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Digital Transformation of Industrial Organizations: Toward an Integrated Framework

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ABSTRACT

Industrial organizations are responding to new risks and opportunities originating from exponentially growing and disruptive digital technologies, by taking company-wide digital transformation initiatives. However, the key enablers of such digital transformation initiatives that facilitate operational performance outcomes in industrial organizations demand further investigation. Therefore, drawing on the sociotechnical system theory (STS), the objective of this study is to explore the digital transformation enablers and their impact on performance outcomes. Research data was collected from four leading industrial organizations that engaged in digital transformation programmes. Our results indicate that leadership, structures, and culture are the key enablers of digital transformation that help industrial organizations to achieve performance outcomes (i.e. collaboration, customer-centricity, and agility). By providing an empirically grounded integrated framework with future research propositions, this study contributes to the existing literature on digital transformation and sociotechnical system theory.

MAD statement

This article aims to make a difference by exploring industrial digital transformation in order to identify the key enablers and performance outcomes. We highlight the need for alignment and joint optimization of social and technical systems to effectively capitalize on the digital transformation initiatives. Moreover, we call for urgent attention to the development of leaders, as well as the further identification of supportive digital transformation leadership competencies. Competent leaders assume a central role in correcting outdated and invalid assumptions, conceptualizing new ideas, and reinforcing cultural values. Furthermore, we elaborate the necessity of cultural transformation in industrial organizations for impactful digital transformation. Lastly, our findings confirm the significance of organizational structure in digital transformation and simultaneously warn that too little is happening.

KEYWORDS

Digital transformation (DT); industrial organizations; leadership; culture; structure; sociotechnical system theory (STS)

Introduction

Industrial organizations are experiencing the transformative impact of digital technologies (Chanas & Hess, 2016; Porter & Heppelmann, 2015); meanwhile, little conceptual and empirical research has examined how industrial organizations are digitally transformed (Ivančić et al., 2019; Warner & Wäger, 2019). Digital transformation employs a combination of advanced digital technologies (technical systems) and organizational practices (social system) to enable major business improvements – better products and services, a competitive advantage, enhanced customer experiences, business model innovation, and new business processes (Autio et al., 2018; Ivančić et al., 2019; Niemi et al., 2021; Singh & Hess, 2017; Vial, 2019). In response to the potential of these positive business outcomes (Ivančić et al., 2019), digital transformation has become a strategic imperative on industrial organizations' agenda (Vial, 2019).

Digital transformation has not only affected the product and service offerings of industrial organizations but has also changed the way they operate (Vial, 2019) and, therefore, requires a company-wide transformation programme – the digital transformation of organizations. The relationship between technology implementation and organizational transformation is not new in the literature (Mumford, 2006). Trist and Bamforth (1951) studied how the interconnected nature of implementing new technologies affects organizations, which led to the emergence of sociotechnical system theory (STS). The STS theory considers both the technical and social factors affecting change within an organization (Cherns, 1976; Davis et al., 2014). Similarly, the concept of digital transformation can be divided into two main categories: technical systems (advanced digital technologies such as cloud computing, internet of things, digital platforms, big data, and analytics) (Gilchrist, 2016) and social systems (people, culture, goals, procedures, and structures) (Davis et al., 2014). Moreover, organizations are considered complex systems that consist of interdependent components (Davis et al., 2014); hence, designing a change for one system (implementation of digital technologies) without considering its effects on other parts of an organization (the social system) will limit its effectiveness (Hendrick, 1997). Therefore, we posit that the STS theory is a powerful lens for examining the digital transformation of industrial organizations, at a time when the expanding influence of digital technologies is disrupting business operations.

Most recent studies have focused on the technological aspects of digital transformation (Henriette et al., 2015; Porter & Heppelmann, 2015; Sony & Naik, 2020), while others have highlighted the need for organizational changes (Duerr et al., 2017; Gehrke et al., 2015; Matt et al., 2015) to accomplish digital transformation. In addition, there are calls to extend the application of STS theory to a wider range of complex problems (e.g. Davis et al., 2014; Sony & Naik, 2020; Verhoef et al., 2019), such as the challenges posed by digital transformation of industrial organizations. Additionally, Matt et al. (2015) have also called for empirical research to test four dimensions (the use of technologies, changes in value creation, structural changes, and financial aspects) to discover commonalities or differences in organizations' digital transformation strategies. Prior literature remains insufficient for explaining the complex phenomenon of digital transformation in industrial organizations (Ivančić et al., 2019), which highlights the utility of applying the sociotechnical embedded paradigm (optimization of social and technical systems).

Although the digital transformation concept has been adopted broadly and our knowledge of digital practices has grown considerably over the past decade (Sony & Naik, 2020; Vial, 2019; Warner & Wäger, 2019), prior literature fails to provide a comprehensive understanding of organizational change (in terms of digital transformation) by offering an integrative perspective. Therefore, a holistic understanding of such a transition towards digital transformation is required to produce clear guidelines for both research and practice in organizational change management. Our literature review revealed the existing fragmented research on digital transformation; we learned that the seminal literature is missing a multiple case study (Sony & Naik, 2020) that explores the key enablers of digital transformation progression in a contemporary setting. Therefore, our study aims to identify and explore digital transformation enablers and performance outcomes by providing an integrative research framework for digital transformation in industrial organizations.

Digital Transformations

Digital transformation has emerged as an important phenomenon for researchers (Bharadwaj et al., 2013) and practitioners (Fitzgerald et al., 2013). This is revolutionizing the way industrial organizations operate through the use of digital technologies (Parida et al., 2019), which is leading organizations toward a new era of industrialization, known as Industry 4.0. Thus, organizations have been forced to alter the value creation paths on which they have relied in the past to remain competitive by introducing a variety of digital technologies (Vial, 2019). These digital technologies include but not limited to the industrial internet of things (IIoT), cloud computing, advanced algorithms, artificial intelligence, hyper-connectivity, self-learning systems, automation, big data and analytics (Gilchrist, 2016). Organizations are now finding new ways to operate with the help of these technologies by devising strategies that embrace the implications of digital transformation and drive better operational performance (Hesse, 2018). These digital technologies are just a small part of the digital transformation of organizations (Vial, 2019), while it requires more effort by organizations to actually digitally transform themselves.

Researchers and practitioners use both terminologies, i.e. digital transformation and digitalization, when referring to the same phenomenon; however, some researchers have tried to differentiate the meaning of both terms (Bockschecker et al., 2018). Both terms are derived from digitization, which is the technological transformation of analogue information into a digital format (Da Silva Freitas Junior et al., 2016). Parida et al. (2019, p. 12) defined digitalization as the 'use of digital technologies to innovate a business model and provide new revenue streams and value-producing opportunities in industrial ecosystems.' Hinings et al. (2018, p. 53) defined digital transformation as follows: 'By digital transformation we mean the combined effects of several digital innovations bringing about novel actors (and actor constellations), structures, practices, values, and beliefs that change, threaten, replace or complement existing rules of the game within organisations, ecosystems, industries or fields.' Moreover, (Vial, 2019) defined digital transformation as 'a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies.' These definitions show that the term 'digitalization' is used for business models, along with product and service digital features, while 'digital

transformation' is a more holistic concept that covers the changes needed in the organization itself to be compatible with digitalization. Since the focus of our research is towards the organizational changes, we use the term 'digital transformation' in this article.

In recent years, scholars have explored the most important aspects of the digital transformation of organizations on a generic or conceptual level. Matt et al. (2015) highlighted the four most important dimensions of digital transformation strategy, i.e. the use of technologies, changes in value creation, structural changes and financial aspects. They argued that the alignment of these four dimensions lead organizations toward a holistic framework that can result in the formulation of a digital transformation strategy for organizations. Empirical study by Chaniyas and Hess (2016) suggests that organizations need to develop separate digital transformation units to create governance and collaboration mechanisms, which can help in developing successful digital transformation strategies. However, the focus of their study remained narrow, i.e. how digital transformation strategies have emerged in incumbent organizations. Gehrke et al. (2016) listed nine main challenges that organizations face in their digital transformation. These challenges include a lack of tools, methods and concepts for process digitization; unclear migration scenarios; a lack of structure and direction for the management of transformation; organizational structure; a lack of collaboration and cooperation; time and budget constraints; low awareness; an unsupportive culture and a lack of competencies. They argued that digital transformation involves overcoming these challenges. Moreover, the literature has addressed the links between digital transformation and business model innovation (Parida et al., 2019), digital innovation (Hinings et al., 2018), and building dynamic capabilities for digital transformation (Warner & Wäger, 2019; Yeow et al., 2018). Most of these studies are conceptual or remained to the literature reviews, which raises the need of empirical study that what actually industrial organizations are going through in their digital transformation journey.

Digital Transformation and Sociotechnical System Theory

Since digital transformation is powered by advanced digital and hyper-connected technologies, it requires a reconsideration of human-technology interaction within an organization (Mitki et al., 2019). Therefore, digital transformation is considered a sociotechnical process that includes social and technical aspects that interact to achieve a common goal (Sony & Naik, 2020). The literature has addressed the relationship between technology and organizational transformation through several theories: sociomaterial theory (Leonardi, 2013), actor-network theory (Callon, 1999), structuration theory (Giddens, 1979), and technology affordances (Gibson, 1979). For example, sociomaterial theory refers technologies as group's localized experiences (Leonardi, 2012) as it argues that the material and social are inseparable; therefore, the distinction between technologies and humans is not acceptable (Orlikowski & Scott, 2008). Structuration theory lacks a consistent structuration account of technology (Jones & Karsten, 2008) and addresses very little about technology-led change. Likewise, technology affordances approach is limited to action potential of a technology, i.e. what people or organizations can do with a particular technology in order to achieve their goals (Majchrzak & Markus, 2012). However, digital transformation requires a holistic approach that can address organization as a whole in order to implement technology-driven change. Therefore, sociotechnical theory is considered

to be a comprehensive theoretical stance to studying digital transformation (Mitki et al., 2019; Trist & Bamforth, 1951).

