012) and build choice engines to help them navigate through online offerings (Thaler & Tucker, 2013). Virtual assistants can provide targeted, sophisticated assistance that goes well beyond responding to basic inquiries (Nili, Barros, & Tate, 2019). Furthermore, firms need to consider marketing to AI platforms, as AI assistants increasingly become the trusted advisors to consumers (Dawar & Bendle, 2018).

3.6 | Implications for management, organization, and governance

The digital transformation implies shifts in organizational structures and cultures, such as from management-driven to data-driven decision-making, from silos to interdisciplinary collaboration, and from risk-averse approaches to agility, experimentation, and improvisation (Levallet & Chan, 2018). Since the early days of digital technologies, creating a knowledge-sharing culture has emerged as an essential ingredient to leverage collaboration technologies (Aggarwal, Teo, Nishant, & Goh, 2011). Increasingly, firms consider the balancing of competing concerns, such as between external and internal collaboration or flexibility and control for external relationships, as a key component of the firms' digital innovation capability (Svahn, Mathiassen, Lindgren, & Kane, 2017). From an organizational perspective, collaborating with external partners at all levels, including in the workforce (e.g., gig work or impact sourcing) or in consortia with other organizations (e.g., blockchain ecosystems) has increased (Gino & Staats, 2012; Petriglieri, Ashford, & Wrzesniewski, 2018; Zavolokina, Ziolkowski, Bauer, & Schwabe, 2020). The widespread availability of digital technologies also allows for unconventional activities, such as law sourcing via social media in response to business disputes involving legal actions (Orozco, 2016). These changes provide challenges to a firm's internal governance mechanisms as well as to external regulations. Internally, firms should avoid to over-govern data

and information without allowing to bypass all formal governance structures (Tallon, Short, & Harkins, 2013). In inter-firm collaborations, such as ecosystems, firms need to establish standards, regulations, and shared governance mechanisms (Lacity, 2018). Technologies, such as AI or the blockchain, require new forms of regulation, for example, to ensure compliance with data protection regulations (Howard, 2019; Rieger, Guggenmos, Lockl, Fridgen, & Urbach, 2019). At the same time, these technologies also provide an opportunity for novel governance mechanisms, thereby enabling regulators to move from reactive to proactive oversight and to benefit from the standardization of interactions (Gozman, Liebenau, & Aste, 2020; Schmeiss, Hoelzle, & Tech, 2019). Nevertheless, there is wide agreement that to organize and govern the digital business landscape is a continuous balancing act (Gozman et al., 2020; Schmeiss et al., 2019; Tallon et al., 2013).

Digital technologies have far-reaching implications for various management activities. Higher information speed and flexibility—if the information flow is managed effectively, for example, through mobile executive information systems—allow for faster decision-making and more effective collaboration (Cross, Davenport, & Gray, 2019; Davenport & Snabe, 2011; Mayer, Bischoff, Winter, & Weitzel, 2012). Furthermore, with the development and diffusion of AI-enabled decision-making solutions emerges the potential to hand over decision-making tasks to the technology, which might be capable of making less biased decisions if given the right training data and technology design (Daugherty, Wilson, & Michelman, 2019; Shrestha, Ben-Menahem, & von Krogh, 2019). Ensuring data credibility, for example, through improving the communication and understanding between data creators and users, becomes more important (Redman, 2013). A key element of the more recent debate centres on human actors' and technological actors' forms of joint decision-making (Metcalf, Askay, & Rosenberg, 2019; Shrestha et al., 2019). Despite its potential, there are also concerns regarding the usefulness of a scientific, data-driven analysis for all strategy and innovation decisions (Martin & Golsby-Smith, 2017). Furthermore, there is a risk of increasing reliance on the technology to analyse data and to derive conclusions, which might lead to passivity, dependence, and vulnerability, as decision makers unlearn to make deliberate choices (Friedland, 2019). For innovation management, the ubiquity of data—if managed effectively—offers a valuable resource (Bilgeri, Gebauer, Fleisch, & Wortmann, 2019; Chai & Shih, 2017; Chen, Schutz, Kazman, & Matthes, 2017). Moreover, co-creation leveraging social media (Jarvenpaa & Tuunainen, 2013; Roberts & Piller, 2016) or platforms for idea management and experimentation (Benbya & Leidner, 2018; Downes & Nunes, 2013) emerged as a new source of innovation. The increasing range of inexpensive, digital tools also facilitates a firm's opportunity for recognition, development, and evaluation activities (Chan, Krishnamurthy, & Desjardins, 2018). In supply chain management, to unleash the potential of big data in terms of unprecedented opportunities for new forms of inquiries and experimentation, firms should expand their capabilities to coordinate, evaluate, and align complex big data (Bowers, Petrie, & Holcomb, 2017; Sanders, 2016). Furthermore, firms need to adapt their supply chains to provide

quickness and product customization by shifting to make-to-order production based on real demand (Sodhi & Tang, 2017). Blockchain applications might be useful to replace ineffective IT solutions to verify the products' and transactions' authenticity (Mattke, Maier, Hund, & Weitzel, 2019).

The increasing and widespread use of digital technologies makes firms vulnerable to multiple forms of cybercrime and misuse (Huang, Siegel, et al., 2019; Madnick, 2020). Information security management should become a priority for all firms, as inadequate security technology and mistakes by human users and network administrators often compromise cybersecurity (Esteves, Ramalho, & De Haro, 2017; McLaughlin & Gogan, 2018). Leaders must learn more about cybersecurity and monitor the state of their organization's data security (Rothrock, Kaplan, & van der Oord, 2018). Furthermore, as many cyberattacks involve insiders, such as employees (Upton & Creese, 2014), weeding out and containing human error through principles like integrity, procedural compliance, a questioning attitude, or formality in communication are beneficial (Winnefeld, Kirchhoff, & Upton, 2015). In line with rising opportunities for cybercrime, demands to protect the privacy of customer data have risen and require firms to stay adaptable to the changing landscape (Greenaway & Chan, 2013). Firms also face customers' rising privacy concerns (O'Leary, 2013), as customers tend to resist personal information being used for predictions of their preferences (Carmon, Schrift, Wertenbroch, & Yang, 2020). Using customer data in secondary markets that are not transparent to the customer also raise ethical issues regarding data stewardship, data due process, and data integrity (Martin, 2015). Ethical concerns also emerge in the context of AI-based algorithms about what we should use them for and how to deal with the accountability for mistakes made by the technology (Martin, 2019; Parmar & Freeman, 2016).

