3 Essay II: Options for designing a digital transformation control system

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Abstract essay II

This paper explores the use of management control measures in the course of digital transformation journeys in small and medium sized enterprises (SMEs) in order to sketch a digital transformation control system. It also examines the role of the publicly promoted concept of "trial-and-error". I describe SMEs that are leaders in terms of digital transformation and analyze the variety of control measures they use in order to follow a structured approach throughout their digital transformation endeavor. I elaborate the role that trial-and-error plays as part of management control procedures. The resulting package of management control measures from cultural, planning, administrative, and key performance indicator-oriented categories rests on the management control systems as a package framework by Malmi & Brown, 2008. It shows the variety of management control measures useful in supporting successful digital transformation in SMEs, pigeonholes the relationship between management control and the phenomenon of "trial-and-error", and thereby gives clues for further academic research to analyze the relationship between sustainable success in digital transformation and management control systems, as well as providing practical advice for SME owners and managers on how to control a digital transformation endeavor.
Keywords: digital transformation, management control, management control systems, MCS, small and medium sized enterprise, SME
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3.1 Introduction

Digital transformation is one of the most important management tasks in the current era of digitalization. All companies must position themselves toward technology exploitation and exploration. Most SMEs will have to adapt their business and their operating models to stay competitive. Thereby, SMEs can realize a range of benefits from the use of management con-

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trol measures, including increased financial and organizational performance, facilitated decision making, optimization in resource allocation, and faster adaptation to the surrounding environment. Assuming that the use of management control measures can have a positive impact on SMEs' digital transformation efforts, I answer the research question: *How should a digital transformation control system be designed?*

Digitization, digitalization, and digital transformation as collective terms describing the growing use of technology in company routines are undoubtedly drivers of economic development nowadays. Digital transformation, in particular, describes the managed adaptation of digital technologies, emphasizing the change aspect in ways of working, roles, and business offering caused by the adoption of digital technologies in an organization, or in the operational environment of an organization in order to ensure sustainable value creation (Gimpel & Röglinger, 2015). The special feature that makes digital transformation new and special is the dynamic interaction of digital solutions and the resulting new business models as well as necessary adjustments of procedures and processes (Wiesböck & Hess, 2019; Yoo et al., 2012). Digital transformation is therefore a multifaceted, high priority management task, involving high complexity regarding a company's use of technology, value creation, structure, and financial aspects (Hess et al., 2016; Matt et al., 2015). SMEs are not excluded as they face the same challenges as large firms.

Research in the field of SMEs has identified a wide range of potential benefits from the use of management control systems (MCS). The use of MCS in SMEs facilitates decision making (Chand & Dahiya, 2010; Duréndez et al., 2011; Villarmois & Levant, 2011), improves the quality of strategic analysis (Chand & Dahiya, 2010; Garengo & Bernardi, 2007; Peel & Bridge, 1998; Tapinos et al., 2005), improves controlling functions (Amat et al., 1994; Chand & Dahiya, 2010; Hakola, 2010), allows for better integration of the business plan and key performance indicators (Manville, 2007), allows resources to be optimized (Laurinkevičiūtė & Stasiškienė, 2011; Villarmois & Levant, 2011), improves overall quality (Chand & Dahiya, 2010), and finally leads to faster adaptation to the surrounding environment (Amat et al., 1994; Laurinkevičiūtė & Stasiškienė, 2011).

The potential value added of MCS in the context of digital transformation, especially in SMEs, has not been addressed in previous literature. Yet, there is some empirical evidence from which I suggest that the use of MCS supports successful digital transformation. On the one hand, companies that invest in advanced information technology (IT) are more likely to adopt MCS (Sharma & Bhagwat, 2007). Further factors that contribute to

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extended MCS usage include strong business competition (Amat et al., 1994; Marc, Peljhan, Ponikvar, Sobota, & Tekavcic, 2010), perceived environmental uncertainty (Alattar, Kouhy, & Innes, 2009; Amat et al., 1994; Gul, 1991; Laurinkevičiūtė & Stasiškienė, 2011), and the management's wish for higher financial performance (Gul, 1991). On the other hand, the failure of SMEs to make appropriate use of MCS contributes to enterprise collapses, especially in environments where distortions occur, as is the case with current technology development (De Loo & Davis, 2003; El-Ebaishi, Karbhari, & Naser, 2003; Halabi, Dyt, & Barrett, 2010; Md. Mostaque, Laitinen, & Gunasekaran, 1998). Formal and informal controls (H. C. Dekker, 2004; Ouchi, 1979) support reorganizing challenges and ensure long-term financial performance if companies are already in financially stressed situations (Laitinen, 2011). Adequately designed MCS also support decision making in organizations that show increasing complexity (Giovannoni et al., 2011). Taking all these facts into account, I expect a positive influence of MCS also throughout digital transformation endeavors.

As MCS are not stable, but evolve in the course of changing institutional environments (Burns & Scapens, 2000; Johnson & Kaplan, 1987), and digital transformation is a rather new challenge for companies to face, I expect that existing MCS may not be sufficient to depict the information and control challenges as well as resulting decision spectrums of SME owners and managers arising from this phenomenon. As a reaction, scholars call, for example, for an integration of agile measures into MCS by mobilizing a "trial-and-error-culture" to make management control leaner, more integrated, and faster (Schäffer & Weber, 2016). Therefore, I use a qualitative research design to search for a digital transformation control system that fits the mindset of SME representatives, whose companies can be considered leaders in digital transformation. A combination of purposeful sampling approaches leads me to include 11 cases of SMEs in my study, ranging from 5 to around 300 employees.

I find the emerging categories to fit well with Malmi and Brown's 2008 MCS as a package conceptualization. Cultural controls, planning, administrative controls, and performance indicator-based controls cover all control measures that the cases under analysis mobilize throughout their digital transformation endeavors. More detailed measures are identified within all these categories to depict the great variety of transformation-fostering areas of control. The findings therefore provide value added to scholars in the field of MCS to expand existing concepts toward coverage of developments in the current age of digitalization, but they also support practitioners in

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underpinning their digital transformation efforts with structured control mechanisms.

3.2 Theoretical background

3.2.1 Approaching management control from the SME perspective

This research aims at broadening the literature stream targeting management control practices in the setting of SMEs. Yet the problem remains that there is little empirical management accounting research targeting the investigation of technological innovation and development. Research in this field has long been concentrated on large enterprises (Anderson, 1995; Robert S. Kaplan, 1994; Monden & Hamada, 1991) because of a lack of supply of practical expertise from SMEs as well as a great amount of heterogeneity with regard to the definition of management control in the SME context (Mitchell & Reid, 2000). Management control in SME settings has simply not been "fashionable" (see: Mitchell & Reid, 2000, p. 386). Recent years have seen a growing interest in management accounting scholars focusing on family firms. To give two examples, Giovannoni, Maraghini, & Riccaboni, 2011, describe the useful influence that management accounting practices can have on knowledge transfer, thereby facilitating professionalization as well as succession processes. Songini & Gnan, 2015, focus on the existence of control measures to solve distinctive, agency-related conflicts in family businesses and related performance outcomes. Around 20 papers focus on the specifics of management accounting and management control in family businesses (literature overviews are provided by, e.g., Helsen, Lybaert, Steijvers, Orens, & Dekker, 2017; Prencipe, Bar-Yosef, Dekker, & Dekker, 2014; Quinn, Hiebl, Moores, & Craig, 2018; Senftlechner & Hiebl, 2015). The overarching notion remains that there is great variance across family firms concerning the individual implementation and use of management accounting and control systems (Quinn et al., 2018). Still, the importance of management accounting and control in general is not affected or limited. Holding true for larger family businesses, but also in micro- and small business contexts, "mutual trust, family-specific goals and the centralization of power emerge as important antecedents of management accounting and control, but they are also affected by the use of management accounting and control instruments." (Senftlechner & Hiebl, 2015, p. 573).

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The definition of management control in general, but especially in the SME context, still remains vague, which makes it difficult to precisely narrow down an object or unit of analysis and to provide theoretical background. Malmi & Brown, 2008, define MCS as "systems, rules, practices, values and other activities management puts in place in order to direct employee behavior" (Malmi & Brown, 2008, p. 290). In the study of MCS, this carries the danger of excluding informal, implicitly applied measures (Kingston & Caballero, 2009). To make the theoretical background of my study as compelling as possible in order not to miss any aspect of management control, I search for connectivity with well-established frameworks of management control, e.g., by Malmi & Brown, 2008, Merchant & Van der Stede, 2012, and Simons, 1987.