STS thinking emerged in 1951 when the UK Tavistock Institute discovered the inter-related nature of technology and social aspects of work while studying the introduction of coal-mining machinery (Trist & Bamforth, 1951). STS theory requires consideration of both technical and social factors when promoting change within an organization (Cherns, 1976); it considers an organization a complex system comprising many interdependent components. Thus, designing change in one segment of this system requires changes in other segments to enhance the effectiveness of this change (Hendrick, 1997). Moreover, STS theory provides a holistic overview of organizational transformation triggered by technological changes, covering organizational structure (Mumford, 2000), organizational culture (Pasmore et al., 2019), and skills and competencies requirements (Sony & Naik, 2020).

The principles of STS theory have been applied successfully in several key domains, especially concerning new technologies and the redesigning of work within organizations (Davis et al., 2014). Some scholars have reported that most studies on digital transformation focus on the technical aspects of this change (Palazzeschi et al., 2018; Sony & Naik, 2020), while others have called for research on the sociotechnical viewpoints of digital transformation (Avis, 2018; Davies et al., 2017). Thus, we argue that the STS theory provides an ideal foundation for studying the phenomenon of digital transformation in organizational change. This study applies the STS theory to studying digital transformation in industrial organizations.

Method

In this study, we adopted a qualitative approach by conducting a multiple case study to address the research objectives. A case study approach gives good justifications for questions of 'what,' 'how' or 'why' when a certain phenomenon occurs, and for obtaining a first-hand and in-depth understanding (Yin, Clarke, Cotner & Lee, 2006). Moreover, case study investigations are considered appropriate when the research is in the early stages and variables of the research topic need to be defined by employing a holistic vision (Matthews & Ross, 2010). It allows researchers to study practices and situations that are understudied and not yet completely described and comprehended, such as the topic of digital transformation (Ivančić et al., 2019). Therefore, a case study approach was chosen to gain first-hand insights and explore digital transformation processes in incumbent industrial organizations in a holistic manner.

Case Selection

This research is conducted in four global industrial organizations with their headquarters in the Nordic countries. The selection criteria of all case companies were based on methodological expediency. Methodological expediency allows the selection of cases that are unique, easily accessible for researchers and provides the opportunity to study the phenomenon in question (Huberman et al., 2012). All case organizations are hard-core engineering companies and were established during the second industrial revolution or earlier (Imran & Kantola, 2018). They have experienced the necessary

changes from the old way of doing business to the modern requirements of the digital age. Case selection, therefore, focused on companies that have started their digital transformation programmes in the past 5 years and are advocates of digital transformation in their respective business communities. Due to a non-disclosure agreement (NDA), aliases are used for all the case companies. Table 1 summarizes the key details of case organizations.

Data Collection

We relied on in-depth interviews and publicly available documents of case companies (web blogs, interviews, videos, reports, information on websites) to gain insights into the digital transformation programmes for this study. In total, we conducted twelve in-depth interviews with the experienced personnel who directly participated in the digital transformation programmes of their respective organizations. Six out of twelve interviewees were from the top-level management of their organizations. Marshall and Rossman (2011) call such participants ‘interviewing elite.’ These individuals are considered influential, prominent, and well informed, having acquired the status of ‘elite’ through achieving senior positions in their organizations (Delaney, 2007). Such participants can provide valuable information, broader views of organization strategy regarding the phenomenon in question, and future plans of the company (Marshall & Rossman, 2011). On the other hand, the remaining six interviewees were from mid-level management, implementing or coordinating digital transformation strategies in their organizations. Therefore, this study emerges from the knowledge of elites who are devising digital transformation strategies and mid-level managers who are practically implementing these strategies, and both enhance the quality of the data. Moreover, there were six face-to-face and six online interviews. Table 2 provides the designation of each participant, along with the codes used for quotations. We followed a snowball-sampling strategy (Marshall & Rossman, 2014), in which the first informant suggested additional informants and facilitated access within the organization. The interview transcripts comprise more than 197 pages and 950 min of transcribed material. For the transcription of interviews, we used an online platform for converting speech into text. ‘First author’ proofread the transcriptions by listening to each recorded interview.

Table 1. Details of case organizations.

Case	Description
Case A	Renowned player in smart technologies and complete lifecycle solutions for the marine and energy sectors A separate dedicated digital organization was developed by hiring CDO to lead DT in the organization 5,1 Billion Sales in 2019
Case B	Market leader in its field and is a pioneer of variable frequency drives, cooling & heating solutions and energy management Digital transformation responsibilities were dedicated to business segment’s heads 6,3 Billion Sales in 2019
Case C	Very big player in forest, wood, and papers industry. Also expanding their business in energy market Digital transformation responsibilities are dedicated to unit heads. 10,2 Billion Sales in 2019
Case D	Global leader in engineering and service solutions Created new digital innovation unit for digital transformation of itself. 9,9 Billion Sales in 2019

Table 2. Interviewees' designation and codes.

Profile of Interviewees	Code
Vice President (Digital Portfolio Mgt.)	VP
GM Digital Deployment and Support	GM
Director Digital Culture	DDC
Senior Manager Digital Transformation	SMDT
Senior Project Manager Digitalization	SPM
Manager Digital Transformation	MDT
Manager Digital and IT systems	MD
Project Manager	PM
Senior Manager Digitalization	SMD
Global Head of a business unit	GH
Global Business Program Manager	GBM
Vice President, IT Strategy and Governance	VPIT

Data Analysis

We systematically coded and analysed the transcribed data (Gioia et al., 2013). We followed the data analysis technique of Gioia et al. (2013), in which raw data is organized into concepts and thereafter develops themes that facilitate the identification of digital transformation patterns in industrial organizations. We used Nvivo 12 software that facilitated the coding approach and enabled us to keep a record of the emergence of concepts and relationships. Initially, we used an open coding approach where raw data was analysed and categorized (Huberman et al., 2012). In the second round, we grouped all coding into four main themes, i.e. leadership, structures, culture and performance outcomes.

Findings

Digital Transformation

Before we provide details of the enablers and performance outcomes of digital transformation that the analysis identified, it is important to ask and answer: 'What does digital transformation actually mean for the case companies?' Our analysis identified seven different understandings of digital transformation. Approximately 66% of the interviewees mentioned that it is about *customer centricity*. For example, SMDT stated, 'It's basically everything and anything we're looking into digitalizing, or making the customer experience more digital'. SPM added, 'digitalization is actually the realization of transferring all this into real customer perspective.' GM put it, 'It connects us with customers more closely. I think this is the biggest difference.' MDIT mentioned, 'how I see the digitalization is that you start selling something that your customers don't even know that they need.' Similarly, an equal proportion (i.e. 66%) of participants thought that as a business enabler, digital transformation is a *big opportunity* for industrial organizations, in terms of value-generation capacity, value addition, creating new business, enhancing current offerings into digital, better chances of success, and providing more services than products. Moreover, 50% of participants perceive digital transformation as something that facilitates operational efficiency. For example, PM stated, 'It helps in reducing resource waste.' MDT mentioned, 'with digitalization, you can do more with less.' VPIT added, 'It is giving us a different playground. It goes more like agility-based trials, experimentation,

new ways of doing things, new ways of solving problems, and bringing operational efficiency.'

We found that 25% of the participants viewed digital transformation as *cultural change*. MDT stated, 'It's more than tools and processes, it's really about the mindset change.' GM also stated similar views: 'It's a mindset change and cultural change that is happening right now.' MDIT added, 'It's change of culture. We need to be faster and we need to have more services than products.' Two participants mentioned that digital transformation brings *experimentation capabilities* to the incumbent originations. For example, PM stated, 'It allows experimentation; for example, you can develop a digital twin of a product for this purpose, to ensure that product value is deliverable.' An equal number of participants viewed it as something that *integrates* the whole value chain. SPM explained, 'It means integration. It's about integrated solutions and a way of thinking in the life-cycle coverage. It's not about just focusing on individual products but taking care of the whole life cycle.' Moreover, the same number of participants said that it brings *transparency*. DDC elaborated, 'It brings visibility for the managers to see real time what's happening in the organization, what are the bottlenecks, and where are the problems.' GH explained, 'this is a huge opportunity to bring transparency to the whole value chain.' Lastly, one participant also viewed it as *flexibility*. PM said, 'digitalization means flexibility; it does not mean standardization.' Figure 1 summarizes these findings regarding what digital transformation means for industrial organizations and how they view it.

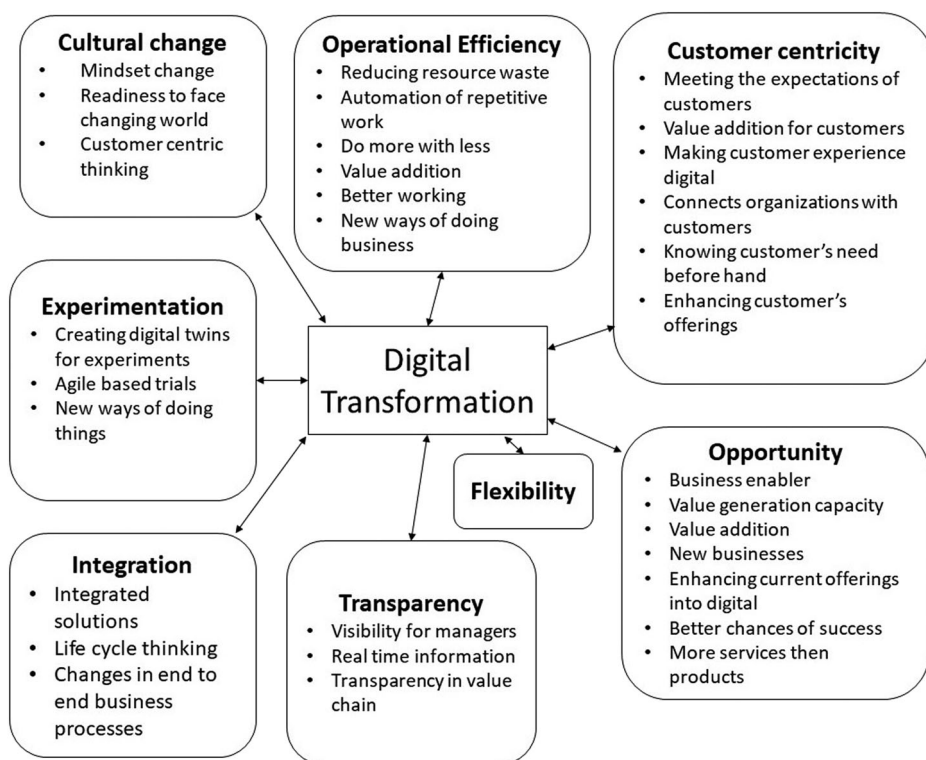


Figure 1. Conceptualization of digital transformation in cases (interview based).