Traditionally, a firm's chief information officer (CIO) was considered as a senior business technology manager whose technical background allowed to serve multiple roles—depending on the particular organizational context—that range from serving as a utility IT director, an evangelist or innovator to a facilitator or agility IT director (Peppard, 2010; Peppard, Edwards, & Lambert, 2011; Thatcher, Carter, & Grover, 2011). Depending on the role, the CIO focuses on delivering the IT infrastructure and services and is in charge of the firm's electronic connection to its customers, is embedded in non-IT themes, such as business strategy or process optimization, or is responsible for the firm's process management (Weill & Woerner, 2013). Generally, a CIO's success builds on multiple factors, including personality traits, managerial, and in particular environmental factors (Peppard et al., 2011; Spitze & Lee, 2012). Based on their technical background and interdisciplinary activity range, the CIO's role was often designed to bridge between business and IT (Colony, 2018; Kohli & Johnson, 2011). However, this ambiguity also required a split of responsibilities among C-level members (Deans, 2011). With the rising importance of big data, a number of firms created the chief data officer as an additional role with a similarly wide range of potential foci as the CIO, but with a clear emphasis on managing a firm's data (Lee, Madnick, Wang, Zhang, &

Whang, 2014). Since 2017, a discussion on the role of a chief digital officer (CDO) has emerged. The roles and responsibilities of this position vary widely, ranging from highly focused roles on technology and marketing to high-ambiguity roles with high influence on strategy development and execution (Wade & Obwegeser, 2019). CDOs might be responsible for building the firm's capabilities for digital innovation, customer engagement, and data analytics (Tumbas, Berente, & vom Brocke, 2017). CDOs might act as an entrepreneur, a digital evangelist, or a coordinator of digital transformation activities within the firm (Singh & Hess, 2017). Furthermore, they might serve as a networker and catalyser, an insider expert, an innovation evangelist, or an IT expert (Reck & Fliaster, 2019).

3.7 | Implications for leadership and employees

Digital technologies provide manifold opportunities to automate work, for example, with AI offering its intelligence in the form of support for humans, by taking over repetitive tasks, and by increasingly improving its context awareness and learning capabilities (Davenport & Kirby, 2016). While automation has an immediate impact on jobs with many routine and manual tasks, it is likely to affect also those occupations where the expected impact is less obvious (Del Sol & Joyce, 2020). For a few but not all occupations, the skills will be deemed obsolete, and the form of value delivery is likely to change, which leads to four potential effects on existing jobs: they might be disrupted, displaced, deconstructed, or durable (Latham & Humbert, 2018). However, as AI becomes capable of taking over analytical tasks, human workers are forced to focus on emphasizing their emotional and social skills (Huang, Rust, et al., 2019; Waytz, 2019). In line with this, the diffusion of digital technologies generally causes a demand for a wide range of new skills and priorities, such as a rising emphasis on entrepreneurial attitudes and business awareness or ethical intelligence (Marion, Fixson, & Brown, 2020) and managerial judgement (Agrawal, Gans, & Goldfarb, 2017; McAfee & Brynjolfsson, 2012). The roles, such as data scientists or translators, have emerged and have become a rare and valuable resource (Brady, Forde, & Chadwick, 2017; Davenport & Patil, 2012; Sahni, Huckman, Chigurupati, & Cutler, 2017). Previously, non-significant skills, such as one's online gaming experience, suddenly become valuable (Petter, Barber, Barber, & Berkley, 2018). Furthermore, digital technologies offer unprecedented forms of learning facilitation that could be leveraged (Lyons, 2017). Unfortunately, many educational training and development programs often fail to meet the market's skill needs (Horn, 2020). Moreover, many firms struggle with compensating the loss of on-the-job learning and apprenticeship experiences, as machines take over more and more basic activities (Beane, 2019; Daugherty et al., 2019).

Over the last decade, firms experienced how digital technologies became an integral component of many, if not all, occupations. Social media tools, such as Twitter, have become state-of-the-art for senior managers, including the C-suite, to communicate effectively and efficiently with a wide range of stakeholders (Gaines-Ross, 2013). The

use of social tools and mobile technologies, allowing employees to bring their own devices, or team-collaboration platforms have helped increase productivity and innovation (Leonardi & Neeley, 2017; Magni & Maruping, 2019; Pitt, Berthon, & Robson, 2011; Steelman, Lacity, & Sabherwal, 2016; van Heck, van Baalen, van der Meulen, & van Osterhout, 2012). However, the effective use of such technologies requires a good task-technology fit and a clear and consistent dialogue about how to use the technologies (Hill & Bartol, 2018). Furthermore, to leverage the potential of internal social tools, leaders should clearly define the tools' purpose and be a role model for how to use them (Leonardi & Neeley, 2017). Moreover, the effective use of such technologies might differ from employee to employee, and leaders are encouraged to coach their team members in finding a customized solution, also to prevent negative effects of worker isolation (Dery & MacCormick, 2012; Johns & Gratton, 2013; van Heck et al., 2012). Fostering employee engagement in innovative tools is challenging and requires a context-specific approach (Bhappu & Schultze, 2018). Generally, firms need to enhance their employee's experience through connectedness and responsive leadership (Dery, Sebastian, & van der Meulen, 2017), focus on building their employees' relational, technological, and mental readiness (Eckhardt, Endter, Giordano, & Somers, 2019), and use practices, such as flexing (temporary adaptations in response to external pressures), revitalizing (change structures, roles, and capabilities), and deepening (rethink and recommit to the purpose) (Eden, Burton Jones, Casey, & Draheim, 2019). The increasing use of digital technologies has very distinct implications for an individual worker's subjective perception of his/her work-life balance (Sarker, Xiao, Sarker, & Ahuja, 2012). Furthermore, the increasing demand of social and emotional skills is more stressful and exhausting (Waytz, 2019). Leading remote works potentially leads to miscommunication and makes it more difficult to evaluate an individual's contribution (Johnson, 2019). To cope with the rising temptations of digital distractions in the workplace, many firms challenge the previously promoted idea of open office designs again (Bernstein & Waber, 2019; Solis, 2019). Others experiment with off-device time periods to improve self-awareness and self-regulation (Russo, Bergami, & Morandin, 2018).