Furthermore, I search for evidence regarding management accounting techniques in a broad sense including budgeting, performance evaluation, costing, decision making, communication, and strategic analysis (e.g., Chand and Dahiya, 2010; Ahmad and Zabri, 2016). My resulting, holistic view on management control references the term "controlling" used especially in German speaking literature, which is ascribed a coordination function within a company's leadership system, thereby aligning planning, control, management information, organization, and human resources management (e.g., Küpper et al., 2013). This perspective, combining elements of management accounting and management control under the denomination MCS, references Becker, Ulrich, & Staffel, 2011, and Laitinen, 2011, and subsumes management accounting as well as performance measurement as formal, particular analytical tools that managers should use for planning, controlling, and improving the efficiency of a company.

A rather new aspect in the theoretical debate on MCS is trial-and-error, which is seen as a culturally anchored measure so that employees are given the freedom to take decisions independently of a previously defined goal within the boundaries of predefined budget limits (see, e.g., Schäffer & Weber, 2016). The concept is related to agile working methods especially in the context of digital transformation, where the development of digital products, services, and processes in an uncertain, dynamically changing environment requires iterative test-and-learn cycles (see, e.g., Gimpel & Röglinger, 2015; Malmi & Brown, 2008; Sebastian et al., 2017). I elaborate the role that trial-and-error plays as part of management control procedures from an empirical perspective.

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3.2.2 Management control systems as a lever of success in digital transformation?

To my knowledge, no previous research has tackled the aspect of specific MCS that support successful digital transformation in SMEs, in either large company or SME settings. Heading in a similar, yet less comprehensive direction, Sharma & Bhagwat, 2007, found, on the basis of four case studies of SMEs, that investments in advanced information systems increase the likelihood of adopting MCS, based on the ability to manage larger amounts of information more effectively.

However, as increasing digitalization is contributing to intense competition as well as perceived uncertainty, thereby forcing companies as well as management to take transformative actions, I draw on evidence from environmental situations that make SME owners intensify the use of MCS. At an individual level, Ritchie & Richardson, 2000, investigated how an owner-manager who feels highly responsible for his or her business tends to increase the use of management accounting systems. A potential explanation is that they become more involved in improving performance and therefore need sophisticated information.

Amat et al. (1994) and Marc, Peljhan, Ponikvar, Sobota, & Tekavcic (2010) highlight the importance of strong business competition as a key external factor that increases the usage as well as the design of MCS in SMEs. They argue that market pressure from competitors entails greater need for information on a company's own costs and operations. By using more MCS, SMEs adapt more quickly to their surrounding environment, as they benefit under perceived uncertainty from the implementation of rigorous internal controls that provide tools to react to and neutralize external threats (Alattar et al., 2009; Amat et al., 1994; Gul, 1991; Laurinkevičiūtė & Stasiškienė, 2011). In addition, Gul, 1991, also found that insufficient use of MCS impedes SME performance in environments with high uncertainty. This may lead as far as inadequate and inappropriate use of MCS, as well as lack of knowledge around them, can leverage firms' difficulties, and thereby contribute to business failure (De Loo & Davis, 2003; El-Ebaishi et al., 2003; Halabi et al., 2010; Md. Mostaque et al., 1998). The rejection of application of management accounting in an adequate manner may result in, e.g., less accurate cost calculations, causing negative effects on price calculation, investment decisions, overhead cost calculation and, above all, overall business performance (e.g., De Loo & Davis, 2003; Laitinen, 2011). A case study by De Loo & Davis, 2003, shows the case of a small record manufacturer at the beginning of the 1920s that faced heavy

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competition from radio broadcasting stations and, based on inadequate management decisions, headed for bankruptcy. The case reveals how technology evolution-caused market change demands management to react properly, relying, e.g., on the correct level of detail in the planning and control of investments in fixed assets, organization, and structures and causal accounting figures, and resulting performance ratios. The absence of such measures did not cause the firm's demise but exacerbated its critical situation.

A resulting support function of MCS in the case of reorganizing challenges is described by Laitinen (2011), searching for factors promoting the reorganization of micro companies in financially distressed situations. Among other factors, his study takes into account organizational change measures such as motivating change, creating vision, developing political support, managing the transition, and sustaining momentum as well as the implementation of MCS (Cummings & Worley, 2015). The last item covers both formal and informal controls, whereas formal controls enclose contractual obligations and formal organizational mechanisms, including outcome and behavior control mechanisms (H. C. Dekker, 2004; Ouchi, 1979), and informal controls (i.e., social control and relational governance) relate to cultures and systems influencing members and are essentially based on mechanisms inducing self-regulation (H. C. Dekker, 2004; Ouchi, 1979). The results show a positive influence of organizational change measures and MCS on the long-term financial performance of micro companies undergoing a process of reorganization. Assuming that company adaptation to dynamic changes in competition, as is the case in digital transformation, demands at least a certain amount of reorganization, e.g., with regard to the metrics of value creation, company structures, and finances (Hess et al., 2016; Matt et al., 2015), I conclude that MCS have the potential to prove useful throughout a digital transformation journey. This conjecture is backed up by Johnson and Kaplan, 1987, as well as Burns and Scapens, 2000, who point out that management control procedures are interconnected and evolve over time. They are therefore not fixed, but develop further with a changing institutional environment, showing the ability to adapt to necessary institutional transformations. This perspective, on the one hand, supports a general usefulness of management control procedures to companies when entering a digital transformation journey and, on the other hand, it highlights how a potential digital transformation control system must reflect the specifics of a company or individual transformation journey.

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Finally, as Giovannoni et al., 2011, show, management control techniques can actively support decision making and thereby align organizations in situations where a business becomes more complex. As long as a formalized management control framework is tailored to a SME's individual leadership style and vision, it supports employees to become "more conscious of the company's changing priorities" (see: Giovannoni et al., 2011, p. 139; see also: Langfield-Smith, 1997). There is no doubt that the evolution of technologies—alongside the inherent, necessary digital transformation of businesses—are factors that critically challenge SMEs in general (De Lema & Duréndez, 2007), thereby widening an owner-manager's decision spectrum.

3.3 Research design, research methods, and sample characteristics

3.3.1 Research design

Given the innovative essence of the research object, I apply explanatory and exploratory methods. Investigating a "contemporary phenomenon in depth and within its real-life context" (Yin, 2014, p. 16) without clear boundaries between phenomenon and context, I assessed a case-based research design in line with Yin, 2014, to be most appropriate. The necessity of "description, interpretation and explanation" (Lee et al. 1999, p. 164) follows from the as yet unknown terrain of the research field, again encouraging a qualitative approach. Executing the research under an interpretive paradigm allows me to take into account personal as well as participants' perceptions, understandings, experiences, and interpretations to identify concepts within the gathered data (J. W. Creswell & Creswell, 2018). These concepts represent management control practices in SMEs, which are the central unit of analysis. When generating these concepts, I will make no difference whether they are explicitly appreciated or appear to be implicitly in use. The study takes up a call by Malmi and Brown, 2008, stating that "building a cumulative body of knowledge about the design and use of MCS becomes difficult without well-articulated definitions and purposes of MCS" (Malmi & Brown, 2008, p. 289). Regarding the design of management control in the digital transformation of SMEs, this study seeks to be a starting point toward a holistic and compelling discussion of what currently happens in the field.

Qualitative designs already play a considerable role in MCS research (López & Hiebl, 2015). Nonetheless, I see no possibility of generalizing or

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transferring existing results toward the given research question. Therefore, entering a path of discovery, I chose to apply different strategies for theorizing.

I describe the cases under investigation based on the data gathered from the interviews as well as further data from publicly available sources, i.e., websites, newspaper articles, magazine articles, social media content, or published books, depending on availability. This narrative section delivers thick description necessary to interpret the results in the given context (Pratt, 2009). Context, stories, and meaning intend to promote the audience's understanding of the applicability of the obtained results (Langley 1999, p. 696–697). Next to major company events, I describe digitally transformative management actions, the accompanying rationales, and measures installed in order to control the initiated actions.