Leadership

Leadership is one of the most important enabler for the successful digital transformation of industrial organizations among our cases. Every company develops its strategy according to its own needs and stage of the digital transformation process, but leadership remains a key enabler. Our data analysis strengthens this notion; incumbent organizations are paying special attention to leadership development for impactful digital transformation. Our data shows two different strategies that the case organizations adopted for this purpose. First, one of the case organizations developed a separate organization that provides digital support to the main businesses. Second, the remaining case organizations have allocated digital transformation tasks to the business/segment heads. However, the commonality between both strategies is that they have allocated digital transformation tasks to the top leadership of their organizations, whether they are working in a separate support organization or as a head of any business segment or function. Moreover, we found that the leadership responsible for digital transformation emerges from both external recruitment and internal allocation of additional responsibility, or even through shuffling from among their main positions to the digital transformation-related positions. For example, VP mentioned, 'to accelerate this digital transformation, our organization has recruited a highly qualified digital leadership team and established a new digital organization with more than 400 existing employees.' On the other hand, SMD explained their strategy by saying, 'we have delegated digital transformation to the function heads. They are responsible for managing required resources to execute digital transformation strategy.'

We identified two main leadership areas on which incumbent organizations are primarily focusing for impactful digital transformation. First, implementing digital transformation requires several work roles of leadership. These include spreading awareness of digital transformation topics, promoting collaboration, driving digital change, driving cultural aspects of digital transformation, leading by example, promoting mentoring/coaching-style leadership, being smart followers, bringing transparency to their actions as well as throughout the organizational value chain, and being value-driven. In order to successfully play these roles, industrial-organizational leadership must work on certain competencies, the second identified leadership area in our study. These competencies include adaptability, the right attitude, communication skills, data-driven decision-making, empowerment, failing fast, experimentation, open-mindedness, risk-taking, trust, surface-level technical knowledge, and vision.

Leadership and Performance Outcomes

Agility: Our results show that leadership has a key role in attaining organizational agility. We found that 50% of the participants gave their views on how leadership can play its role in attaining agility. A few of them related it to the leadership competency of adaptability and flexibility. For example, SMDT stated, 'there is one thing that is key, which is adaptability. You can also call it being agile or being flexible, but adaptability is basically strong change-leadership skills.' SMDT further added, 'It means that there is no more strategic planning or yearly plans, there is no more project linear execution. It's always about being able to adopt the change, based on the new information, changing markets, and

changing situations.’ SMDT also stressed that leadership should come out of the KPI mindset and think for the betterment of the overall organization as a whole. He added, ‘It’s not anymore about my team or my domain, but it could be that you as a leader are operating agile teams and willing to share the resources for innovation projects or specific projects that are not necessarily connected to your tight KPIs.’ VP stated that ‘Job of leadership is to challenge the existing processes of the organization by bringing new and agile ways of working’. GM said that ‘they are using agile ways of working now to manage the services’. MDIT shares similar views: ‘We have the technology available and we can transform or change our processes, make them smart, fast, or agile, but then the biggest role of leadership required here is how they transform the people in order to adopt these changes.’ So, leaders must play new work roles and develop those competencies that this study identifies, in order to make their organization agile for digital transformation.

Customer Centricity: Similarly, our data analysis shows that without the complete commitment of leadership, it is impossible to achieve customer centricity in the organization. We found that 75% of the participants mentioned the role of leadership in attaining customer centricity for impactful digital transformation. The responses of the participants can be categorized into two main streams. The first suggests that leaders should work to provide solutions to their customers and drive value for them. For example, MDT stated, ‘different kinds of things are affecting our customers and their businesses. So, as leaders, we need to be ready to solve those future problems and give them solutions.’ Chief digital officer (CDO) mentioned (in an online interview), ‘my specific responsibilities include cyber security, all of IT, all of the innovation, processes, and capabilities, including working with start-ups and all digital product development. All of that translates into “how do we drive value for customers through digital?”’ He further added, ‘It starts with the leader’s knowledge of products and customers, what they want, and where they’re changing.’ MDIT viewed it as ‘you start selling something that your customers don’t even know that they need.’

The second stream of responses on customer centricity spoke about the leader’s role in co-creation with customers. For example, SMDT stated, ‘leaders should be piloting together with the customers.’ VP added, ‘in innovation, we are trying to be customer-centric. Leaders need to think about how we can involve much more the voice of customers, instead of thinking how to move from an idea all the way to the product.’ PM added, ‘a big challenge for leadership today is to stay technically updated about all new developments happening in the industry. It is also an opportunity to be on the frontline and shaping the future, together with the customers.’ SMDT said, ‘leaders have to involve customers in piloting. It requires leaders to balance the speed of execution with the level of quality needed.’

Collaboration: Furthermore, it is very important for leadership to promote a collaborative environment in the organization for impactful digital transformation. Our data analysis shows that 50% of the interviewees spoke about the role of leadership in promoting collaboration for digital transformation. MDT stated, ‘we are promoting collaboration quite a bit here. We have a lot of hidden knowledge among the people who have been working for us for 20–25 years ... therefore, it is important to make collaborations (between experienced and novel employees) within different kinds of tasks.’ SMDT added, ‘you should know how to coordinate, how to network, and how to pull the

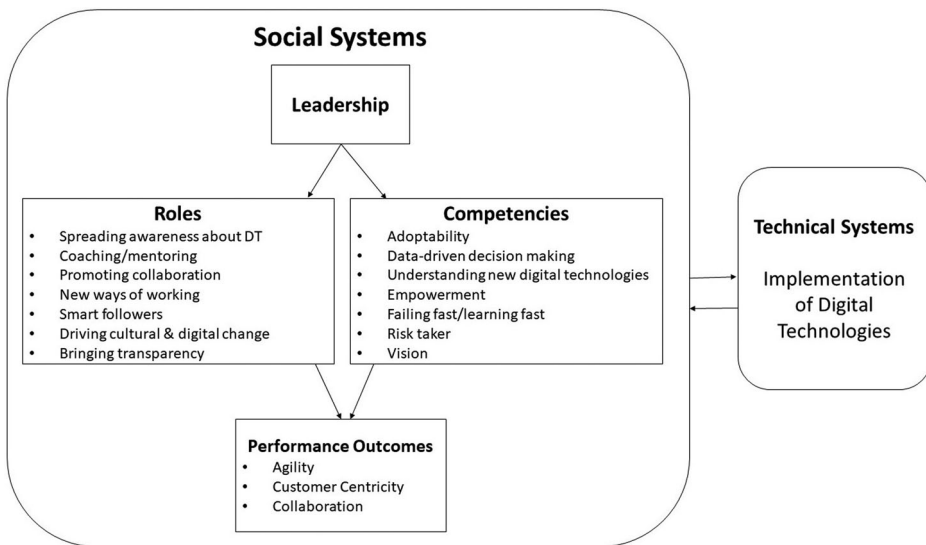


Figure 2. Leadership roles and competencies to achieve performance outcomes.

strings of knowledgeable people and connect them with others.’ He further associated this with the visionary competency that ‘leaders who have this long-term sense of giving direction while, at the same time, having the teams co-develop, create, and innovate within that main vision. And it’s the vision, which doesn’t just look inward to the company but looks to more of an ecosystem view of opportunities.’ SPM mentioned that ‘when it comes to the management, it’s all about connecting people.’ MDIT added, ‘so, basically, the data is available that we can start using, and then we need to put people together, so they are not competing in the wrong way.’ GBPM and SPM had similar views on leaders needing to find the right balance between digital and business people and mixing them well to generate the required results.

Figure 2 summarizes our findings on roles and competencies that leadership requires to achieve performance outcomes.

Structure

Organizational structure emerged as the second enabler of digital transformation of our case companies. A general perception of industrial organizations is that they possess very rigid structures, mainly due to their long, successful history, traditional deep-rooted leadership, and product-oriented approach. We have found this to be true through our data analysis; however, we have also observed new structures popping up in these organizations to implement a digital-transformation agenda. As the previous section discusses, one of the case organizations developed a whole new structure (digital organization) in order to support digital transformation for its business organizations, while the rest of the organizations delegated digital transformation tasks to business/functional heads, who developed new teams to support digital transformation within their businesses or functions. We also learned of some steps taken, when one of the case organizations developed a new organization-level team that stays in contact with all the businesses and

keeps track of their digital-transformation initiatives, providing digital support as well. Thus, incumbent industrial organizations have formed new structures to support digital transformation. However, the extent to which it has impacted the existing structures of the organization is debatable. Our data showed that it has very little impact on the existing formal structures of case organizations, although informal structures arise.

The hierarchy of industrial organizations still consists of long chains. For example, as SPM explained,

If we take the example here of services, we have four team vice presidents (VP), every VP has six-to-eight directors under him with their own management teams, and every director has his own general manager under him, who also has his own management team. So, as an engineer, you can imagine that if you have an idea to run a project, it takes a while to get somewhere.

Similarly, SMDT stated that digital transformation has not yet impacted organizational structure, but it is shaking the informal structures of these organizations. For example, the VP stated, 'I have a team of 35 people; I have instructed all of them to report to one person, and that one person reports to me.' Similarly, GM added, 'we are working on becoming less and less hierarchical all the time, especially for digital transformation. But it goes hand-in-hand with company culture as well.'

As industrial organizations still possess a rigid hierarchy, and formalization is also high in the case organizations. The interviewees understand that they are still very process-oriented organizations. For example, SMD said, '(we are) very much kind of a process-oriented company.' PM explained, 'when we do some project, we have some gate-models, we have decision-making points on how we have to make decisions. When we have to make a decision, it should be based on those points and what the decision should be.' MDIT added, 'within business organizations, it is much more bureaucratic.' While addressing the formalization and hierarchy, SPM said, 'the corporate structure actually defines that you cannot do things without approval. And approval can have several layers. Still, I would say that we, as a company, have quite a good focus on empowering people.' GBPM also shared his views that 'we have globally defined processes and ways of working, but it is more like a framework that managing directors can mold according to their needs.' He further added that 'personally, I like freedom with responsibility ... you take care of this part and I'll take care of that part. How you do it is up to you.' So, our data shows that leaders who are dealing with digital and related topics are more open toward less formalization and promoting a more goal-oriented approach.