With the increasing diffusion of digital technologies in the workplace, particularly with AI, the collaboration of humans with technologies attracts rising attention. The literature suggests that AI's impact is most significant and beneficial if the technology augments instead of replaces human workers (Brynjolfsson & McAfee, 2012; Wilson & Daugherty, 2018). Malone (2018) refers to humans and technologies that form a collective intelligence as superminds that are capable of achieving more than each of them could achieve in isolation. To reach a flourishing human-AI collaboration, we need to carefully meter out the level of humanoid features assigned to the material co-workers (Frick, 2015). Moreover, this requires firms to invest in their employees to foster their adoption and interest in collaborating with AI (Wilson & Daugherty, 2019). Leveraging the collaborative intelligence of their human and material workforces also requires firms to adapt their business processes (Wilson & Daugherty, 2018). Furthermore, in the collaboration with technologies, humans need to shift

their emphasis to soft skills, such as creativity, sensory perceptions, or emotional intelligence (Daugherty et al., 2019). This implies that to contribute to the value creation, humans should either reach a higher cognition level, complement a certain form of intelligence that a machine fails to provide, monitor the machine's activities, or engage in the machines' further development (Davenport & Kirby, 2015). In line with this, new job categories emerge as firms increasingly need experts who train the machines, who are capable of explaining their outputs, and who ensure the machines' responsible use (Wilson & Daugherty, 2018).

With the changing demands on human resources, managing human resources needs to adapt as well. Firms need to understand the new skills required for the tasks remaining in the hands of human workers and how to develop and acquire the right talent (Barro & Davenport, 2019). To recruit digital talent, firms presently deal with high competition (Kane, Palmer, Phillips, & Kiron, 2017). At the same time, digital technologies allow firms to use data-driven decision-making support to identify talent or digital tools, such as gamified assessments, to ease the recruitment process (Bersin & Chamorro-Premuzic, 2019; Philpot & Monahan, 2017). To acquire and retain talent, firms need to understand how to increase the attractiveness of their digital infrastructure and social tools policies for Generation Y (Leidner, Koch, & Gonzalez, 2010) or how to motivate and reward people in new roles, such as the data scientists, in manners they care about and that provide them the autonomy, support, and culture required to perform their role (Davenport & Patil, 2012; Harris & Mehrotra, 2014). Generally, the use of big data analytics offers promising application fields in human resources (HR), such as talent identification (Philpot & Monahan, 2017) or to customize leadership training (Buckingham, 2012)—but deriving valuable insights remains a complex endeavour (Baesens, De Winne, & Sels, 2017). Furthermore, in all HR-related efforts including the use of digital tools for assessments of talent and performance or by allowing AI to perform managerial tasks, ethical and legal considerations emerge as one of the challenges for HR management (Bersin & Chamorro-Premuzic, 2019; Tambe, Cappelli, & Yakubovich, 2019).

4 | DISCUSSION: DERIVING AN AGENDA FOR FUTURE RESEARCH

The objective of this paper was to understand the contribution of academic research to help guide practitioners in dealing with the challenges of digital transformation. To achieve this, back in 2017, we started out by interviewing CDOs and senior managers in charge of driving their firms' digitalization journey to capture their key activities and interests, to learn from their lessons learned, and—most importantly—to understand their major challenges and concerns. This allowed us to understand that, in 2017, practitioners faced challenges concerning the scope of digital, the process and structure for approaching the digital world, the development of a customized digital strategy and transformation agenda, the achievement of tangible outputs, effective mechanisms for stakeholder alignment and inter-

organizational collaborations, the acquisition of new skills, new collaboration dynamics, and the social impact of firms over-relying on digital technologies. By now, in 2020, we can review a decade of academic literature published in practitioner-oriented journals on topics related to digital transformation. We systematically analysed the publications in the four practitioner-oriented academic journals to learn about the themes addressed and the guidance provided to management over time. This analysis revealed that from 2010 to 2016, a total of 109 papers were published, whereas since 2017 until the beginning of 2020, a total of 133 papers were published. Figure 4 offers an overview of the technologies and themes addressed over the years. We can observe that, from a technological perspective, there has been a shift over time from early-stage technologies, such as social media, to more complex and recent technologies like the blockchain and AI. With regard to the thematic emphasis, we notice an increasing attention on the digital technologies' implications for management, the organization, governance, employees, and leadership.