The main theory development is executed using an abductive methodological approach (Timmermans & Tavory, 2012). No prior, pre-determined hypotheses guided the research project, yet the existing literature on management control practices cannot be neglected. Still, the evolving concepts are inductively developed from the reality of data. Considering the broad area of study, the research process included iterations of the collection of large volumes of non-standardized data, data coding, the generation of meaning from the data, and finally the elaboration of existing theory from the data (Fisher & Aguinis, 2017). A multiple case design was chosen because, first, of the absence of prior research and resulting difficulty in formulating a priori hypotheses (Ferreira & Merchant, 1992), and, second, multiple cases add confidence and robustness to the findings (Miles et al., 2014; Yin, 2014). The multiple case design provides the opportunity to show greater variance by comparing and contrasting found models of MCS. The study leads to a package of MCS that have been proved valuable by SMEs that successfully embarked on a journey of digital transformation.

3.3.2 Sampling approach

Empirical units of analysis are selected SMEs that successfully mastered digital transformation. In order to ensure fit to a real-life context and ongoing discussion with practitioners as well as in academia, the scope of digital transformation aspects under investigation is not limited upfront. According to the work of Matt et al., 2015, digital transformation in the cases under investigation can therefore be related to changes in the use of tech-

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nologies, changes in value creation, structural changes, and financial aspects. As an instance of verification of the degree of digital transformation in their respective fields, I applied a set of criteria by Dehning et al. (2003, p. 654). The sample firms used IT to either fundamentally alter traditional ways of doing business by redefining business capabilities and/or business processes and relationships, and/or to dramatically change how tasks are carried out. The latter aspect leads to IT being recognized as important in enabling the firm to operate in different markets, serve different customers, and help gain considerable competitive advantage by doing things differently. This categorization served as a preselection criterion to ensure the companies have successfully initiated or completed steps of digital transformation (Eisenhardt, 1989; Miles et al., 2014).

A purposeful, multi-level sampling approach was applied (Fletcher & Plakoyiannaki, 2009), making two rounds of sampling necessary. I identified an initial set of seven SMEs that successfully mastered steps of digital transformation. In order to find basic concepts, I therefore used a critical case sampling approach. The cases were chosen as being "rich in information because they are unusual, special or make a point quite dramatically. The logic of this sampling strategy lies in lessons learned about unusual conditions or extreme outcomes manifested in the case." (see: Fletcher & Plakoyiannaki, 2009, p. 179). The cases were identified in cooperation with technological experts and consultants from the chamber of skilled crafts for Munich and Upper Bavaria, as they have the deepest insights into the business and operating models of the eligible firms. The SMEs under consideration had fully or partially transformed core elements of their business model (Osterwalder & Pigneur, 2010). Interviews and the sampling of additional data around these initial cases took place in July and August 2017, originally targeting the topic of digital transformation strategies (Trenkle, 2019). Therefore, core topics of the initial set of interviews were general questions about the digital transformation of the companies, covering aspects of management control only as a side aspect. Table 3-1 gives an overview of the seven initial cases including their core business, number of employees, the organizational scope of digital transformation, and major areas of success from digital transformation.

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Table 3-1: Initial cases to inspire code development for MCS in digital transformation (see also: Trenkle, 2019)

Company (1st interview phase)	Carpenter	Denturist	Electronics technician	Electronics technician	Joiner	Metalworker	Tailor
Abbreviation	A	B	C	D	E	F	G
Core business	Woodwork	Dental technology	Industrial fire prevention technology	Capacitive and optical sensor technology	Woodwork	Metal construction, plastics injection molding	Textiles
Number of employees	15–20	35–40	15–20	120–130	30–35	25–30	5–10
Organizational scope of digital transformation	Processes	Products and processes	Products and processes	Processes	Processes	Processes	Products and processes
Success from digital transformation	– Successful positioning in high quality, high margin sector – Efficiency gains due to lower qualification re-quire-ments in production – Reduction in marketing budget by 80 %	– Constantly enhancing client base by offering high quality dentures at lower cost in a shorter range of time	– Development of digitally enriched product providing USP – Efficiency gains by reducing manual office work & digital tools in pre-paration of assembly & installation processes	– Conquest of a niche market and USP deve-lop-ment	– Conquest of a niche market and USP deve-lop-ment	– Establishment of competitive plastics injection molding business	– Invention of techno-logically advanced, high quality fashion products

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After data collection and initial analysis of the first set of cases were executed, I went back to the field to collect data from four additional cases to double-check and expand patterns emerging from the data (Timmermans & Tavory, 2012). I thereby changed the sampling strategy from critical case to theoretical sampling, where the cases under investigation are supposed to fit to the "emerging concepts in order to explore the dimensional range or conditions along which the properties of concepts vary. The rationale of theoretical sampling is to select cases that are likely to replicate or extend the emergent theory, or to fill theoretical categories." (see: Fletcher & Plakoyiannaki, 2009, p. 179). Again partnering with technology experts and consultants from the chamber of skilled crafts for Munich and Upper Bavaria, I put the focus on SMEs that not only are known to be leaders in digital transformation aspects, but were also considered to be innovative in business model categories such as structured in their approach to execute business, being able to drive the discussion in interview situations more toward management control aspects. As is recommended for case study-based research to increase the likeliness of replication, I tried to choose "extreme situations and polar types in which the process of interest is 'transparently observable'." (see: Eisenhardt, 1989, p. 537, Pettigrew, 1990, p. 275). The resulting four additional cases formed the basis of my analysis, setting the focus of my study on SMEs ranging from around 20 up to 400 employees. Data collection in the second phase took place from September to November 2017. The interviewees in this round—one from each of the case companies—are listed below in Table 3-2, including additional company information.

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Table 3-2: Sample cases for second interview round—overview

Company (2nd interview phase)	Electronics technician	Modeler	Heating engineer	Precision mechanic
Abbreviation	H	I	J	K
Core business	Milking/stable technology; energy steering systems	Model and mold making	Installation and maintenance of heating systems	Mechanical parts for semiconductor industry
Number of employees	20–30	30–40	20–30	300–350
Organizational scope of digital transformation	Products and processes	Processes	Products and processes	Processes
Success from digital transformation	– Establishment of a new software business unit – Efficiency gains due to reduction in manual office and storage work	– Positioning as a preferred supplier for automotive and aerospace customers – Efficiency gains due to establishment of a digital test database for production programs	– Positioning as high quality heating specialist – Efficiency gains due to reduction in manual office work – Establishment of a new software business unit	– Positioning as a preferred supplier for semiconductor industry – Efficiency gains due to lower qualification requirements in production

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The final analysis and list of constructs are therefore based on 11 cases, which is slightly above the range of 4–10 cases recommended by Eisenhardt (1989) and Yin (2014) to ensure the quality and certainty of a qualitative study. Being located in a 100-kilometer radius around a major German city, all the SMEs share a common cultural background and cover urban as well as rural areas. As I claim generalizability across similar SME situations as provided by the cases under investigation, I applied an industry-spanning approach. All firms assessed the extensive use of digital technologies as generally beneficial across their value chains, regardless of whether the main source of value added stems from automation in production, digitally leveraged products, software products supplementing a hardware-oriented product portfolio, or the implementation of a web shop as the main sales channel. Therefore, I consider them leaders in digital transformation, being far ahead in terms of digital transformation of the current standards in their respective sectors.

By partnering with experts from the chamber of skilled crafts for Munich and Upper Bavaria, all cases under analysis are attributable to the German skilled craft sector, a German phenomenon, most members of which can be characterized as SMEs. The German "Trade and Crafts Code" lists 98 professions that belong to the skilled craft sector. Although shielded by law, the classification of a skilled craft business is not clearly delimited, as companies characterized in this manner can provide both services and manufacturing goods (Glasl et al., 2008). As soon as a company fulfills the legal requirements to be a skilled craft business, its membership of the chambers of skilled crafts is mandatory. Almost all skilled craft firms can be considered family firms, where management and ownership lie in the same hands (Glasl, 2007). Around 1 million companies in Germany belong to the skilled craft sector, of which 55 % have below five, 24 % have 5–9, 13 % have between 10 and 19, and the remaining 8 % have 20 employees or above (Statistisches Bundesamt, 2017).

I continued sampling until the new insights emerging from additional case analysis was minimal. At this point, I was not able to identify additional dimensions regarding particular aspects of MCS from an interview, the dimensions, constructs, and themes seemed well developed in terms of their properties and demonstrated variation (Fauchart & Gruber, 2011).