Structure and Performance Outcomes

Agility: We found that organizational structures play a key role in attaining organizational agility. Approximately 66% of the interviewees linked the role of organizational structure to attaining organizational agility. In our analysis, we found three main categories of ways that structural changes can bring agility to incumbent organizations. First, a few participants identified the process-oriented approach (formalization) as one of the hurdles in attaining organizational agility. They stressed the need to change that, in order to become agile. For example, MDT stated, 'we are a waterfall company and the way of doing things is very slow. It doesn't respond to the changes as fast as needed for this

transformation.’ SMDT stated that ‘we are looking into how we move from a waterfall model to maybe a hybrid model, if not necessarily agile.’ SMDT further explained the waterfall model as ‘basically very long, rigid. It’s not agile at all ... we must move away from this approach toward agile and iterative ways of doing things.’ Second, VPIT indicated that they are becoming flexible in goal-setting now, to attain organizational agility, which, again, is linked with formalization. He stated, ‘earlier we had yearly goals, but now we have adopted a more agile way than that. So, we can change goals during the year by analyzing the changing environment.’ He further added, ‘earlier, it was a taboo that you could not change yearly goals, but now we are becoming more flexible.’ Third, interviewees linked flexibility in resource sharing and resource allocation as something that can promote organizational agility. DDC explained, ‘we should adopt an agile working environment where we can utilize cross-functional resources. Currently, people are allocated to certain positions by function or organization, and cross-utilization of competencies is not very high.’ MDIT stated that ‘there should be no boundary lines between teams. You should be able to combine people and knowledge from anywhere in the organization into one team. ... The structure should be able to allow that; only then you can be agile.’ She further added, ‘You need to empower such teams (less formalization) and that’s the key.’

Customer Centricity: If we analyse the topic of structures in relation to customer centricity, it ultimately falls under external collaboration or integration topics. In relation to collaboration, the topic of structures addresses both internal and external collaboration. Therefore, we are discussing results related to external collaboration (only customers/ no other stakeholders, e.g. suppliers) in this section. We found that 75% of the interviewees shared views on how their organizations are integrating their customers with their systems and structures, in order to attain customer centricity for digital transformation. One of the case organizations made major structural changes for this purpose. SMDT explained, ‘from January next year, we are reorganizing ourselves in order to be more customer centric ... we understand that customer centricity is one of the principles that digital transformation is bringing.’ VP expressed the same views:

One of the things pushing us to merge now from three divisions to two is around this whole transformation. Because if we want to be customer centric, there is no point in keeping the services and business organizations separate. It is required if you really want to be customer centric and serve the customer throughout the life cycle, as one company.

SPM raised the need to break the silo-oriented approach toward customers and stressed the need for life-cycle thinking when delivering value to the customers. He stated, ‘but the challenge is that we are still silo oriented. People have to focus on the whole package that we have to deliver to the customer.’ This view is also aligned with previous views of VP and SMDT, on organizational restructuring to attain customer centricity. Similarly, the concept of co-creation with customers also requires close collaboration between the organization and its customers. It also raises the need for changes in organizational structures, to integrate customers with the organization. GM explained, ‘we need to open up our landscape toward customers ... it means that we will co-create with customers much more.’ GM further added that ‘if somebody wants to test a new type of doing business or provide new services with the customers, we allocate a separate team for this purpose ... it’s like an initial internal start-up setup.’ CDO shared his views on that, ‘even though we

are focusing on digitalization within the company, the benefits will be reaped by the customers. Co-creation and co-innovation will be a standard process, and the new ways of working will show in everything we do, from sales to manufacturing.'

Collaboration: The topic of collaboration is very much interlinked with the third construct of structures, i.e. integration. All of the respondents shared their views on how structural changes can lead to enhanced collaboration in their respective organizations. The topic of collaboration in relation to structures can be divided into two main categories, i.e. internal collaboration and external collaboration.

Regarding internal collaboration, we have identified three types of collaboration affecting structures. First, case organizations are promoting collaboration between experienced and inexperienced personnel, by bringing them closer to each other on different topics. The purpose of such collaboration is to enhance the knowledge-sharing between them, on which MDT remarked. Second, the new setup of the digital organization works hand-in-hand with business organizations. It is a completely new structure for such industrial organizations, where a newly formed support organization is working closely with the business side, to provide digital competencies, although it has some challenges, such as trust between the business and the digital people, different leadership styles, and lack of understanding between them. GH, GBPM, VP, MDIT, VPIT, and SMDT stated these challenges; however, all of them agree on recruiting external digital experts and mixing them with business experts, to enhance digital transformation. None of them think that only recruiting external digital experts or only training internally for digital competencies is a good idea for digital transformation. VPIT put it, 'our target has been that we always will be together with the business (rather than starting our own business initiatives).' He further stated, 'we work strongly together with the businesses ... because basically the business sets the demand (for digital competencies).' Third, one of the case organizations created a new position, 'senior manager of digitalization,' in order to align different digital initiatives taken by different business segments. The purpose of this new role was to eliminate the silos among the business segments and enhance their collaboration on similar topics of digitalization, mentioned by SMD. He stated, 'so I had the task of taking up this cross-functional role to bring people together and break the silos.' VP also stressed the notion of eliminating the silos by stating that 'we have created acceleration centers where we are pulling people from different parts of the organization to work together ... because everyone tends to work in their silos because of their profit-and-loss responsibilities.' Similarly, GH stated, 'what I see is a more collaborative model, a more cross-functional model, that takes relevant people from different functions together and drives it as an initiative.'

External collaboration consists of collaborating with external stakeholders, such as customers, suppliers, and even the integration of newly acquired companies (digital-native companies that brought new digital competencies to the case organizations). We have already discussed collaboration with customers in the last section on 'customer centrality.' Therefore, in this section, we discuss it with respect to other external stakeholders. We have identified three main streams of external collaboration in relation to structures. First is ecosystem integration. CDO stated that 'ecosystem thinking is looking at the end-to-end value chain and asking 'Where do we play a primary role?'' Second is integration with suppliers. CDO explained, 'our success depends on the partnership and collaboration of our customers and suppliers.' Third, case organizations focused on

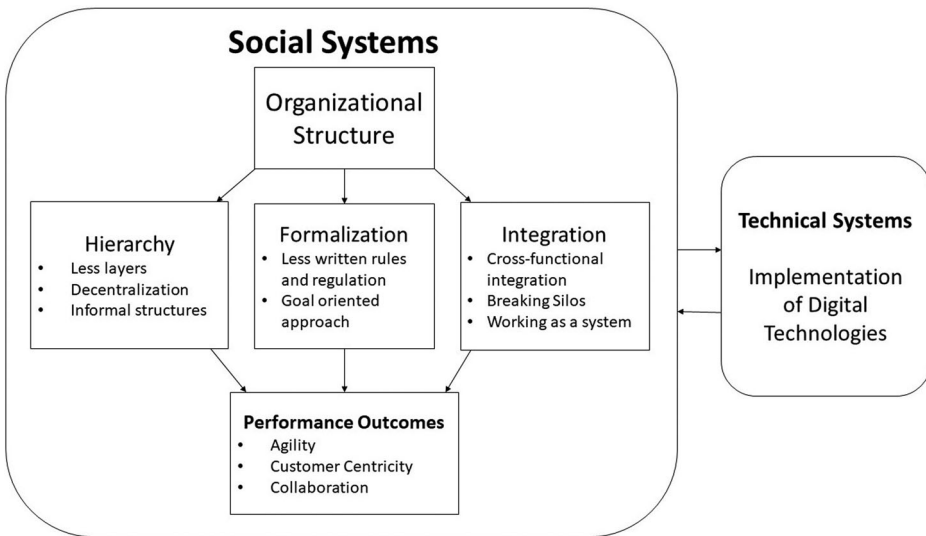


Figure 3. Structural elements to achieve performance outcomes.

acquisitions of ‘digital native companies, e.g. start-ups’ and emerged/collaborated with them to build their digital competencies. SMD explained, ‘we’re looking into partnerships because we don’t think that we can do all of it (digital transformation) ourselves. It’s also an area where we are struggling a bit; we are not that fast at finding partners, but it’s something we need to do more as a partnership and with acquisitions.’ VP stated that ‘we also work with external partners to actually sort of accelerate some of the stuff in the beginning (of digital transformation).’

Figure 3 summarizes identified structural elements to achieve performance outcomes for impactful digital transformation.

Culture

Culture is perceived as third enabler for the digital transformation of industrial organizations. This remains the most-mentioned word by the interviewees and shows the importance of cultural change for digital transformation. The incumbent organization’s digital transformation programmes pay special attention to cultural change. For example, PM stated that ‘it is disrupting our organizational culture.’ Similarly, SDT said, ‘digital transformation has a huge impact on the company’s culture.’ GM stated, ‘the biggest change happening now is cultural change and mindset change.’ Similarly, SPM explained, ‘the main thing is that the culture needs to be changed. It is not the development resources, not the development projects that could be done differently, OK, there are improvements in those as well, but it is the culture that needs to adapt as well.’

We have identified three main constructs of culture about which incumbent organizations are taking steps. First, case organizations are focusing on the development of new values in their systems. These values include bringing agility to actions, openness toward digital transformation, an experimentation culture, failing fast, co-creation and validations with customers, sharing culture, feedback culture, coaching culture, taking ownership,

empowerment, collaborative mindset, support for everyone, promoting innovation, and ecosystem system thinking. Second, the development of new artefacts includes the development of new formal and informal structures, digital learning platforms, digital innovation platforms, utilization of robotic process automation, usage of artificial intelligence, intranets for digital collaboration, learning management systems, internet of things, big data and analytics, digital language, and celebrating failures. Third, we identified some assumptions that case organizations intend to remove for impactful digital transformation. These include that people are afraid of unknown possibilities of digital transformation, digital transformation is a threat to personnel positions or jobs, fear of asking customers, fear of making mistakes, and relying on past success.