By comparing the major challenges and concerns addressed by managers in 2017 with the body of literature published between 2017 and 2020, we notice that for a few of the major challenges perceived in 2017, solutions have been proposed in the literature. For example, our interviews in 2017 indicated that firms still struggled with defining what the digital transformation means for them, what it affects, and how they can align it to their strategy and operations. Since 2017, the *understanding of what the digital transformation* means, what it includes, and how far-reaching its implications are have improved tremendously. The increase in publications on digital technologies in all managerial themes reflects this. Moreover, the discussion about the potential elements and dimensions of digital transformation (e.g., Gurbaxani & Dunkle, 2019) shows the enhanced understanding of the term and its meaning. Second, managers expressed confusion around *how to organize and approach digital transformation endeavours*. The vast majority of the publications that focus on how firms can manage the digital transformation has appeared since 2017. This includes the suggestion of a six-phase guiding process (Leonardi, 2020) or advice on how to scale the initiatives (Davenport & Ronanki, 2018). Furthermore, we have observed an intense debate on the ingredients for a successful transformation, such as clarity of the strategy in alignment with the firm's operational backbone, leadership, and organizational culture (Iansiti & Lakhani, 2020; Sebastian et al., 2017), and the importance of a firm's capability to identify and respond to weak signals in their environment (Venkatraman, 2019). Third, there was a *strong interest in inter-firm collaborations*, such as platform communities and ecosystems, in both academia and practice. Yet, we knew little about organizing new modes of inter-firm competition in the digital context, especially when the increasing relevance of inter-firm collaborations leads to cooperation challenges. Since 2017, we have noticed an increasing number of papers on the ecosystems approach when it comes to digital transformation. This approach illustrates how a firm's success depends on other stakeholders in the ecosystem (Adner & Kapoor, 2016; Furr et al., 2016; Jacobides, 2019). Furthermore, the ecosystems' perspective identifies value drivers at the network and

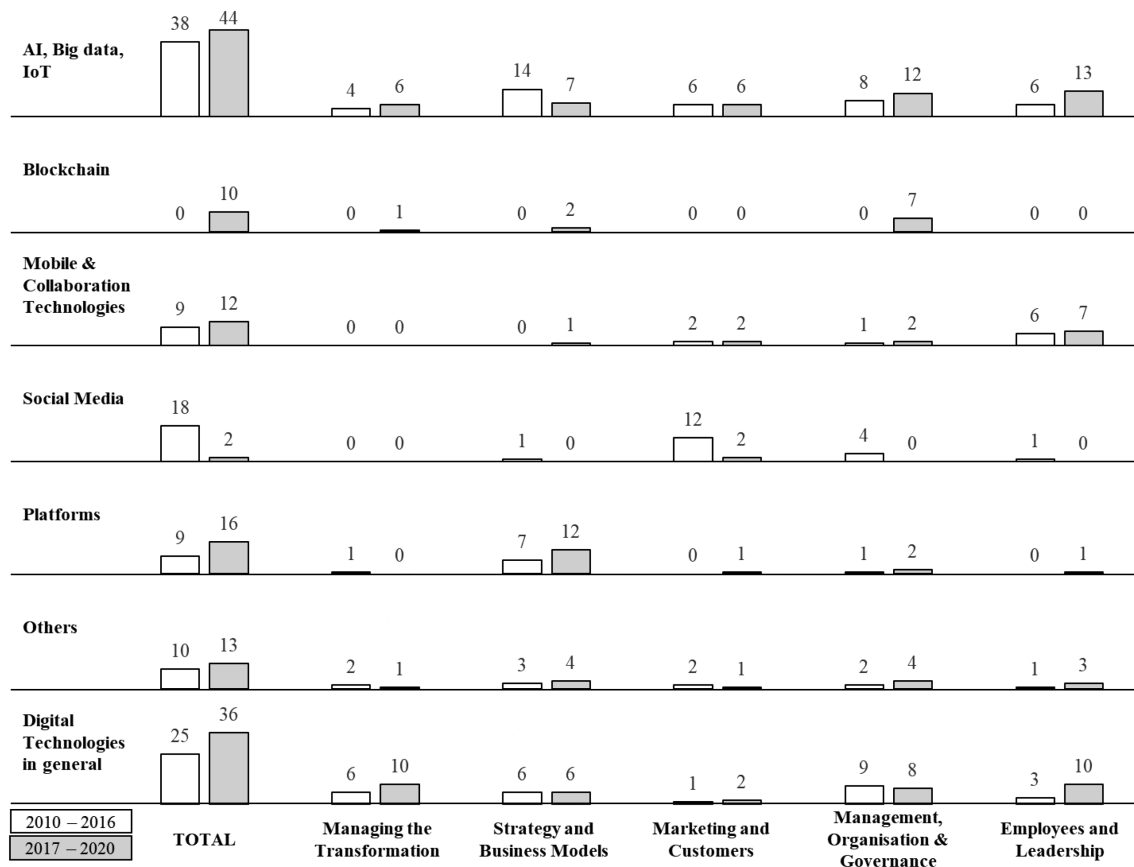


FIGURE 4 Comparison of literature foci 2010–2016 and 2017–2020

not only at the single firm level (Knee, 2018) like in a pan-industrial company where different stakeholders are centred around 3D printing (D’Aveni, 2017) or in a consortia-based approach to derive value from blockchain (Zavolokina et al., 2020). Moreover, to create new value-added services, research argues that an internal cultural shift towards interdisciplinary collaboration in a fast-moving, agile, and experimentation-friendly environment is crucial (Ibarra, 2019; Westerman et al., 2019).

However, a number of challenges raised in 2017 still require further research. One aspect is *the measurement of success and performance of digital transformation initiatives*. Back in 2017, managers in charge of digital transformation raised tensions concerning how to legitimate their exploratory approaches in the digital sphere. While the sense of urgency for engaging in digital activities has risen in the meantime, the challenge to commit to performance measures in the highly uncertain and fast-developing environment remains unsolved. Understanding how we can align traditional management activities, particularly strategic planning and controlling, to the nature of digital business therefore offers interesting avenues for future research. A second aspect that remains at least partly unanswered concerns *the development of the skills and capabilities* required by an effective workforce in the digital era. The recent literature contributions helped shed light on the type of skills required, in particular by emphasizing human’s