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3.3.3 Data sources

I used my network within the chamber of skilled crafts for Munich and Upper Bavaria to identify both the seven case companies for the primary round of analysis as well as the four additional cases. Technology experts and consultants are in regular contact with a broad range of SMEs from the skilled craft sector, some attending 200 appointments with company representatives annually. Using their experience, I asked them to provide me with contact details of representatives from companies that fulfill the already mentioned criteria. I was given the opportunity to benefit from their well-developed personal relationships, as they first contacted the owner-managers via telephone or email and asked them whether they were willing to participate in the study. This approach proved to be highly successful in terms of willingness to participate as well as openness in the upcoming interview situations. There were no refusals to participate, although time management became critical because of time constraints regarding the availability of company representatives. After my introduction by experts and their consent to participate, I sent the potential interview partners an email that explained the purpose and scope of the study, asking for an interview at the company site. The resulting semi-structured, open interviews with the owners and managers of SMEs from different sectors in skilled craft businesses were the main source of valuable data. The chosen procedure involves risk prevention with regard to three potential challenges in interview situations: "lack of trust", "lack of time", and "level of entry" (Myers & Newman, 2007).

In order to facilitate upcoming data analysis, I let a junior researcher join the interview situations whenever possible. Only two exceptions were caused by time constraints, when interviews were arranged at short notice. All interviewees were owner-managers. The primary approach to interviewing the owner-manager to gain knowledge around the digital transformation journey of a SME and its driving rationales was derived from the "focus of many family firm owners to keep control of the firm by also conducting the firm's management." (Dekker et al., 2013, p. 81–82). Nevertheless, interview situations were not closed. Whenever the owner-managers within the interview situation suggested inviting additional staff, I let, e.g., children working in the company or co-managers join. Overall, I conducted 11 interviews within the primary seven cases and one interview each in the additional four cases.

The interviews were recorded, and no participant imposed any restriction with regard to recording. At the start of each interview, I explained

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the context and targets of the project, not focusing on the given phenomenon of MCS in digital transformation, but instead asking the interviewees to elaborate on their firms' digital transformation journey, core areas of digital transformation, and their personal attitude toward technology, all in the form of an informal discussion. Whenever they explained a development step in their company, I asked them to go into the details of guiding rationales, thoughts, evaluations, convictions, opportunities, drawbacks, etc. Potential general questions were: How has your company developed throughout digital transformation? What changes occurred? Who was involved in decision making? How do you evaluate success in terms of digital transformation? Have you adapted the structures of your company? Given the broad field of investigation, these questions helped to give a necessary amount of guidance to the evolving conversation, while still allowing flexibility to explore in depth any issue raised by the interviewees.

All interviews were taped and transcribed. This led to more than 400 pages of written interview data. I triangulated the interview data obtained, according to availability, by additional information (e.g., Flick 2014; Easterby-Smith et al. 2008; Guba et al. 1981). Taking into consideration the systematic approach to triangulation of Denzin (1978), who distinguishes four different types of triangulation (data sources, investigators, theories, and methods), I applied two differential strategies: different data sources and different investigators. Potential sources of information were the firms' websites, social media entries, newspaper articles, books, gild information material, event invitations and summaries, and financial information. A conceptually comprehensive approach was hampered by the scarcity of structured information around the SMEs under investigation. Therefore, I had to confine myself to comparing interview data with publicly observable actions, which still yielded interesting insights, especially when elaborating the thick description.

3.3.4 Methods of data analysis

Data analysis included multiple iterations of coding. The written interview transcripts were imported into the data analysis software MAXQDA. Within a first cycle of coding, segments of data were conceptually labeled searching for evidence of control measures throughout the companies' digital transformation journeys (Saldaña, 2016). By making use of constant comparisons, I searched for appropriate classifications. This process resulted in the first version of a code book, which was a list of descriptive codes

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at the level of first order concepts (Gioia et al., 2013), including their properties. To give an example, in a data block where the interviewee explicitly or implicitly describes a company's controlling limitations to the use of technology, e.g., based on ethical concerns, this block was coded as implemented "boundaries of technology use". Cross-case analysis among the initially collected seven cases was applied to "improve the likelihood of accurate and reliable theory, that is, a theory with a close fit with the data" (Eisenhardt, 1989, p. 541).

In the second round, the concepts were then grouped into categories, a set of higher level concepts under which I grouped the lower level concepts that subsequently became subcategories. These second order categories will be referred to as themes in line with Gioia et al. (2013). To stay with the given example, I found interviewees explicitly or implicitly describing the company's core aspiration levels considering digital opportunities in business and operating models, defining "uniqueness". Together with the concept of "boundaries of technology use", I introduced the category, i.e., theme, "digital values". This was the point in the data analysis process at which I went back to the field to collect the additional four cases. A majority of patterns found in the original cases were replicable by the newly generated data, whereas new concepts also emerged from the additional cases (for a description of this replication strategy, see, e.g., Yin 2014; Miles et al. 2014, p. 103) by this systematic seeking of the full range of variation of the research object.

Using data structure figures proposed by Gioia et al. (2013), in a third round of coding, the categories found were further aggregated into core categories, i.e., aggregate dimensions. This last step led to a final set of four dimensions that seek to describe a comprehensive system of management controls, able to foster successful digital transformation in a SME context.

In order to give the context necessary to ensure a satisfying degree of transferability, junior scientists, after joining the interviews at the company sites, were asked to deliver summarizing case reports. These reports were used in two ways: The in-team discussion clarified understanding of digital transformation and supporting management control measures. Furthermore, summaries of the reports are presented as thick description in this paper, intended to support readers' understanding (Guba et al., 1981). The work of junior researchers included the coding of the data. Ambiguities and misunderstandings were eliminated using a negotiated agreement approach (Campbell et al., 2013).

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3.4 Case descriptions

The next paragraphs report major digital transformation developments in the four theoretically sampled cases under investigation from the second round of interviews. Special emphasis is thereby given to embedded management control measures. Taking an ex post perspective allows the treatment of explicit as well as implicit control measures and actions as equal. I label all observations toward management control, aside from the original formal or intuitive intention of the company owners.

3.4.1 Electronics technician (H)

The company under investigation is a founder-owned firm, about 80 kilometers outside Munich and specializing in sales, assembly, and servicing of automated machinery in dairy farming. Founded in 1992 as a single-man business, it had grown to about 30 employees at the time of this investigation. With the agriculture sector already depending heavily on digital tools, the firm specializes in sales and installation of highly digital enriched milking robots, additional electronic stable equipment, as well as automated steering software for single-farm energy consumption and production systems. The company has two branches, providing an emergency service in the case of machine failure at client sites within a few hours every day of the year. Since 1997, when milking robots became industry standard, the company has been able to deliver yearly double-digit growth in sales.

In the past 20 years, when the company first introduced computer technology for automated data processing, the owner has seen digital technologies as a normal source of efficiency increase. Various initiatives have already been implemented or tested. Inventory management and barcode-based warehouse logistics enable optimized traceability of consumption and the whereabouts of components. Current projects are dedicated to the introduction of cloud solutions, online document management, and smartphone app-based documentation of working hours. Furthermore, maintenance appointment planning is another procedural example that is already supported by automated database technology. On the product side, the company always headed for differentiation by focusing explicitly on sales, installation, and maintenance of high-tech milking robots, automated feed systems, and analytical hard- and software supply chain supervision tools. To enable fault-free operation of the installed machinery, the compa-

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ny is offering a digitally enabled remote maintenance service. Furthermore, the owner, together with technologically skilled employees, developed an energy management system for agricultural operations. It is used to manage locally produced electricity from farmers' own plants such as photovoltaic, wind, or biomass, which many farms have at their disposal. The intelligent control of electricity and its storage in batteries, ice reservoirs for milk cooling, the use for heating water to disinfect milk tanks, or for charging electric vehicles and equipment can provide considerable savings for farmers. As a result of the increasing automation on the client side, the firm was also able to constantly expand its expertise to the same extent and benefit from this development.

When considering additional technology investments, the basic motivation was mostly to scale activities with the current staff, e.g., current initiatives are targeted to speed up internal information exchange and billing, and reduce multiple manual data recording and checking of hours. Further motives for IT investments are an assurance of increased functionality and flexibility as well as higher security standards, thus preventing the internal IT infrastructure from becoming outdated. In this way, before entering a project as well as when evaluating a project's success, the owner assesses its potential benefits. Depending on the subject, financial figures are not generally calculated, but on a case-to-case basis. Decisions for investments are made exclusively by the owner, but input from employees is always actively encouraged within team meetings. The owner sees no advantage in a dedicated financial investment budget in technology, as a clear distinction between technology and non-technology investments is not possible. Projects are financed exclusively via traditional financing channels such as internal financing or bank loans. Public funds are considered unnecessary. For the issue of financial and operational risk mitigation, a spin-off including external equity financing of current software development activities is taken into consideration.