Culture and Performance Outcomes

Agility: Initiating agility is one of the key tasks for cultural-change initiatives in incumbent organizations. We found that 83% of participants gave their views on how cultural change can create agility for the case organizations. We identified three different categories that showcase organizations focusing on cultural change to increase agility. First, agility is one of the most important topics of cultural change for digital transformation, as SMDT mentioned. The main reason behind it is that the case organizations had been operating on waterfall-model bases, where things move very slowly. Now because of digital transformation, they are moving toward agility, which requires massive change in their culture, especially the ways of working. For example, MDT stated, 'we need to have speed in our actions in order to answer the expectations of a younger workforce.' He further said, 'agility is one basic change in our way of working, as we have been a waterfall company.' SMDT explained, 'I would say that's the concept of how you work in an agile way. I'm not talking about adopting any specific methodology of agility, but what really are the principles of the agile way of working and being able to adopt them at a certain level that makes sense for your organization is a must.' We also found other participants like VP, CDO (secondary data), GM, and GBPM, who stressed the need for change in ways of working, to attain agility. Second, SPM raised the need for change in management design to attain agility. He said, 'It (challenge) seems to be the design of management. They talk about rapid and agile delivery. The sad thing is that the culture needs to be changed.' Third, GM recommended adopting failing fast and customer-centric thinking as the key to achieving agility. He said, 'so, "fail fast" is one of the slogans ... so try something and if it works, go for it. Otherwise, stop and involve the customer in that.' We also heard similar views from VPIT, who said,

Digital transformation is giving us a different playground that goes more like agile-based trials, which means that you start to try something that would be valuable, and you have to have a new way of doing to get over the business but, then, also be able to cancel and/or reject the initiative if it seems that it is not going to be feasible to implement.

Customer Centricity: Similarly, bringing customer-centric thinking is another key task for cultural change, required for digital transformation. Our data analysis showed that 92% of the participants mentioned how cultural change can help in bringing customer centricity. First, one of the main problems with industrial organizations is that they assume that they already know what the customer's problem is and what the solution should be. It is one of

the biggest assumptions that industrial organizations must correct. They must adopt the customer's validation culture, to be a genuinely customer-centric organization, as MDT said. CDO shared similar views in an online interview: 'This is a digital mindset, the service-design approach, and it's asking, "what are the end needs? Who is the customer and what are their needs?"' SMD stated that in an ideal culture for customer centricity, 'we would be working more from the outside in. We would be working with the customers on creating solutions ... we would have made proofs of concepts and gone out and tested these things with customers.' He further explained, 'customer-centricity would be our way of doing.' Second, VP mentioned that they are trying to promote such a culture, where people do not start any development without involving the customers upfront. He said,

We are trying to promote such sort of mindset that whatever you do, you must involve customer co-creation. Only then we can move from being a product-oriented company to being a service-oriented company ... this is a fundamental shift that we are looking to do with digital transformation.

CDO also shares similar views that 'co-creation and co-innovation will be a standard process, and the new ways of working will show in everything we do, from sales to manufacturing.'

Collaboration: Furthermore, enhancing collaboration among the internal stakeholders, as well as with external stakeholders, is another key objective for cultural-change initiatives in incumbent organizations. We found that all of the participants stressed promoting collaborative culture for digital transformation. We identified five different categories of such collaboration. The first is related to collaboration with customers, already discussed in the last section, in the form of customer validation, customer co-creation, and customer-centric thinking. However, here is one additional point on the usage of digital platforms to bring customers closer to the case organizations. Case organizations are integrating customers' systems with their digital systems, as well as using different digital platforms to enhance this collaboration. Second, case organizations are using different artefacts, such as intranets, innovation applications, and digital-learning applications, to promote collaboration among the internal stakeholders of the organizations. For example, SMDT said, 'most learning happens by doing and sharing and learning from others. So, in that sense, we are promoting it from a learning-culture angle, I think that the collaboration platforms that I mentioned earlier are helping in that way.' Third, the last statement by SMDT also shows that they are promoting a sharing culture in order to bring internal stakeholders closer to each other. Fourth, one of the case organizations has recently developed a physical artefact, i.e. a new campus to which they are bringing all the stakeholders (factory, lab, customers, suppliers, and academia) to co-locate and collaborate on R&D. Fifth, we identified one cultural problem in collaboration between digital people and business people, namely, the usage of technical language. For example, SMDT mentioned,

It is about using language that people understand and relate to, for example we talk about 'agile,' 'RPA,' etc. in digital transformation, and now the questions from people are, 'Hey, what language is this? What does it mean?' There is risk as well in speaking a language that people don't connect with.

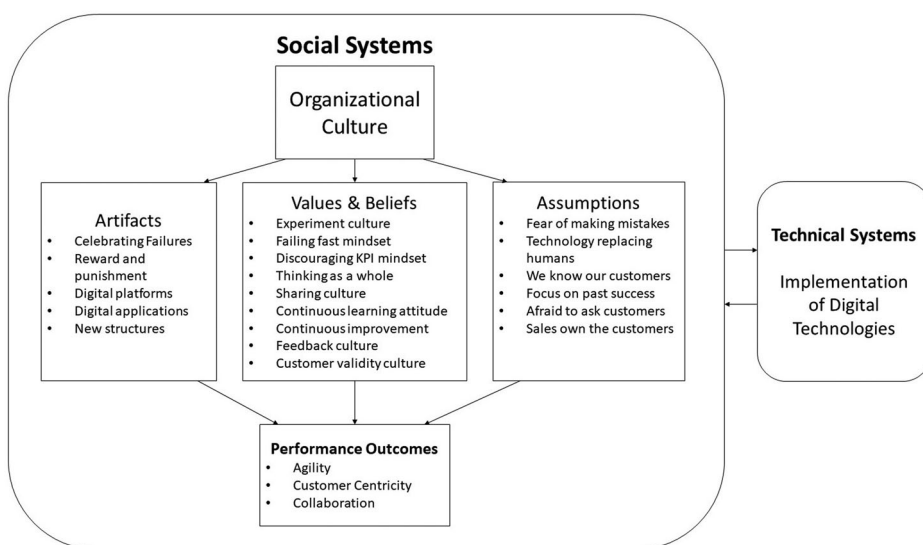


Figure 4. Cultural elements to achieve performance outcomes.

Therefore, it is very important to use a language that is understandable for all. It also requires a leadership role to make such language understandable for all by coaching and mentoring them.

Figure 4 summarizes the key-focus elements of cultural change happening in the incumbent organizations, to achieve performance outcomes.

Discussion

We identified leadership, structure, and culture as the main digital transformation enablers in industrial organizations. According to our analysis, industrial organizations require transformation involving these three enablers to ensure organization-wide impact of digital transformation. The transformation of these three enablers leads industrial organizations toward agility, customer centricity, and collaboration, the main performance outcomes behind a digital transformation of these organizations. We discuss each of these enablers and performance outcomes in following.

We reported that digital transformation often starts with the emerging new work roles of leadership as they devise and implement a digital strategy in incumbent organizations (Haffke et al., 2016; Horlacher et al., 2016). It is a leadership task to ensure that digital technologies are properly leveraged and aligned with the objectives of the organization (Horlacher et al., 2016; Singh & Hess, 2017). Moreover, leaders have to ensure that the right organizational structure and culture (Reck & Fliaster, 2019) exist in their organization to align technical (digital technologies) and social systems (structure and culture) (Mumford, 2000). Furthermore, leadership roles that lead to digital transformation must be filled by leaders with the right set of competencies (Imran et al., 2018), who can align technical and social systems by implementing the required changes (Higgins & Mcal-laster, 2004; Mumford, 2000; Reck & Fliaster, 2019). Our study identified adaptability, the right attitude, communication skills, data-driven decision-making, empowerment, failing

fast, experimentation, open-mindedness, risk-taking, trust, surface-level technical knowledge, and vision as the most important leadership competencies. However, our results show a mix of opinions on whether or not these competencies exist in incumbent organizations' leaders. As our participants are the ones who lead the digital initiatives, they strongly believe that traditional leadership in industrial organizations is lacking most of these competencies. Furthermore, we have identified links that how these emerging work roles and set competencies can help industrial organizations in achieving the performance outcomes. Based on this discussion, we propose the following.

Proposition 1: Developing identified leadership competencies facilitates the digital transformation of industrial organisations and enables them to be more agile, customer-centric, and collaborative.

Our research framework (Figure 5) reveals that organizational structure is another very important enabler that aids and hinders the successful digital transformation of industrial organizations (Gehrke et al., 2016). Since industrial organizations, such as incumbent firms, have a long and successful history in the field of engineering and product development, they have routines and processes that have been well-developed over the decades (centralized structures) (Brown & Magill, 1994; Mumford, 2000) and are very hard to transform. In this preview, organizational structure is one of the most rigid artefacts (Schein, 1985) in industrial organizations, which is very hard to transform. Our analysis shows similar results as most of the interviewees mentioned that the digital transformation projects have not yet affected the traditional organizational structures. However, they understand the importance of structures and the need for change.