empathetic and emotional contributions (Huang, Rust, et al., 2019; Waytz, 2019), their ethical intelligence (Marion et al., 2020), managerial judgement (Agrawal et al., 2017), and data analytics capabilities (Brady et al., 2017; Sahni et al., 2017). However, recent publications have also raised a mismatch between the skills available on the market and the skills required by firms (Horn, 2020) and the unleveraged, unprecedented means whereby digital technologies can facilitate learning (Lyons, 2017). Furthermore, recent contributions highlight that traditional, on-the-job learning and apprenticeship opportunities disappear (Beane, 2019; Daugherty et al., 2019). The literature has also taught us that the digital workplace can be more exhausting (Waytz, 2019) requiring employees to find their balance by themselves with on-times and off-times (Russo et al., 2018). While content-specific knowledge remains relevant, these developments indicate that new skills and capabilities—that we fail to train sufficiently in most formal educational programs—increase in relevance. Understanding how we might be able to leverage digital technologies to identify relevant learning needs and to facilitate learning, potentially in new forms outside of formal programs, remains to be an interesting field for future research. As a third aspect, *the challenge to cope with the negative social impact of digital technologies* remains as a white spot in the literature. This concerns the firms’ activities, for example, when laying off workers who have been replaced by technologies;

however, it also concerns the overall development of the digital markets. An example is the emergence of powerful hub firms that capture a disproportionately high share of the value created (Iansiti & Lakhani, 2017a). At the macro-level, questions concerning the accountability and responsibility for controlling the development of the global digital markets emerge. Furthermore, we need to understand how firms can potentially prevent and cope with the negative consequences caused by other actors using digital technologies. This also builds on the still early-stage debate concerning the ethical consequences of using, for example, the data collected by digital technologies (Martin, 2015) and the accountability of technological actors (Martin, 2019; Parmar & Freeman, 2016).

Furthermore, a number of new questions have appeared. One aspect concerns the increasingly powerful *role that technologies*, particularly AI-based solutions, take. An example is the emerging power of AI platforms in marketing, which steps in between the brands and consumers (Dawar & Bendle, 2018). Another example is the decision makers' increasing dependence on technologies (Friedland, 2019). These examples illustrate how—despite being very useful for a particular purpose—those technologies take over the capacity to influence our lives. Developing criteria that help evaluate when and how this is a more or a less desirable state and identifying the potential consequences emerges as a promising avenue for future research. Within this theme, the design of future human-technology collaborations—a debate that has thus far focused on promoting human augmentation (e.g., Malone, 2018; Wilson & Daugherty, 2019, 2018)—emerges as one of the themes requiring additional focus. Furthermore, while we notice more and more inter-firm collaborations and work sourcing options, such as gig work, thus far, the nature of the firm has not been seriously questioned. Understanding how new technologies enable completely *new forms of organizations and how regulation at a global scale* that go beyond the small scale restructurings, such as the use of microwork solutions (Gino & Staats, 2012), can support the deployment of these solutions is another interesting field for future research. Another aspect concerns the increasingly required *fusion of physical and digital worlds*, such as in the workplace. The current COVID-19 pandemic has pushed many firms and individuals to switch from a predominantly physical to a potentially temporary digital world. While this situation has pushed the use of digital means and forced individuals to learn quickly about useful rules and routines in the digital world, a new challenge emerges: How, instead of choosing between digital and physical, we can combine the advantages of both worlds. Last but not least, thus far, we notice many articles and initiatives that focus on responding to the threats and leveraging the opportunities provided by one particular digital technology. With the further development and increasing diffusion of *multiple digital technologies simultaneously*, the implications for the interactions of multiple connected digital technologies provide an interesting field for future research. Supported by the display of the far-reaching implications of the diffusion of digital technologies for all management functions and beyond, this call particularly addresses *inter-disciplinary perspectives* that incorporate disciplines, such as ethics and legal besides management and information systems.

5 | CONCLUSION

This paper's discussion reveals the ubiquity not only of digital technologies in everybody's business and personal life but also in the managerial themes affected. The objective of this work was to combine practical and research views on what is known and what are the remaining challenges and research directions when it comes to digital transformation. By combining the insights from interviews with CDOs and other senior managers in 2017 with a systematic literature review of digital technologies and their impact on business and management (2010–2020), we have identified (1) what are the practical challenges that were addressed by the literature (i.e., *what digital transformation entails; how to organize and approach digital transformation endeavors; and inter-firm collaboration practices*); (2) challenges identified by management in 2017 that require further attention from researchers (i.e., *measurement of success and performance of digital transformation initiatives; the overview of skills required for digital transformation; and formats and organizations to ensure their successful delivery over time and the social impact of digital technologies*); and (3) emerging research avenues, such as *the roles that technologies will take in the future; new forms of organization and corresponding regulation at a global scale; interaction between physical and digital environments; and inter-disciplinary perspectives of investigating how different technologies interact and incorporating ethics and legal views*. The avenues that we suggest mirror the interdisciplinary nature of the transformation and emphasize the need to investigate them from different academic points of view.

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research centres on the strategic implications of digital technologies on business and society.

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APPENDIX A: SUMMARY OF INTERVIEW FINDINGS

Theme	Challenges	Extraction of supporting quotes
(A) Awareness and understanding of the increasingly digital environment	Need to clarify what digital entails	<ul style="list-style-type: none"> - “The term digital is rather washed-out. It is a synonym for many terms and only a few people can tell you what it means.” (I3) - “Digitization ranges from gluing technologies together to designing new business models so that new markets can be created using digital technology.” (I6) - “I distinguish between automation and digitalization. For example, if we implement fraud prevention in our insurance business, that is automation – you can automate detection, use mathematical correlations, and estimate the probability of fraud. But this is also something I can use to develop a product for the customer. I can generate new workflows – there are many opportunities – and this is digitalization.” (I3)
	Digital transformation as a continuous process involving all levels of the firm	<ul style="list-style-type: none"> - “I like to call it the digital revolution, because that is what it actually is. It changes all aspects of society... it changes everything. Digital transformation means changing oneself both outside and inside.” (I2)

(Continues)