The in-house digitization projects are planned and carried out in cooperation with an IT service provider. Only the creation and maintenance of the homepage was carried out by the company itself.

As employee acceptance has appeared to be the most critical factor when striving for digitally enabled process improvements, several initiatives try to ensure staff support. Monthly employee interviews have proven their worth in clarifying problems. In addition, the provision of smartphones and laptops per employee leads to greater acceptance of the technologies and simplified cooperation workflows. Before entering a technology optimization project, feedback from employees plays a strong role in the per-

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sonal assessment of the company owner. Initiatives with a fundamental impact on work processes are tested and evaluated by internal lead users before going live, based on expected benefits such as time savings or process simplification. Even after the introduction of a new system, if it lacks acceptance by the employees in regular operation, it may well be discontinued. Taking digital warehouse optimization as an example, the initial initiative had to be abandoned after a couple of months. After 3 years, an optimized system was put back into operation including hiring a dedicated warehouse clerk, which increased employee acceptance. Another project served to digitize the assembly plans and thus to allocate the employees to the various orders for the current week. However, the system was not suitable for the high flexibility required as a result of plant failures as well as changing individual conditions on the individual construction sites. On the basis of these findings, the system was finally abolished again, showing evidence of a trial-and-error setting.

To overcome the biggest obstacle to expansion, the lack of skilled personnel, the owner offers employees the chance to get involved in programming or product development activities next to their job routine, thus leveraging their intrinsic technology skills.

3.4.2 Modeler (I)

The model construction company in the analysis was originally established in the 1960s. The current owner-manager took it over from his uncle at the beginning of the 1990s. At that time, all process steps were carried out by hand with only minimal mechanical support. Even during training with his uncle, today's owner recognized the potential benefits of automated manufacturing technology: for example, an efficient administration of the production programs, fast manufacturing with numerical control machines, and the manufacturing of complicated geometries. He had therefore already convinced his uncle of investments in digital technology during the handover phase.

In a first step, numerical control machines, a programming system, and digital measurement equipment were purchased and digitally networked, striving for efficiency gains from the abolition of floppy disk handling. The resulting flexibility and production speeds were well received by customers from the automotive and domestic appliances industries. From five employees at the beginning, the company has since grown to just under 50 employees today. The company still manufactures design and functional

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models, especially for the automotive and aviation industries. A special focus is on the processing of carbon fiber. As the company is regionally well recognized as an innovative leader, the owner is a member of political consultation committees at the highest level. He is a regular speaker on technology at dedicated professional meetings, which he uses on purpose for both networking as well as profiling and positioning his company.

Through its work for very attractive customers and the modern design of workspaces and production halls, including the latest technology, the company succeeds in recruiting highly qualified employees as required. Attractive technical facilities for private and business use are a matter of course.

The entire technical infrastructure, including the company's work stations, software program configuration, network systems and servers, are managed by an external provider. If employees have a technical problem, they approach the service provider independently. Here, the boss places full trust in the abilities of his employees, striving for a non-hierarchical organization where employees can approach the management without any hurdles. This implies open communication from top-down as well as bottom-up. In daily work routines, the use of digital tools such as desk sharing or advanced video-conferencing is mandatory. External partners are also integrated into the production process via technical communication interfaces.

Design and production are organized highly consistently. Employees write production programs and simultaneously book production times on the milling machines. This guarantees high quality production and optimum utilization of the technical potential of the machines regarding forward speed and dimensional scope. Digital test programs are used for production preparations to guarantee optimum feed speeds in the respective machine–material combinations. A continuous improvement process along speed and quality criteria, production and assembly times is the focus of the owner-manager's controlling. The goal is to reduce manual interventions along the production process as far as possible. Key financial figures such as sales or profit earning capacity play a minor role in planning the yearly degree of utilization, because of a planning lead time of just a few months. Nevertheless, as the owner-manager considers financials to be a result of well-structured operations, he ascribes the linkage between operations-oriented control measures and long-term business development high importance.

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3.4.3 Heating engineer (J)

The company was founded by the current owner and has been constantly expanded since 2004. Today, the company employs almost 30 people. In its core business, the company concentrates on the high quality installation of heating systems. The offer is supplemented by remote maintenance for both private and business customers. In order to ensure as high an efficiency as possible throughout the enterprise, the owner focused on the application of digital techniques from the start. With a background in measuring and sensor technology, the owner-manager himself considers digital opportunities to be a major future driver for his business. Based on a structured process model of his firm, the owner-manager exploits and explores new technologies by prioritizing areas according to the expected benefits, especially scalability based on existing resources and steady growth. On this path, he has already acquired two competitors in order to gain additional workforce. The focus in digital transformation is on the order processing workflow that is as technologically integrated as possible. Manual intervention at all levels, be it order creation, customer service provision, warehouse management, backoffice support and invoicing, is to be reduced. The main goals include increasing profitability, maximizing customer satisfaction, and minimal management influence in the service provision processes. Hierarchies are flat, yet there is a clear distinction between management and field staff. The owner-manager ideally does not want to get involved in the daily business, seeing himself more in a strategic leadership role. Digital transformation actions are targeted to support this role, yet he admits that his firm has not reached the estimated level.

Owing to limited financial and personnel resources, where management is solely in the hands of the owner and his wife, new digital transformation initiatives and targets are defined every year on a rolling basis. Digital transformation started with digital order management in the merchandise management system. The goal was to increase accuracy in the invoicing of service provisioning and installation, e.g., to bill consumed and assembled goods and working hours correctly. Bearing in mind those economic metrics and usability by mechanics in the field, the company developed a digital management cockpit together with other owners in similar situations. This system combines a customer relationship management system with a real-time order tracking functionality. After several development steps, involving regular research and development circles including subsidized research funding, this system has emerged to a full-scale field management software. The owner has real-time overview of pending orders and can op-

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timally allocate his employees. Financial key performance indicators such as sales and projected profits are available on a running basis, including a comparison year-on-year. Operation- and quality-focused performance indicators can also be extracted from the system, allowing the setting of standards and enabling steady company growth. The field staff have tablet computers at hand, supporting a predefined workflow and allowing automated data exchange with the office staff via web applications, email, and photos. External partners are partially integrated, and selected suppliers are bound by customized interfaces. Final, full-scale integration with the warehouse management for automatic invoicing is already planned, making the paperless company a vision, which is about to become reality within a few years. As a side effect, the field management system is nowadays distributed to other companies via a separate legal unit.

The owner-manager sees the impact that digital transformation has among the staff as a selection process. Employees who acknowledge the support of their work by digital tools are motivated, attracted, and bound to the company; employees who dislike the enclosed full transparency of their daily schedule leave the firm willingly. This offers every single employee the chance to steer his schedule according to what he considers to be the most economical use of his resources, leveraging overall perceived working quality and results.

External IT service providers are engaged in various positions. Data are hosted on cloud servers to allow plug-and-play integration in the case of hardware outages. Freelancers supported the development and implementation of the field management software. Customers can contact the company and place inquiries via a user-friendly website, with the design being optimized based on user experience. In addition, the company is present on a manufacturer-owned online transaction platform.

The company finances its digital transformation activities based on cash flows, bank loans, and selected government subsidy funding. Still, financial controlling objects such as sales, costs and savings, and profit are subordinate to operational measures, targeting process and structural improvements.

Trial and error as a control measure is not mobilized systematically. When evaluating the usability of the field management system, the owner-manager tested some alternative configurations. When implementing the system throughout his own firm, a limited transition period allowed the employees to get used to the system and to customize features. Still, trial and error as a distinct measure is limited to product development.

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3.4.4 Precision mechanic (K)

The company was founded by the current owner family about 40 years ago. Started as a two-person business, it employs more than 300 people today. The two sons of the founding couple are members of management. The company specializes in high-precision parts for the semiconductor industry. Most recently, it launched a self-developed, highly specialized 3D printer to cover an additional business segment.

Owing to early cooperation with large industrial companies and the resulting competition, the firm was encouraged to stay at the edge of production technology from the start. From punch cards to initial machine networking to central data storage to complete networking of production preparation and production, the company has gone along with every technological step. Recently, the company has been testing the use of robots that, in cooperation with employees, can further increase the speed of the production process. The main challenge along this digital transformation path has been to keep all interfaces in line; some projects were delayed by years because of lack of interface permeability, data consistency, and data quality. Most interfaces must be customized, combining data on products to manufacturing technologies. The production process is monitored digitally in real time. This means that data on incoming orders, order status, machine operating status, and customer inquiries is recorded, monitored, and optimized by the company management at any time.