Organizational structure has a major impact on the targeted performance outcomes (found in our study) of digital transformation. If we analyse the concepts of agility, customer centricity and collaboration (Earley, 2014; Luokkanen-Rabetino et al., 2017; Smet

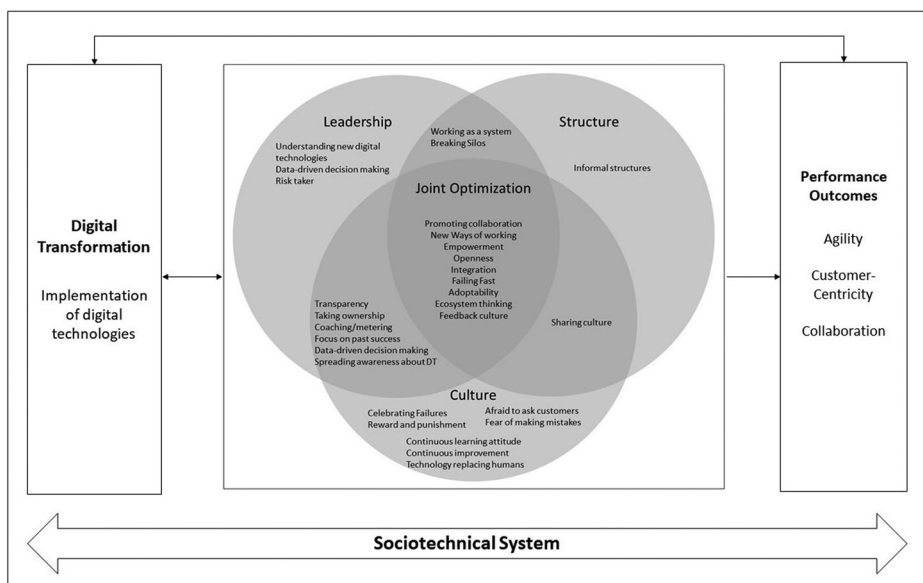


Figure 5. Research framework.

et al., 2018; Vial, 2019), it requires structure with de-layered or flatter hierarchy, decentralized power of command, less formalization and more cross-functional integration (Bernstein et al., 2016; Burton & Obel, 2018; Livijn, 2019; Mumford, 2000; Schwarzmüller et al., 2018). Moreover, digital technologies can lead organizations toward both centralization (by reinforcing classical power structures) and decentralization (as information becomes more distributed) (Schwarzmüller et al., 2018). On one hand, this enables a shift of power from legitimate profiles to those with expertise by identifying those with the most knowledge in the field (Leonardi, 2007). On the other hand, digital technologies allow increased managerial control and a strengthening of existing hierarchies by offering computer-aided monitoring tools (Dewett & Jones, 2001; Schwarzmüller et al., 2018). Therefore, structural changes must be planned very carefully for digital transformation (Vial, 2019). In our analysis, we also found similar views from interviewees that the structure of incumbent firms must find a right balance between centralization and decentralization. Based on this discussion, we propose the following.

Proposition 2: Flexible organisational structures (decentralisation, less formalisation, internal and external integration) drive the digital transformation of industrial organisations and enable them to achieve performance outcomes (agility, customer-centricity and collaboration).

Last, our results identified organizational culture as an enabler that incumbent organizations focus on the most for digital transformation. In the literature, culture is discussed as an enabler of transformation (Scheibe & Gupta, 2017) and an obstacle regarding the adoption of new digital technologies (Duerr et al., 2018; Hallikainen et al., 2017; Shahzad, 2020). Impactful digital transformation is not possible without changing the basis of the organization, which lies in its culture (Armenakis et al., 2011; Nambisan et al., 2017; Westerman et al., 2014). Additionally, industrial organizations develop their own culture over a long period of time, which is often very slow to change (Vincenti, 1993). Therefore, our results identified a special focus on cultural change in the incumbent industrial organizations. Organizational culture provides unwritten and unspoken rules for how to cope in the organization (Duerr et al., 2018). Schein (1985) divided culture into three sub-parts: artefacts, beliefs and values, and assumptions. The artefact is the most visible aspect of the culture, e.g. new digital tools and technologies or organizational structures (Schein, 1985). In our analysis, we identified that digital technologies and tools (artificial intelligence, robotic process innovation, intranet, in-house innovation applications, collaborative tools, e.g. Skype) are being implemented, which shows that the artefacts are visibly changed in the incumbent organizations. On the other hand, structures are still not changed formally. Beliefs and values are one of the most important parts of transformation, because even the best-designed digital strategy may fail if the organization's values do not embrace the transformation (Duerr et al., 2018). Therefore, we see the main focus on value change in the digital transformation projects of incumbent firms, e.g. developing a failing fast mind-set to promote experimental culture, customer co-creation to enhance customer centricity and sharing culture to enhance internal collaboration and agility. Based on this discussion, we propose the following.

Proposition 3: Cultural aspects of values, assumptions, and artefacts underpin digital transformation to achieve performance outcomes (agility, customer centricity and collaboration) in industrial organisations.

Unlike the extant research that concentrates on technology adoption in digital transformations (Li, 2020), our analysis shows that the combination of leadership with the right set of competencies, changes in traditional organizational structures and refreshed organizational culture can lead industrial organizations to an impactful digital transformation by achieving performance outcomes i.e. agility, customer centricity and collaboration. Digital transformation enables close collaboration between the organization and its stakeholders (internal and external) by using advanced digital technologies, e.g. digital platforms (Klötzer & Pflaum, 2017). In addition, it helps organizations to involve customers in product development and concept development phases (also known as co-creation or co-innovation) (Lucas et al., 2013), which enhances customer centricity. Moreover, agility is another important performance outcome that industrial organizations target to compete in this fast-changing digital world (Vial, 2019).

This study examined the ongoing digital transformation of incumbent firms, which are hard-core engineering organizations with a history of over 70 years, and which we refer to as industrial organizations. To explain this digital context, we have drawn on sociotechnical system theory (STS). STS theory advocates that organizations need to consider technical and social factors to promote any transformation (whether it concerns the introduction of new technology or a business change programme) (Cherns, 1976). Davis et al. (2014) consider organizations to be complex systems, which comprise many interdependent factors that enable or disable digital transformation. Therefore, bringing a change to one part of such a system triggers the need for change in other interrelated parts. We have found such evidences in our results as well, where making the changes in one part of any construct lead towards changes in other parts too. Because digital transformation starts with the implementation of new digital technologies (Gilchrist, 2016), consequently, this requires changes in the social part of industrial organizations that we have strongly observed in incumbent organizations.

In STS, the social and technical elements must work together to accomplish organizational goals, and the key issue here is to design change in such a way that both parts yield positive outcomes, called 'joint optimization' (Appelbaum, 1997; Di Maio, 2014). Our results demonstrate that the identified dimensions of enablers, i.e. leadership, structures, and culture, are jointly optimizing in order to achieve the performance outcomes for impactful digital transformation. The joint optimization within the social elements is happening due to the introduction of new digital technologies in the organization. Figure 5 presents this whole phenomenon, where the implementation of new digital technologies (technical systems) is integrating with social systems (leadership, structure, and culture). The social system is jointly optimizing within itself as well, and this whole interaction is leading toward common goals, i.e. performance outcomes (agility, customer centricity, and collaboration). We found that most of the identified constructs (in social systems) are interlinked with each other, which creates such scenarios that making changes/updates in one construct, lead toward changes in others as well, hence, leading our framework (Figure 5) towards joint optimization. For example, if leadership is developing its competency of empowerment, it inevitably leads toward less hierarchical approaches, a more goal-oriented approach, and a more open culture. Similarly, if leadership is playing the role of promoting collaboration in the organization, it requires making changes in the hierarchy to break silos, as well as promote openness so that people can collaborate on common topics. Therefore, based on our results, all three constructs of

leadership, structure, and culture overlap with each other during organizational-change processes in many aspects, resulting in joint optimization of digital-transformation enablers. Figure 5 summarizes the research framework for this study.

Implications

Theoretical Implication

The findings of this study extend the extant research into digital transformation and sociotechnical system theory in a number of ways. First, the study introduces a sociotechnical systems perspective on the understanding of digital transformation, which aligns with a call for the application of STS theory in new domains (Davis et al., 2014). Such a perspective provides the digital transformation literature with a holistic viewpoint on the most important social elements (enablers) that need attention in order to achieve performance outcomes. Second, past literature on STS theory has highlighted that the critical system failures occur for ‘non-technical’ reasons (Di Maio, 2014). Therefore, our research sheds light on the most critical social elements (non-technical), namely leadership, structures and culture, the kind of changes/updates required in these elements and how such changes can lead industrial organizations toward impactful digital transformation. Third, we have further explained how social elements are jointly optimized within themselves, leading digital transformation journeys of industrial organizations toward common goals, expressively contributing to the STS literature from a joint-optimization point of view (Appelbaum, 1997; Di Maio, 2014). Fourth, our study also contributes to the body of literature on leadership (Vial, 2019), structures (Matt et al., 2015), and culture (Imgrund et al., 2018), by explaining what kinds of changes these elements require in relation to the digital transformation of industrial organizations. Fifth, we explained in detail that how each enabler (leadership, structures and culture) is interlinked and impacting identified performance outcomes, (agility, customer centricity, and collaboration). Lastly, we have significantly contributed to the digital transformation (Sony & Naik, 2020; Vial, 2019; Warner & Wäger, 2019) and organizational change-management literature, by providing a holistic research framework and future research propositions.

Managerial Implications

This study has several important managerial implications. First, it guides practitioners to the realization that the digital transformation should not be managed as an isolated technical project. As a variety of technical and social activities enable the contributions of the advanced digital technologies, it is critical to align and jointly optimize their social and technical systems to effectively capitalize on the digital-transformation initiatives. Second, we have learned from the literature that engineers or technical leaders, trained and rewarded for technical excellence, are frequently frustrated with ‘social design constraints’ (Di Maio, 2014) and, hence, can ignore the social part while implementing new digital technologies. Such tunnel vision can lead digital transformation to failure (Di Maio, 2014). Therefore, this study warns practitioners against ignoring the social elements and encourages them to utilize sociotechnical thinking while planning and implementing digital-transformation strategies. Third, this study specifies the most important social

elements (leadership, structure, and culture) that need special attention from digital transformation practitioners while planning this change. Moreover, this study explains in detail how these social elements can contribute to attaining performance outcomes (agility, customer centricity, and collaboration) for impactful digital transformation.

Fourth, findings also emphasize the important role of organizational leadership in this change. Therefore, we call urgent attention to the development of leaders, as well as the further identification of digital transformation-supporting leadership competencies. Competent leaders assume a central role in correcting outdated and invalid assumptions, conceptualizing new ideas, and reinforcing cultural values. Lastly, the findings also illuminate the reality check regarding abundantly applied inflexible approaches to structuring industrial organizations. Our findings confirm the significance of organizational structure in digital transformation and simultaneously warn that too little is happening in this dimension of digital transformation. To reap the benefits of digital-technology-enabled transformation, practitioners must transform organizational structures accordingly.