Theme	Challenges	Extraction of supporting quotes
		<ul style="list-style-type: none"> - “I see many presentations on digital transformation that deal with Uber or Airbnb. And do not get me wrong, I'm fascinated by what those firms do, because they have changed how we live and how we work. But there is no transformation. All of them were built on a green field.” (I1) - “Digitalization is basically a momentum of permanent change that will never stop.... It will never again feel as in earlier times when we still had phones with dial plates.” (I2) - “There is an analogous part, there is a cultural part, and there is a technological part. Digital might be the engine that has an impact on these three dimensions, but it is not the transformation itself. And everybody in this company, from the president to the board to all the employees, understands that we are in a difficult competitive situation. And everybody understands that digitalization means efficiency potential, staff reductions, and savings. Additionally, people are aware that we can build new business with it, but business that are more uncertain....” (I3)
<p>(B) Responding to the increasingly digital environment and managing digital transformation</p>	<p>Need for a clear and customized digital strategy and related transformation agenda</p> <p>Need to ensure tangible outputs and to drive implementation</p> <p>Need for effective coordination mechanisms for stakeholder alignment and decision-making and inter-organizational collaboration</p>	<ul style="list-style-type: none"> - “Customized transformation means finding those methods and tools that fit the company and that enable the company to make the transformative moves that fit and need to be done.” (I3) - “In the construction industry, we mostly focus on digital worksite management, but we need to focus more on how the value of buildings can be improved.” (I6) - “It is all about developing new business fields; not only by building on today's core business areas, but also by building completely outside today's key business areas.” (I4) - “It is all about developing new business fields; not only by building on today's core business areas but also by building completely outside today's key business areas.” (I4) - “For a large incumbent, such a change is a major challenge. You need a disruptive target that you can reach with multiple iterations. That is completely different from stating that you have an established core that you expand iteratively.” (I3) - “We started with the support from the CEO directly, so it was top-down initially but the program was organized in a bottom-up way with seed financing only.” (I6) - “Steering committees are springing up like mushrooms.... suddenly, you have to involve the entire company.... We have so many interfaces within and beyond all

(Continues)

Theme	Challenges	Extraction of supporting quotes
		<p>types of company boundaries to which we have to go. That does not work anymore....” (I1)</p> <p>- “Digital is a topic that can only work across disciplines. None of the models that I develop works just in silos 1, 2, or 3. I always have all of them involved to some extent. I orchestrate all of this. I observe the imbalance in terms of culture and strategy between different areas of the company. And that makes my work so interesting and challenging – a key component is to moderate and orchestrate all of this to make it happen.” (I3)</p> <p>- “... digital projects across different organizations to challenge the barriers between different actors. We are facilitators that drive digitalization with our members and share their knowledge of the maritime industry.” (I5)</p> <p>- “... more and more models of inter-firm cooperation and sharing. The question of revenue sharing is always key in this respect.... The topic of coopetition is becoming increasingly important.” (I3)</p>
(C) Changing work and collaboration	<p>Need for decision makers and employees to acquire digital literacy</p> <p>Emergence of new team composition and collaboration dynamics</p>	<p>- “I have realized that my role is a lot about building our board members’ knowledge of digital technologies. They are brilliant at managing our core business; incredibly intelligent people... but I found that they have very limited knowledge of the opportunities and the changes that the digital provides. And, this is not just about knowledge; it is also a bit about attitude.” (I4)</p> <p>- “... need to develop a much stronger sense of data economics. We need the technology to execute this. It also requires skilled professionals, such as data scientists or data engineers, to drive this.” (I3)</p> <p>- “We started by bringing key people into the new product development (software development specialists, digital marketing). We also did a couple of acquisitions to introduce new talent. My concern is that we bring them to our classical (stage gate) way of working, while they come from a totally different environment.” (I6)</p> <p>- “We have many amazing young people here. It is a young team, a very young team. The average age is around the mid-twenties, early thirties. I am by far the oldest – but that is how we want it to be. My deputy is 17 years younger than I am; he is in his early thirties and he has the same rights and responsibilities as I do.” (I2)</p>

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Theme	Challenges	Extraction of supporting quotes
	Perceived responsibility, awareness, and helplessness regarding digital technologies' social impact	<ul style="list-style-type: none"><li data-bbox="1061 184 1412 409">- "What is our social responsibility?... What does our technology do to society? The people – most of whom are academics, well-qualified, and educated, with a lot of experience – none of them did anything wrong, but in the end of the day... well, it will affect many people everywhere." (I1)<li data-bbox="1061 415 1428 661">- "What are we supposed to do with all these people? That is a topic that bothers me, that worries me a lot.... All of these technological developments will most certainly emerge, but nobody has thus far been able to provide an answer to the question of what we should do with all these people? And I do not have an answer either." (I2)