Automated interfaces connect the company to its main customers, who send orders directly to the order management system. Data are then exchanged reciprocally, and actual data from produced workpieces are returned for further usage to the customers. Similarly, the company itself is interconnected to its core partners, e.g., tool suppliers. If any problem occurs, digital communication tools such as desk sharing are mobilized.

The company has a high demand for qualified manpower. In order to win the war for talent, the company opens up production facilities for society and conducts targeted public relations, e.g., in the local press or at schools, in order to recruit employees. The digital transformation journey has further increased the attraction, as young talented people as well as experienced skilled workers or lateral entrants are on recent recruitment lists. All employees are asked to share ideas on technological improvements openly, with either their supervisors or the management team.

As the largest company in the analysis, the company is structured hierarchically on account of its size. The current structure has been established in recent years to ensure manageability. Overall responsibility for digital

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topics lies with top management, but the department manager level also has objectives for digitization. Employees can make suggestions to their managers at any time, which are then passed on to the company management in aggregated form. Specially designated employees are responsible for the technical performance of selected machines ("machine godfathers"), and they also perform other operational functions throughout the production process. In order to be able to produce continuously, the machines are equipped with an automated emergency call system that sends an error message to employees during shift breaks when the machine is at a standstill. Employees can communicate interest if they wish to fill key digital positions.

When evaluating digital transformation activities, the management focuses on quantitative and qualitative operational objects first, e.g., throughput times, production speed, energy savings, and product quality. Expected sales, costs, and cash investments at a project level are brought in in relationship to these figures in the case of major process-influencing investments to measure the estimated impact. If only single production steps are involved, the company experiments with new technologies without any further consideration in order to increase efficiency by evaluating their impact on workers and their interplay with machines. Trial and error does not play a structured role in the company's management control efforts.

3.5 Results: Components of a digital transformation control system

The companies under investigation show great variance in management control measure use throughout digital transformation. The following section reveals four control dimensions, their essential specifications, and characteristic expressions that mark a digital transformation control system. Figure 3-1 provides an overview of the four dimensions: cultural controls, planning, administrative controls, and performance-indicator-based control objects. Selected examples from the case companies highlight the findings that are based on explicitly implemented control measures as well as implicitly or subjectively used controls that owner-managers in the companies consider. All measures are summarized in overview presentations in the appendix of essay II, i.e. appendix 3–1—3–4.

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Cultural Controls				
Digital Values		Digital Symbols		Digital Personnel
Planning	**Administrative controls**			
Digital risk management	Digital controlling procedures	Communication policy	Organization structure	Governance structure
Performance-indicator-based control objects				
Financial objects of control		Operational objects of control		Web-based objects of control

Figure 3-1: MCS package similar to Malmi & Brown, 2008, adapted for digital transformation.

The general control categories evolving from the data are summarized, adapting the MCS as a package framework of Malmi & Brown, 2008. The findings are subject to one general curtailment: aspects of strategic planning were excluded from the analysis. For dimensions and planning options when developing a digital transformation strategy, see, e.g., Hess et al., 2016.

3.5.1 Cultural controls

All cases under analysis are driven by a culture encouraging innovation and technological curiosity. Without this, a digital transformation-leading position in the sector is not attainable. This culture is manifested in three observable patterns: digital values, digital symbols, and digital personnel.

Digital values: Company owners are aware of strategic as well as operational opportunities provided by technology exploitation and exploration. In order to benefit, they need to allocate scarce financial and personal resources to their adoption. Digital values are thus basic principles that guide digital transformation—explicitly by core values that are formulated and internally or externally revealed, or implicitly formed by guiding thoughts that owner-managers apply when evaluating digital potentials. They take two basic forms: The value (1) "uniqueness" describes owners', i.e., companies', core aspiration levels when considering digital opportunities regarding value-creating activities such as client services, service levels, products, or processes. As one interviewee stated, "We are highworkers – we are not engaged in crafts, we are engaged in highcrafts." This mission is spread around employees as well as customers. In contrast, the value (2) "boundaries of technology usage" sets limitations on the use of technology, e.g.,

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based on ethical concerns. "When machines start to interact with humans, boundaries have to be clear. That is not a funny issue." is an example statement from the data that describe this aspect.

Digital symbols: Besides being explicitly mentioned by the company owners, the values are transported by digital symbols. I was able to identify three potential areas played by company owners to signal the high emphasis they place on technology usage. One is a ubiquitous (1) "public presence" of technology related topics, where the company is present on websites, in newspaper articles, or social media channels, always fostering high technological standards. This can also mean offering inside views of the company production facilities, e.g., by "open doors days". Interviewees stated, "An attractive and convenient website, showing our abilities, is elementary today." or "We are open to the public, give interested people insights to our plants, and use social media for attracting talent." Another form of symbol is (2) "signaling hard- and software", where the high standards of technological equipment within the company and among the workforce are purposefully used to impress employees, customers, or the interested public. "We need to show our clients the highest technological standards, so they take us seriously." And "all work stations are equipped with high-level, design computers, signaling progress." are examples that mark this category. Another form of digital symbol is (3) "elementary publications", i.e., published technology-specific books and brochures, where, e.g., the company owner reveals his deep knowledge of technology topics from his field to the public. This category remains less often used among the companies under analysis. I found one interviewee stating, "I have written down my findings in a book, triggering debates with practitioners and academic staff." Another one: "Printing elaborate brochures on high-value paper is a considerable investment, but it is worth it."

Digital personnel: A last category of digital controls I find in the data is the availability of sufficient digital personnel, which can be observed in two ways. On the one hand, this means the (1) "attraction of talent", where the companies prove their ability to attract digital talent at the individually necessary scale. The use of this aspect as a control measure is indicated by the following statement "Employees today want to work in a digitally enriched environment, it means a lot to them." Digital talent thus refers not only to the technical skill level, but also a value aspect: "Today we attract talent that values transparency provided by the usage of digital tools." Besides, I also consider a (2) "technologically knowledgeable leader" as a control measure itself. It is common among the case companies that all owner-managers show a high personal level of ambition around technological ad-

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vancements. Being aware of their central role in leadership, they consider this fact necessary to create a successful digital transformation journey. All of them give statements such as: "Most things I could do myself, I have acquired the necessary knowledge." or "I read a lot, about business and technology. I have the personal ambition to understand everything."

3.5.2 Planning

Within planning as an ex ante form of control, a company sets goals to direct employee behavior and provides standards to be achieved (Flamholtz, Das, & Tsui, 1985; Malmi & Brown, 2008). As I have mentioned before, strategic planning issues were excluded from the analysis in order to reduce complexity in this research project, and as the issue is subject to other scholarly examination. Therefore, my analysis finds one central category that is subject to extensive planning efforts in the cases under analysis, the management of risks arising from technology adoption.

Digital risk management: Despite overweighing potential benefits that company owners ascribe to extensive technology usage, they are aware of incorporated risks. Two areas of concern are targeted by control measures among the cases under analysis, the first one being (1) "data theft prevention". Owner-managers, being aware of their leading and exposed positions, fear losing knowledge of products and processes to competitors or value chain partners. This not only incorporates proprietorial intellectual property, but also knowledge of customers, who place their trust in the reliability of the case companies. Therefore, they take extensive efforts to minimize threats from data theft. Example statements: "We carefully consider which data we give to partners outside the company." and "We have to be in line with highest security standards – that is an essential prerequisite by our clients." A second area of concern is (2) "digital disaster recovery planning", where companies introduce measures to ensure persistence in the case of major hardware, software, or network outages. This can be triggered by customer requirements, e.g., when "Clients expect to know what happens when a fallout occurs? This is an evolving task that needs to be updated regularly.", but can also be critical based on company-intrinsic considerations, when data and the availability of networks are critical to ensure sustainable functioning of processes. "Cloud data in general is safer than data on company owned servers. Therefore, we can be sure that critical data can't get lost."

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3.5.3 Administrative controls

The case companies use a range of measures that are explicitly focused on controlling the process of value creation. Administrative control measures summarize procedures, policies, and structural interventions occurring in the course of a digital transformation endeavor to ensure manageability, i.e., creation and distribution of information and knowledge, responsibilities, and accountabilities.