Limitations and Further Research

It is important to also note the study's limitations. First, the study only captured scenarios from large, multinational, hard-core engineering organizations, which must be considered when seeking to transfer the findings to other types of organizations. Moreover, these findings should not be considered exhaustive, and the inclusion of other organizations may reveal further contributions. Second, the choice of method also has inherent limitations. Although the study mostly relied on high-profile interviewees to provide a rich perspective, more interviews could have further expanded the findings. Third, while the data was analysed, significant time was spent in consolidating the interpretations of the data; other researchers might have drawn additional conclusions. Fourth, STS theory is often labelled as a simplistic and prescriptive approach to studying organizational change. Therefore, we encourage future researchers to use empirically grounded studies and descriptive results based on an in-depth case study, multiple cases, and/or survey design (Scacchi, 2004). Furthermore, we call for further studies that investigate questions regarding leadership, structure, culture, performance outcomes, and the relationships between these constructs in the context of digital transformation, by employing more case companies and a larger sample of participants. Sixth, our study provides an important opportunity for future research by stating propositions based on the findings of this study. Lastly, future research should also focus on cross-case analysis to find the differences between unlike digital journeys of organizations.

Conclusion

This study presents a multiple-case study of four industrial organizations, exploring how industrial organizations are organizing and managing their digital-transformation journeys. The findings shed light on the most important social elements (leadership, structure, and culture) that play a key role in the digital transformation of incumbent organizations. The findings provide more insights into how each identified social element plays its role in achieving performance outcomes (agility, customer centricity, and collaboration) for impactful digital transformation. Moreover, this study stresses the need for sociotechnical

system thinking while implementing digital transformation strategies. It highlights how the joint optimization of each identified social element can help incumbent organizations achieve common goals. Last but not least, this study provides a holistic framework that will guide researchers, practitioners, and industrial organizations on how to embark on their digital transformation journeys.

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References

- Appelbaum, S. H. (1997). Socio-technical systems theory: An intervention strategy for organizational development. *Management Decision*, 35(6), 452–463. <https://doi.org/10.1108/00251749710173823>
- Armenakis, A., Brown, S., & Mehta, A. (2011). Organizational culture: Assessment and transformation. *Journal of Change Management*, 11(3), 305–328. <https://doi.org/10.1080/14697017.2011.568949>
- Autio, E., Nambisan, S., Thomas, L. D. W., & Wright, M. (2018). Digital affordances, spatial affordances, and the genesis of entrepreneurial ecosystems. *Strategic Entrepreneurship Journal*, 12(1), 72–95. <https://doi.org/10.1002/sej.1266>
- Avis, J. (2018). Socio-technical imaginary of the fourth industrial revolution and its implications for vocational education and training: A literature review. *Journal of Vocational Education and Training*, 70(3), 337–363. <https://doi.org/10.1080/13636820.2018.1498907>
- Bernstein, E., Bunch, J., Canner, N., & Lee, M. (2016). Beyond the holacracy hype. *Harvard Business Review*, 38–49.
- Bharadwaj, A., El Sawy, O. A., Pavlou, P. A., & Venkatraman, N. (2013). Digital business strategy: Toward a next generation of insights. *MIS Quarterly: Management Information Systems*, 37(2), 471–482. <https://doi.org/10.25300/MISQ/2013/37:2.3>
- Bockschecker, A., Hackstein, S., & Baumöl, U. (2018). Systematization of the term digital transformation and its phenomena from a socio-technical perspective – a literature review. In *Twenty-Sixth European Conference on Information Systems (ECIS)*. AIS.
- Brown, C. V., & Magill, S. L. (1994). Alignment of the IS functions with the enterprise: Toward a model of antecedents. *MIS Quarterly: Management Information Systems*, 18(4), 371–403. <https://doi.org/10.2307/249521>
- Burton, R. M., & Obel, B. (2018). The science of organizational design: Fit between structure and coordination. *Journal of Organization Design*, 7(5), 1–13. <https://doi.org/10.1186/s41469-018-0029-2>
- Callon, M. (1999). Actor-network theory-the market test. *The Sociological Review*, 47(1). <https://doi.org/10.1111/1467-954x.46.s.10>
- Chanas, S., & Hess, T. (2016, June 27–July 1). *Understanding digital transformation strategy formation: Insights from Europe's automotive industry*. PACIS 2016 Proceedings, Chiayi, Taiwan, 296. <http://aisel.aisnet.org/pacis2016/296>
- Cherns, A. (1976). The principles of sociotechnical design. *Human Relations*, 29(8), 783–792. <https://doi.org/10.1177/001872677602900806>
- Da Silva Freitas Junior, J. C., Maçada, A. C. G., Brinkhues, R. A., & Montesdioca, G. Z. (2016, August 14–16). *Digital capabilities as driver to digital business performance*. AMCIS 2016: Surfing the IT Innovation Wave – 22nd Americas Conference on Information Systems, San Diego, CA, USA.
- Davies, R., Coole, T., & Smith, A. (2017). Review of socio-technical considerations to ensure successful implementation of Industry 4.0. *Procedia Manufacturing*, 11(6), 1288–1295. <https://doi.org/10.1016/j.promfg.2017.07.256>
- Davis, M. C., Challenger, R., Jayewardene, D. N. W., & Clegg, C. W. (2014). Advancing socio-technical systems thinking: A call for bravery. *Applied Ergonomics*, 45(2), 171–180. <https://doi.org/10.1016/j.apergo.2013.02.009>
- Delaney, K. J. (2007). Methodological dilemmas and opportunities in interviewing organizational elites. *Sociology Compass*. <https://doi.org/10.1111/j.1751-9020.2007.00028.x>
- Dewett, T., & Jones, G. R. (2001). The role of information technology in the organization: A review, model, and assessment. *Journal of Management*, 27(3), 313–346. <https://doi.org/10.1177/014920630102700306>

- Di Maio, P. (2014). Towards a metamodel to support the joint optimization of socio technical systems. *Systems*, 2(3), 273–296. <https://doi.org/10.3390/systems2030273>
- Duerr, S., Holotiuk, F., Wagner, H.-T., Beimborn, D., & Weitzel, T. (2018, January 3–6). *What is digital organizational culture? Insights from exploratory case studies*. Proceedings of the 51st Hawaii International Conference on System Sciences (pp. 5126–5135), Waikoloa Village, Hawaii, USA. <https://doi.org/10.24251/hicss.2018.640>
- Duerr, S., Wagner, H.-T., Weitzel, T., & Beimborn, D. (2017, February 12–15). *Navigating digital innovation – the complementary effect of organizational and knowledge recombination*. Wirtschaftsinformatik Proceedings, St. Gallen, Switzerland (pp. 1363–1377).
- Earley, S. (2014). The digital transformation: Staying competitive. *IT Professional*, 16(2), 58–60. <https://doi.org/10.1109/MITP.2014.24>
- Fitzgerald, M., Kruschwitz, N., Bonnet, D., & Welch, M. (2013). Embracing digital technology: A new strategic imperative | Capgemini consulting worldwide. *MIT Sloan Management Review*, 55(1), 1–13.
- Gehrke, L., Bonse, R., & Henke, M. (2016, June 17–22). *Towards a management framework for the digital transformation of logistics and manufacturing*. 23rd EurOMA Conference, Trondheim, Norway (pp. 1–10).
- Gehrke, L., Kühn, A. T., Rule, D., Moore, P., Bellmann, C., Siemes, S., & Standley, M. (2015). *A discussion of qualifications and skills in the factory of the future* (pp. 1–28). <https://doi.org/10.1515/auto-2015-0068>
- Gibson, J. J. (1979). The theory of affordances. In *The people, place, and space reader* (1st ed.). Routledge. <https://doi.org/10.4324/9781315816852>
- Giddens, A. (1979). Central problems in social theory. In *Central problems in social theory*. Palgrave. <https://doi.org/10.1007/978-1-349-16161-4>
- Gilchrist, A. (2016). *Industry 4.0: The industrial internet of things*. Apress. <https://doi.org/10.1007/978-1-4842-2047-4>
- Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2013). Seeking qualitative rigor in inductive research: Notes on the Gioia methodology. *Organizational Research Methods*, 16(1), 15–31. <https://doi.org/10.1177/1094428112452151>
- Haffke, I., Kalgovas, B., & Benlian, A. (2016, December 11–14). *The role of the CIO and the CDO in an organization's digital transformation*. Proceedings of the 37th International Conference on Information Systems, Dublin, Ireland (Vol. 1, pp. 1–20).
- Hallikainen, H., Paesbrugge, B., Laukkanen, T., Rangarajan, D., & Gabrielsson, M. (2017, January 3–6). *How individual technology propensities and organizational culture influence B2B customer's behavioral intention to use digital services at work?* Proceedings of the 50th Hawaii International Conference on System Sciences, Waikoloa Village, HI, USA. <https://doi.org/10.24251/hicss.2017.552>
- Hendrick, H. (1997). Organizational design and macroergonomics. In G. Salvendy (Ed.), *Handbook of human factors and ergonomics* (pp. 594–627). John Wiley & Sons. [https://doi.org/10.1002/\(SICI\)1520-6564\(199922\)9:3%3C321::AID-HFM9%3E3.0.CO;2-N](https://doi.org/10.1002/(SICI)1520-6564(199922)9:3%3C321::AID-HFM9%3E3.0.CO;2-N)
- Henriette, E., Feki, M., & Boughzala, I. (2015). *The shape of digital transformation: A systematic literature review*. Mediterranean Conference on Information Systems (MCIS) Proceedings, 10.
- Hesse, A. (2018). *Digitalization and leadership – how experienced leaders interpret daily realities in a digital world*. Proceedings of the 51st Hawaii International Conference on System Sciences. <https://doi.org/10.24251/hicss.2018.234>
- Higgins, J. M., & Mcallaster, C. (2004). If you want strategic change, don't forget to change your cultural artifacts. *Journal of Change Management*, 4(1), 63–73. <https://doi.org/10.1080/1469701032000154926>
- Hinings, B., Gegenhuber, T., & Greenwood, R. (2018). Digital innovation and transformation: An institutional perspective. *Information and Organization*, 28(1), 52–61. <https://doi.org/10.1016/j.infoandorg.2018.02.004>
- Horlacher, A., Klärner, P., & Hess, T. (2016, August 11–14). *Crossing boundaries: Organization design parameters surrounding CDOs and their digital transformation activities*. Twenty-Second Americas Conference on Information Systems, San Diego, CA, USA (pp. 1–10).