APPENDIX B: RESULTS OF THE SYSTEMATIC LITERATURE REVIEW

Technology	Demystifying the potential of digital technologies	Managing the transformation	Implications for strategy and business models	Implications for customers and marketing	Implications for management, organization, and governance	Implications for employees and leadership
Artificial intelligence, big data, Internet of Things	<p>Technology-specific potential:</p> <p>- AI: Brock & von Wangenheim, 2019; Gerbert & Spira, 2019; Iansiti & Lakhani, 2020; Tarafadar et al., 2019; Watson, 2017</p> <p>- Big Data (Analytics): Barton & Court, 2012; Barton & Court, 2013; Hagiu & Wright, 2020</p> <p>- IoT: Gandhi & Gervet, 2016; Porter & Heppelmann, 2014, 2015</p>	<p>Technology adoption:</p> <p>- AI: Davenport & Davenport & Ronanki, 2018; Fountaine et al., 2019</p> <p>Successful navigation:</p> <p>- Big Data (Analytics): Barton & Court, 2012; Vaia et al., 2012; Wixom et al., 2013</p> <p>- AI: Iansiti & Lakhani, 2014, 2020; Waller, 2019</p>	<p>Business models for the digital era:</p> <p>- AI: Bughin, 2018a; Garbuo & Lin, 2019</p> <p>Big Data (Analytics): Gruel & Piller, 2016</p> <p>Strategies for the digital era:</p> <p>- AI: Luca et al., 2016; Reeves et al., 2015</p> <p>Strategies with and for data:</p> <p>- Big data (Analytics): Alfaro et al., 2019; Anand et al., 2016; Dallemule & Davenport, 2017; Davenport, 2013, 2014; Herterich et al., 2016; Krämer et al., 2019; Najjar & Kettinger, 2013; Parmar et al., 2014; Piccoli & Pigni, 2013; Pigni et al., 2016; Ross et al., 2013; Short & Todd, 2017; Watson et al., 2010; Wixom & Ross, 2017</p>	<p>Leverage data and analytics, AI for marketing:</p> <p>- AI: Kumar et al., 2019; Overgoor et al., 2019; Urban et al., 2020</p> <p>- Big data (analytics): John et al., 2018; Nichols, 2013; Robert, 2015</p> <p>- AI: Dawar & Bendle, 2018; Latinovic & Chatterjee, 2019</p> <p>Improving customer experience, customer engagement: customer journeys:</p> <p>- Big data (analytics): Müller et al., 2016; Thaler & Tucker, 2013</p> <p>- IoT: Agarwal & Weill, 2012; Ives et al., 2016</p>	<p>Organization, governance, and regulation:</p> <p>- AI: Howard, 2019</p> <p>- Big data (Analytics): Tallon et al., 2013</p> <p>Management:</p> <p>- AI: Daugherty et al., 2019; Metcalf et al., 2019; Friedland, 2019; Shrestha et al., 2019</p> <p>- Big data (Analytics): Bowers et al., 2017; Chai & Shih, 2017; Chen et al., 2017; Cross et al., 2019; Martin & Golsby-Smith, 2017; Redman, 2013; Sanders, 2016</p> <p>- IoT: Bilgeri et al., 2019; Davenport & Snabe, 2011</p> <p>Privacy, security, and ethics:</p> <p>- AI: Carmon et al., 2020; Martin, 2019; Parmar & Freeman, 2016</p> <p>Big data (Analytics): Martin, 2015</p> <p>- IoT: O'Leary, 2013</p> <p>IT leadership:</p> <p>- Big data (Analytics): Lee et al., 2014</p>	<p>Skills, capabilities, and learning:</p> <p>- AI: Agrawal et al., 2017; Beane, 2019; Daugherty et al., 2019; Davenport & Kirby, 2016; Huang, Siegel et al., 2019; Waytz, 2019; Wilson, Daugherty, & Bianzino, 2017</p> <p>- Big data (Analytics): Brady et al., 2017; McAfee & Brynjolfsson, 2012</p> <p>Collaboration with technologies: Daugherty et al., 2019; Davenport & Kirby, 2015; Malone, 2018; Wilson & Daugherty, 2018; Wilson & Daugherty, 2019</p> <p>Changing HR practices: - Big data (Analytics): Baesens et al., 2017; Barro & Davenport, 2019; Buckingham, 2012; Davenport & Patil, 2012; Harris & Mehrotra, 2014; Philpot & Monahan, 2017; Tambe et al., 2019</p>

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Technology	Demystifying the potential of digital technologies	Managing the transformation	Implications for strategy and business models	Implications for customers and marketing	Implications for management, organization, and governance	Implications for employees and leadership
Blockchain	Technology-specific potential: Felin & Lakhani, 2018; Pedersen et al., 2019; Tapscott & Tapscott, 2017	Technology adoption: lansiti & Lakhani, 2017a	Strategies with and for data: Dutra et al., 2018; Jensen et al., 2019		Organization, governance, and regulation: Gozman et al., 2020; Lacity, 2018; Rieger et al., 2019; Schmeiss et al., 2019; Zavolokina et al., 2020 Management: Mattke et al., 2019	
Mobile and collaboration technologies	Technology-specific potential: - Mobile: Siggelkow & Terwiesch, 2019; Stieglitz & Brockmann, 2012			Changing modes and means of communication: - Mobile: Gupta, 2013; Piccoli & Ott, 2014 Improving customer experience, customer engagement, customer journeys: - Mobile: Siggelkow & Terwiesch, 2019 - Collaboration: Nili et al., 2019	Management: - Mobile: Mayer et al., 2012 - Collaboration: Chan, Krishnamurthy, & Desjardins, 2020 Organization and regulation: - Collaboration: Aggarwal et al., 2011	Work design implications: - Mobile: Dery & McCormick, 2012; Johnson, 2019; Johns & Gratton, 2013; Hill & Bartol, 2018; Russo et al., 2018; Sarker et al., 2012; Solis, 2019; Steelman et al., 2016; Pitt et al., 2011; van Heck et al., 2012) - Collaboration: Magni & Maruping, 2019; Leonardi & Neeley, 2017 Changing HR practices - Collaboration: Bersin & Chamorro-Premuzic, 2019; Leidner et al., 2010
Social media	Technology-specific potential: Kane, 2015		Business models for the digital era: Mandviwalla & Watson, 2014	Marketing and brand awareness: Barwise & Meehan, 2010; Cervellon & Lirio, 2017; Heath et al., 2013; Hofman & Fodor, 2018; Holt, 2016; John et al., 2017; Mount & Martinez, 2014; Sashittal et al., 2014 Changing modes and means of communication:	Organization, governance, and regulation: Orozco, 2016 Management: Deans, 2011; Jarvenpaa & Tuunainen, 2013; Roberts & Piller IT Leadership Deans, 2011	Work design implications: Gaines-Ross, 2013