Digital controlling procedures: I find five dedicated procedural methods in use in digital transformation that are mobilized to extract key performance indicators (see next chapter), thereby allowing managers to gain explicit knowledge on the expected benefits and drawbacks of decisions and actions. This knowledge includes quantitative monetary information (sales, investments, costs, profit earning capacity, etc.), other quantifiable information (e.g., timelines), and more qualitative information (complexity, acceptance, etc.). (1) "Life cycle planning" targets to schedule machine and software investments and reinvestments along with technological improvement opportunities, enabling companies to streamline opportunities arising from technological improvements with imperatives along with the assurance of technological reliability throughout machinery and software landscapes. Company owners state: "We always evaluate future reliability when evaluating technology investments." and "All replacement investments are driven by technological improvements." Another measure in use is (2) "classical budget/actual comparison" of business-related figures, although the difference occurs when management cockpit tool and instrument usage allows real-time calculations. One participant in the study made clear: "I use our management cockpit twice or three times a day to see our current situation and headroom for optimization." Further procedures include (3) "scenario analysis in make-or-buy situations" to compare the value from internal vs. external provision of knowledge and resources toward technology, and (4) "target costing", i.e., to evaluate product prices according to customers' willingness to pay. While the first is used commonly among the cases ("With regard to products and services, we always evaluate whether it might be advantageous to rely on external providers."), the latter is only applied by two cases under analysis.

Guiding the overall interest of the study, cases under analysis make regular use of (5) "trial-and-error" circles. This means that they enable experimental settings, incorporating external (customer) and/or internal (employee) user experience. Potential foci target the product offering, e.g., innovative combinations of material and 3D printing technology to develop

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a new product offering in company B, as well as the enrichment of workflows with digital tools, e.g., an optimized allocation of employee resources to assignments in company H or the introduction of robots to selected production lines in company K. Interviewees state: "In case of really new products, that never existed, experiments are absolutely necessary." "Robots were really new for us. We are carefully analyzing the benefits, trying different process alternatives, before we rollout on a larger scale." Nonetheless, none of the cases under analysis relies on experimental methods as a sole alternative to more conservative procedures, already known in past decades when digital methods were not omnipresent. As one interviewee clarifies: "In a case where no relevant financial investment is necessary, we just introduce a service and see how customers react." Other cases agree on this view, not only regarding services, but also including tools and product development activities. For "trial-and-error" to become a valid extension of the management control spectrum, it needs situations with an ex ante capsulated scope, limited initial financial investments, some relevant capabilities among the existing staff or existing core partnerships, and vision by the owner-manager to guide efforts. It is not a sense-making tool, randomly applicable independently from an individual company's situation.

Communication policy: The way in which information streams are directed and supported is crucial and a target of extensive consideration among the case companies. I identify four political principles regarding communication. Most company owners agree on the importance of regular (1) "bottom-up communication", actively fostering upward feedback regarding acceptance, benefits, and potential areas of improvement relating to the use of technologies. This can lead to an overall absence of hierarchies, where all employees including the owner-manager communicate face to face, to a simple encouragement to share ideas openly: "It is important to ask the employees: 'How do you like it?' – They have the best knowledge." This bottom-up communication often happens in informal daily business situations, but is also the core driver of regular, formalized (2) "technology dedicated meetings". Their institutionalization is ascribed high importance to create official platforms for exchanging innovative ideas, including giving rationales that drive management decisions and explicating individual employees' value-adding ideas throughout the digital transformation journey. To give examples from the interviews: "For us, communication is extremely important. Meetings among the leadership team as well as involving every single employee take place every week.", "Technology issues are collected throughout the entire company and discussed at least once a month

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among the whole team." Further political considerations also include the (3) "usage of digital tools", "externally" to communicate with partners (suppliers, customers) and (4) internally, using platforms for communication and knowledge sharing. External tools include video conference calls or desk sharing, so that "co-working across the value chain becomes normality" and "connections via team viewer in discussions with suppliers make it possible to solve problems instantaneously." Internally, one case company uses an intra-organizational social media-like platform to share knowledge, documents, and client information. A more common internal digital communication lever is sophisticated, customized data pools, e.g., to simulate production processes across departments, or to document order fulfillments to offer a more accurate client service and at the same time speed up the billing process.

Organization structure: The organizational structure needs to enable necessary flexibility to allow for adoptions outside the established business processes to support successful transformation activities. This entails enabling the inclusion of necessary skill sets, accounting for additional employees in IT-related positions, and enabling the management of critical interfaces along the value chain. I find four organizational measures supporting management control in digital transformation. Within (1) "digital lead user groups", some case companies ring-fence limited numbers of employees from the rest of the organization, giving them the objective to get used to and prove the benefits of new technologies. After a few weeks or months, these employees get back to their normal organizational environments, become promoters of the technology, and thereby enable it to spread around the rest of the employees, infecting the whole company. One interviewee stated: "When introducing a new tool, I pick a group of employees, let them try it, and ask for feedback before a company-wide rollout, incorporating investments on a larger scale." Whereas these groups can potentially be found in all parts of the organization, there is a focus on (2) "digital sales capacity" targets to ensure that especially sales resources understand digital channels and digitally enriched products. To speak in the words of interviewees: "Offering highly innovative products requires dedicated sales efforts – clients have to be convinced by a professional." and "If somebody orders a table online, she demands supreme online service as well. Availability on all channels is a must." Besides sales, (3) "headcount in IT positions" is affected in the course of a digital transformation journey, as soon as a company does not rely solely on outsourcing IT-related positions. To account for adaptations in IT-related headcount, three cases consider reassignments and new hires. "Investing in technology itself is

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not enough; often I need to hire staff that can handle the technology." Most cases see (4) "critical interface management" as a key organizational challenge. The optimal design of organizational interfaces along changed workflows, e.g., between production preparation, production, sales, is considered an imperative, regardless of whether the measure is used consciously to increase process efficiencies ("Throughout our workflow from design to production, people need to know technological requirements and limitations.") or unconsciously to achieve other business objectives such as excellent customer service ("As clients place their order directly in our ERP, our process design must take care of this.").

Governance structure: Whereas organizational aspects focus on process organization, governance measures are targeted to ensure that enterprise structures reflect the challenges of technology adoption. This includes managerial controlling activities that come along with the increasing influence of IT in general, external providers, and the growing number of employees who see technology not as "something new", but rather as something "natural". I find three governance measures that the cases under analysis introduced to account for technology adoption. Most evident is (1) "technological authorization management", where company management delegates executive activity and decision making regarding the use of technologies to knowledgeable specialists among the firm's staff. In general, the case companies consider action in this respect important to account for a rising degree of required special knowledge. Owner-managers admit that technology adoption and management increase the amount of top management decisions to be made at a technically detailed level, causing perceived overload. An example quote: "At some point, it becomes too much complexity for myself. I needed a professional who takes over responsibility." On the contrary, innovative workflow systems enable shifting routine activities from office and management to the field, yielding headroom for corporate development activities at top management level and perceived value added with non-managing employees. "We have given more responsibility to the employees in the field. Procurement, service documentation, etc. So there was a whole host of changes, which, I think, have led to a little bit of everyone coming back to a certain level." Another form of explicit governance control measure is (2) "technology contractor management". Company owner-managers assign the management of IT contractors fully or partially to operative employees without a formal management role. As most cases under analysis make use of outsourcing regarding vital IT functions, their connection to the management and accompanying responsibilities must be clarified. An interviewee sums it up: "An external profession-

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al is supervising our IT. He is almost part of the management." Besides the reduction in problems arising in principal–agent situations in general, the main rationale throughout digital transformation is to leverage dynamic reactions in the case of vital IT application outages that makes the partial delegation of power from owner management to employees useful, if not necessary. "It does not make any sense for me to control everything. I trust my people. If one has a technical problem, he himself calls the contractor." A last, yet only structurally used in two of the cases, measure, is (3) "preference-based job tasking". Owner-managers let employees enjoy a high degree of freedom toward individual exploration of technology. As the case companies experience how young employees naturally show a great interest in digital technologies and bring along capabilities in IT applications outside their normal job routines, they seek to benefit from windfall profits regarding the qualifications of their employees. These benefits can lead to an increase in motivation: "Every employee wants to be the first to work with the new machine. They wait for it, so I can assign the one who is most energized. This is highly motivating." Furthermore, it helps to deepen the roots employees have within their employing firm, diminishing the risk of individual boredom and resulting enticement: "Those young employees are really deep into IT. If I can offer them the necessary degree of freedom for personal development, the firm stays attractive for them."