- Huberman, A., Miles, M., & Janet Ward, S. (2012). Increasing the generalizability of qualitative research. In *The qualitative researcher's companion* (pp. 171–202). <https://doi.org/10.4135/9781412986274.n8>
- Imgrund, F., Fischer, M., Janiesch, C., & Winkelmann, A. (2018). *Approaching digitalization with business process management approaching digitalization with business process management as technological advancements have made the internet ubiquitously available*. Institute of Business Administration.
- Imran, F., & Kantola, J. (2018). Review of Industry 4.0 in the light of sociotechnical system theory and competence based view: A future research agenda for the evolute approach. In J. Kantola, S. Nazir, & T. Barath (Eds.), *Proceedings of the AHFE 2018* (pp. 118–128). Springer. ISBN 978-3-319-94709-9.
- Imran, F., Shahzad, K., Butt, A., & Kantola, J. (2018). Leadership competencies for digital transformation: Evidence from multiple cases. In J. Kantola, S. Nazir, & T. Barath (Eds.), *Proceedings of the AHFE 2020*. Springer. https://doi.org/10.1007/978-3-030-50791-6_11
- Ivančić, L., Vukšić, V., & Spremić, M. (2019). Mastering the digital transformation process: Business practices and lessons learned. *Technology Innovation Management Review*, 9(2), 36–50. <https://doi.org/10.22215/timreview/1217>
- Jones, M. R., & Karsten, H. (2008). Giddens's structuration theory & IS research. *MIS Quarterly*, 32(1), 127–157. <https://doi.org/10.2307/25148831>
- Klötzer, C., & Pflaum, A. (2017, January 4–7). *Toward the development of a maturity model for digitalization within the manufacturing industry's supply chain*. Proceedings of the 50th Hawaii International Conference on System Sciences (pp. 4210–4219), Waikoloa Village, HI. <https://doi.org/10.24251/hicss.2017.509>
- Leonardi, P. M. (2007). Activating the informational capabilities of information technology for organizational change. *Organization Science*, 18(5), 813–831. <https://doi.org/10.1287/orsc.1070.0284>
- Leonardi, P. M. (2012). Materiality, sociomateriality, and socio-technical systems: What do these terms mean? How are they related? Do we need them? In P. M. Leonardi, B. A. Nardi, & J. Kallinikos (Eds.), *Materiality and organizing: Social interaction in a technological world* (pp. 25–48). Oxford University Press.
- Leonardi, P. M. (2013). Theoretical foundations for the study of sociomateriality. *Information and Organization*, 23(2), 59–76. <https://doi.org/10.1016/j.infoandorg.2013.02.002>
- Li, F. (2020). The digital transformation of business models in the creative industries: A holistic framework and emerging trends. *Technovation*, 92-93, 102012. <https://doi.org/10.1016/j.technovation.2017.12.004>
- Livijn, M. (2019). Navigating in a hierarchy: How middle managers adapt macro design. *Journal of Organization Design*, 8(7). <https://doi.org/10.1186/s41469-019-0046-9>
- Lucas, H. C., Agarwal, R., Clemons, E. K., El Sawy, O. A., & Weber, B. (2013). Impactful research on transformational information technology: An opportunity to inform new audiences. *MIS Quarterly: Management Information Systems*, 37(2), 371–382. <https://doi.org/10.25300/MISQ/2013/37.2.03>
- Luokkanen-Rabetino K., Rajala, A., Sillanpää, I., & Shahzad, K. (2017). Supply chain intelligence. In M. Kohtamäki (Ed.), *Real-time strategy and business intelligence*. Palgrave Macmillan.
- Majchrzak, A., & Markus, M. L. (2012). Technology affordances and constraints in management information systems. In E. Kessler (Ed.), *Encyclopedia of management theory*. Sage Publications.
- Marshall, C., & Rossman, G. (2011). *Designing qualitative research* (5th ed.). Sage.
- Marshall, C., & Rossman, G. B. (2014). *Designing qualitative research*. Sage.
- Matt, C., Hess, T., & Benlian, A. (2015). Digital transformation strategies. *Business and Information Systems Engineering*, 57(5), 339–343. <https://doi.org/10.1007/s12599-015-0401-5>
- Matthews, B., & Ross, L. (2010). *Research methods. A practical guide for the social sciences*. Pearson Longman.
- Mitki, Y., Shani, A. B., & Greenbaum, B. E. (2019). Developing new capabilities: A longitudinal study of sociotechnical system redesign. *Journal of Change Management*, 19(3), 167–182. <https://doi.org/10.1080/14697017.2018.1490337>

- Mumford, E. (2000). A socio-technical approach to systems design. *Requirements Engineering*, 5(2), 125–133. <https://doi.org/10.1007/PL00010345>
- Mumford, E. (2006). The story of socio-technical design: Reflections on its successes, failures and potential. *Information Systems Journal*, 16(4), 317–342. <https://doi.org/10.1111/j.1365-2575.2006.00221.x>
- Nambisan, S., Lyytinen, K., Majchrzak, A., & Song, M. (2017). Digital innovation management: Reinventing innovation management research in a digital world. *MIS Quarterly*, 41(1), 223–238. <https://doi.org/10.25300/MISQ/2017/41:1.03>
- Niemi, M. K., Dan, S., Kalliokoski, J., Shahzad, K., Shakeel, S. R., Alagirisamy, R., & Laurila, I. (2021). *Talent retention and the development of digital skills: A study of the ecosystem-based digitalisation academy located in Vaasa, Finland*. Publications of the Ministry of Economic Affairs and Employment. <http://urn.fi/URN:ISBN:978-952-327-840-0>
- Orlikowski, W. J., & Scott, S. V. (2008). Sociomateriality: Challenging the separation of technology, work and organisation. *The Academy of Management Annals*, 2(1), 433–474. <https://doi.org/10.5465/19416520802211644>
- Palazzeschi, L., Bucci, O., & Di Fabio, A. (2018). Re-thinking innovation in organizations in the Industry 4.0 scenario: New challenges in a primary prevention perspective. *Frontiers in Psychology*, 9, 30. <https://doi.org/10.3389/fpsyg.2018.00030>
- Parida, V., Sjödin, D., & Reim, W. (2019). Reviewing literature on digitalization, business model innovation, and sustainable industry: Past achievements and future promises. *Sustainability*, 11(2), 391–409. <https://doi.org/10.3390/su11020391>
- Pasmore, W., Winby, S., Mohrman, S. A., & Vanasse, R. (2019). Reflections: Sociotechnical systems design and organization change. *Journal of Change Management*, 19(2), 67–85. <https://doi.org/10.1080/14697017.2018.1553761>
- Porter, M. E., & Heppelmann, J. E. (2015). How smart, connected products are transforming companies. *Harvard Business Review*, 93(10), 96–114. <https://doi.org/10.1017/CBO9781107415324.004>
- Reck, F., & Fliaster, A. (2019). Four profiles of successful digital executives four types of effective digital executives in business organizations. *MIT Sloan Management Review*, 60(3), 1–7.
- Scacchi, W. (2004). Socio-technical system design. In W. S. Bainbridge (Ed.), *Berkshire encyclopedia of human-computer interaction* (pp. 1–10). Berkshire Publishing Group.
- Scheibe, K. P., & Gupta, M. (2017). The effect of socializing via computer-mediated communication on the relationship between organizational culture and organizational creativity. *Communications of the Association for Information Systems*, 40, 294–314. <https://doi.org/10.17705/1CAIS.04013>
- Schein, E. H. (1985). *Organizational culture and leadership: A dynamic view*. Jossey-Bass.
- Schwarz Müller, T., Brosi, P., Duman, D., & Welp, I. M. (2018). How does the digital transformation affect organizations? Key themes of change in work design and leadership. *Management Review*, 29(2), 114–138. <https://doi.org/10.5771/0935-9915-2018-2-114>
- Shahzad, K. (2020). Blockchain and organizational characteristics: Towards business model innovation. In E. Markopoulos, R. Goonetilleke, A. Ho, & Y. Luximon (Eds.), *Proceedings of the AHFE 2020*. Springer. https://doi.org/10.1007/978-3-030-51626-0_9
- Singh, A., & Hess, T. (2017). How chief digital officers promote the digital transformation of their companies. *MIS Quarterly Executive*, 16(1), 1–17. <https://aisel.aisnet.org/misqe/vol16/iss1/5>
- Smet, A. D., Lurie, M., & George, A. S. (2018, October 27). Leading agile transformation: The new capabilities leaders need to build 21st-century organizations. *McKinsey and Co*. <https://www.mckinsey.com>
- Sony, M., & Naik, S. (2020). Industry 4.0 integration with socio-technical systems theory: A systematic review and proposed theoretical model. *Technology in Society*, 61. <https://doi.org/10.1016/j.techsoc.2020.101248>
- Trist, E. L., & Bamforth, K. W. (1951). Some social and psychological consequences of the longwall method of coal-getting: An examination of the psychological situation and defences of a work group in relation to the social structure and technological content of the work system. *Human Relations*, 4(1), 3–38. <https://doi.org/10.1177/001872675100400101>

- Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Qi Dong, J., Fabian, N., & Haenlein, M. (2019). Digital transformation: A multidisciplinary reflection and research agenda. *Journal of Business Research*. <https://doi.org/10.1016/j.jbusres.2019.09.022>
- Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *Journal of Strategic Information Systems*, 28(2), 118–144. <https://doi.org/10.1016/j.jsis.2019.01.003>
- Vincenti, W. G. (1993). *What engineers know and how they know it*. <https://doi.org/0801845882>
- Warner, K. S. R., & Wäger, M. (2019). Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal. *Long Range Planning*, 52(3), 326–349. <https://doi.org/10.1016/j.lrp.2018.12.001>
- Westerman, G., Bonnet, D., & McAfee, A. (2014). *Leading digital*. Harvard Business Review Press.
- Yeow, A., Soh, C., & Hansen, R. (2018). Aligning with new digital strategy: A dynamic capabilities approach. *Journal of Strategic Information Systems*, 27(1), 43–58. <https://doi.org/10.1016/j.jsis.2017.09.001>
- Yin, R. K., Clarke, C., Cotner, B., & Lee, R. (2006). *Handbook of complementary methods for research in education*. Routledge.