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Technology	Demystifying the potential of digital technologies	Managing the transformation	Implications for strategy and business models	Implications for customers and marketing	Implications for management, organization, and governance	Implications for employees and leadership
Platform	Platforms and ecosystems: Edelman, 2015; Edelman & Geradin, 2016; Hagiu & Altman, 2017; Hagiu & Rothman, 2016; Hagiu & Wright, 2013; Iansiti & Lakhani, 2017; Klee, 2018; Sampier, 2018; Suarez & Kirtley, 2012; Van Alstyne et al., 2016; Zhu & Iansiti, 2019 Sharing economy business models: Chasin et al., 2018; Constantiou et al., 2017; Frey et al., 2019; Mocker & Fonstad, 2017; Tan et al., 2017; Tauscher & Kietzmann, 2017; Zhang et al., 2018; Zhu & Furr, 2016	Organizational, governance, and regulation: Gino & Staats, 2012; Petriglieri et al., 2018 Management: Benbya & Leidner, 2018	Work design implications: Bhappu & Schultze, 2018	Malhotra & Malhotra, 2016; Malhotra et al., 2012; Shore et al., 2018 Improving customer experience, customer engagement, customer journeys: Dong & Zhang, 2016; Kumar & Rajan, 2012; Ransbotham & Gallaugh, 2010	Collaborating with technologies: - Robotics: Frick, 2015 Skills, capabilities, and learning:	
Others: additive manufacturing, augmented reality, cloud, robotics, others	Technology-specific potential: - Additive manufacturing: Ben-Ner & Siemsen, 2017; Bonnín	Technology adoption: - Robotics: Hallikainen et al., 2018; Lacity & Willcocks, 2016b	Platforms and ecosystems: - Additive manufacturing: D'Aveni, 2017	Changing modes and means of communication:	Management: - Additive manufacturing: Sodhi & Tang, 2017 Privacy, security, and ethics:	(Continues)

Technology	Demystifying the potential of digital technologies	Managing the transformation	Implications for strategy and business models	Implications for customers and marketing	Implications for management, organization, and governance	Implications for employees and leadership
	<p>Roca et al., 2017; D'Aveni, 2015, 2018</p> <p>- Augmented reality: Morvan et al., 2020; Nevo et al., 2011; Porter & Heppelmann, 2017</p> <p>McAfee, 2011; Lacity & Reynolds, 2014</p> <p>- Robotics: Lacity & Willcocks, 2016a</p>	<p>Business models for the digital era: - Additive manufacturing: D'Aveni, 2018; Garmulewicz et al., 2018</p> <p>- Cloud: Xiao & Hedman, 2019</p> <p>- Others: Bell et al., 2012; Wang & Ren, 2012</p>	<p>Marketing and brand awareness: De et al., 2018; Lewnes & Keller, 2019; Edelman, 2010</p> <p>Improving customer experience, customer engagement, customer journeys: Edelman, 2015</p>	<p>Organization, governance, and regulation: Levallet & Chan, 2018; Svahn et al., 2017</p> <p>Management: Downes & Nunes, 2013</p> <p>Privacy, security, and ethics: Greenaway & Chan, 2013</p> <p>IT leadership: Brynjolfsson & McAfee, 2012; Colony, 2018; Kohli & Johnson, 2011; Peppard, 2010; Peppard et al., 2011; Reck & Fliaster, 2019; Singh & Hess, 2017; Spitze & Lee, 2012; Thatchar et al., 2011; Tumbas, Berente, & vom Brocke, 2017; Wade & Obwegeser, 2019; Weill & Woerner, 2013</p>	<p>Others: Esteves et al., 2017; Huang, Rust, et al., 2019; Madnick, 2020; McLaughlin & Gogan, 2018; Rothrock et al., 2018; Upton & Creese, 2014; Winnefeld et al., 2015</p>	<p>Others: Latham & Humberd, 2018; Petter et al., 2018</p>
Digital technologies in general	<p>The potential of digital technologies in general: Andriole, 2017; Bogers et al., 2018; Brynjolfsson & Collis, 2019; Brynjolfsson & McAfee, 2012; Furr & Shipilov, 2019; McGrath, 2020</p>	<p>Transformation process: El Sawy, Kraemmergaard, Amsinck, & Lerbech Vinther, 2016; Gurbaxani & Dunkle, 2019; Hansen et al., 2011; Leonardi, 2020; Matt et al., 2016; Smith & Watson, 2019; Weill & Woerner, 2018; Westerman et al., 2014</p> <p>Successful navigation: Bughin & van Zeebroeck, 2017; Furr & Snow, 2015; Ibarra, 2019; Mockler et al., 2014; Rigby, 2011, 2014; Sebastian et al., 2017</p> <p>Venkatraman, 2019; Winkler & Kettunen, 2018</p>	<p>Strategies for the digital era: Grover et al., 2018; Hansen & Kien, 2015; Ross et al., 2017; Sia et al., 2016; Wessel et al., 2016</p> <p>Business models for the digital era: Bryce et al., 2011; Hansen & Kien, 2015; Kavadias et al., 2016; McGrath, 2020; Ross et al., 2019; Tan et al., 2017</p> <p>Platforms and ecosystems: Adner & Kapoor, 2016; Furr et al., 2016; Jacobides, 2019; Li et al., 2018; Reeves et al., 2019</p>	<p>Marketing and brand awareness: De et al., 2018; Lewnes & Keller, 2019; Edelman, 2010</p> <p>Improving customer experience, customer engagement, customer journeys: Edelman, 2015</p>	<p>Organization, governance, and regulation: Levallet & Chan, 2018; Svahn et al., 2017</p> <p>Management: Downes & Nunes, 2013</p> <p>Privacy, security, and ethics: Greenaway & Chan, 2013</p> <p>IT leadership: Brynjolfsson & McAfee, 2012; Colony, 2018; Kohli & Johnson, 2011; Peppard, 2010; Peppard et al., 2011; Reck & Fliaster, 2019; Singh & Hess, 2017; Spitze & Lee, 2012; Thatchar et al., 2011; Tumbas, Berente, & vom Brocke, 2017; Wade & Obwegeser, 2019; Weill & Woerner, 2013</p>	<p>Skills, capabilities, and learning: Del Sol & Joyce, 2020; Horn, 2020; Lyons, 2017; Sahni et al., 2017; Marion et al., 2020</p> <p>Work design implications: Bernstein & Weber, 2019; Dery et al., 2017; Eden et al., 2019; Eckhardt et al., 2019</p> <p>Collaboration with technologies: Brynjolfsson & McAfee, 2012</p> <p>Changing HR practices: Kane et al., 2017</p>