3.5.4 Performance indicator-based control objects

The companies under analysis calculate a number of indicators in order to assess the potential advantages and disadvantages of digitization measures. I find evidence for three different areas that are illuminated by quantitative performance indicators in the course of digital transformation. Next to financial and operational objects of control, web-related aspects especially are explored numerically. The numbers obtained from the calculations form a central junction within the digital transformation control design. On the one hand, they are mobilized by some of the aforementioned types of control, e.g. procedures such as real-time budget/actual comparisons. On the other hand, they intend to operationalize, measure, and visualize most of the other types of control, enabling a cybernetic function of target setting, evaluation, and modification.

Financial objects of control: Financial considerations play a superior role in SMEs when it comes to planning digitization activities. All the cases under analysis mention the great importance of financial indicators, not only

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when evaluating technology investments, but throughout all investment decisions. Therefore, financial observation points in the control of digital transformation do not differ from general, basic financial indicators, yet the owner-managers mentioned eight measures explicitly in the interview situations. With regard to (1) "charge out rates", owner-managers focus on necessary adjustments caused by digital improvements, which may offer the opportunity to realize higher margins or to gain competitive advantages from lower prices. Case H: "Technology eases access to day, night, and holiday surcharges to calculate charge out rates more precisely." Changes arising in labor expenses due to adaptations regarding skill and job requirements emphasize the importance of (2) "labor costs" as a financial control object. Case G: "Technology professionals demand salaries way above what we are used to paying." New customer habits regarding communication and an arising shift in sales toward digital channels lead to the necessity of recalibrating (3) "marketing expenses", taking into account digital channels such as websites, social media, and platforms in contrast to and combination with traditional offline channels such as newspaper ads or mailings. Case A: "We were able to decrease our marketing expenses by 80 % due to a shift from offline to online marketing." (4) "Total IT investments" and (5) "running IT costs" are both financial categories under direct influence over the course of adapting digital technology, making them self-evident objects of management control. Case I: "Of course we calculate the necessary investment. It's a vicious circle. Once you play along in the high-end sector, customer expectations trigger an investment spiral." By adding the expected influence of technological improvements in the business and operating model on (6) "sales", the firms' owner-managers evaluate the (7) "profit earning capacity", i.e., the overall financial benefits associated with technology investments. Case D: "Turnover is a very convincing figure to calculate the benefits of technology investments – not on a single-investment perspective, but strategically." Case J: "Profit earning capacity is an important aspect, not in the short run, but long-term." When it comes to funding digital transformation endeavors, the SMEs under analysis are actively screening the market for, e.g., scientific government subsidy programs granted for technology investments, making (8) "subsidy funding quota" another object of financial control. Case G: "Government and scientific subsidies are necessary, without them nothing would happen."

Operational objects of control: All owner-managers agree that, in considering and evaluating technological improvements, processes play a major role. Operational aspects relate to the process elements that are critical to

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the speed of value creation and the speed at which companies can realize the benefits from technology usage. I find four operational control objects. Technology improvements alongside necessary process alternations can require several months until they reveal their potential positive effects. Companies under analysis take into account transition periods for systems to work, and for organization and staff to get used to technology usage, controlling (1) "adaptation time". Considerations include an adaptation period of staff to technology usage, new workflows including data handling, and software selection times, whereby the evaluation of the future viability of software providers is crucial in the decision on a software provider. Focusing on their staff and the importance qualified personnel play at a strategic and operational level, selected cases ascribe (2) "employee motivation" a special importance, thereby emphasizing employees' positive associations with routine use of technology. Case D: "I see the expenses associated with a tool, and I can relate it to acceptance by the staff, they like it, and I see it is no longer dispensable." Case K: "There are always people who do not feel comfortable with change in workflows. They need to see the benefits to be in, e.g., increased production speed." All cases agree on the importance of (3) "processing time" and control essential influence factors in the value creation process. Examples include failure rates, interface complexity—measured by the frequency of manual entries of the same data alongside the value creation process—shipping times, production and assembly time per object/order, and the time span between the provision of a service or product provision and the related invoicing. Finally, cases take into account (4) "scalability of current activities", thereby judging the ability to increase scale in current activities based on technological improvements by calculating the degree of utilization of machines and employees before and after technology investments. This last control object is related in the examples to a bottleneck perspective in the value creation process. Actively considering flexibility in personnel deployment reveals headroom where existing human capacity can be allocated more efficiently based on technology-oriented job infusion. Case H reveals: "Our website and social media integration were developed by an employee, who is a tech fanatic." Cases E and G, on the contrary, focused on their machinery to scale their operations, as they evaluated the potential benefits from including robots in production lines, taking into account that production machines did not operate at capacity limits.

Web-based objects of control: The online channel as an addition to traditional offline sales channels incorporates an imperative such as a website, accompanied by additional tools such as social media platforms, and web

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shops. Along come opportunities to evaluate the success factors of each channel, to communicate with customers, and to build or even lose reputation. Some cases under analysis make extensive use of web-based controlling. I distinguish four different objects of control. The most common is (1) "search engine positioning", where cases watch and steer their placement in relevant search engines. They admit: Case A: "Of course we look on web ranking and play around with search engine optimization and marketing." Case H: "It is important that we are found by clients. We are very active in this direction." Furthermore, cases constantly control their (2) "web recessions and valuations" by screening and interacting on online commentaries, judgments, ratings, or reviews. Case D: "If a potential customer nowadays is interested in a company, he/she reads recessions." Case I: "Also business clients look online for valuations and experiences from peers. The search engine ranking in that case is not too important." When the website is considered a central element in the sales process, cases control (3) "website convenience", where they scrutinize customers' and partners' experiences when entering the company website and relate improvements to user experience. Case A: "We regularly get feedback from customers that their attention was caught by our website; they appreciate structure and information density." Case I: "Especially for new clients, the website is extremely important. They not only appreciate the final product, but also our technical equipment." The interplay between website and social media is targeted by selected cases via (4) "web journeys". They measure discoverability and click journeys by defined target groups via digital channels to customize the overarching online experience, apart from the website, to user preferences. Case H: "On Facebook, it is very easy to see which information was considered valuable, e.g., via likes." Case I: "Applicants, but also young engineers from existing and potential customers, appreciate the sort of information and pictures they get via social media channels."

3.6 Discussion

This paper identifies four categories of a digital transformation control system by revealing the variance of indicators that were applied by SMEs that successfully transformed either their business and/or their operating models based on technology adoption. The driving thoughts of SME proprietors and managers who are leaders in digital transformation are condensed into a package of controls, applying a case-based research design.

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By setting my results into the context of the existing literature on MCS as a package, I aim to elaborate on how the specific context of digital transformation can be operationalized in a comprehensive control framework. This study reveals categories and concepts of controls suitable for application in digital transformation. The categories evolving from the data show fit to the "MCS as a package" framework of Malmi & Brown, 2008, where different types of management controls are systemized to a package for further empirical research. This indicates the encompassed exhaustiveness of different types of management control measures supporting successful digital transformation. Covering *cultural*, *planning*, *administrative*, and *performance indicator-based controls* fostering successful digital transformation, a broad theoretical understanding of management controls is provided by reference to Malmi & Brown, 2008, which supports the high degree of generalizability of their MCS framework (see also: Strauß & Zecher, 2013). Potential influence factors such as societal context and types of rationality are left out (Broadbent & Laughlin, 2009).

Adopting the Malmi and Brown, 2008, "MCS as a package" view allows me to show the wide variety of measures and at the same time neutrally attribute the same level of impact to all categories in order to discuss the specifics of digital transformation control as opposed to general aspects of management control. In contrast to Merchant & Van der Stede, 2012, I do not find evidence for a strict command and control process, where management control measures are only used to execute a predetermined strategy without an influence of MCS on the development process of strategic initiatives. I find both evidence that SME managers act deliberately and monitor a strategic initiative based on defined measures, and also evaluate indicators subjectively or consider measurements implicitly, thereby re-adjusting their strategy. This observation positions my results in line with Simons, 1995, who sees an influence of MCS on strategy as MCS "serve as 'levers' for implementing business strategy and achieving profit goals" (see: Strauß & Zecher, 2013, p. 247). Compared with both Merchant and Van der Stede's 2012 results, actions and personnel/culture as objects of control, as well as Simons', 1995, belief, boundary, diagnostic control, and interactive control systems, my findings serve to detail applicable measures in the context of digital transformation, e.g., by including trial-and-error as a controlling procedure or by introducing web-based key performance indicators. Yet, in contrast, both concepts enclose informal control mechanisms such as values and beliefs only if they are written down and thereby become formalized. This narrow point of view would exclude observations from my data based on interpretation, which gives my results higher ex-

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planatory power in the context of SMEs, where MCS appear to be less formalized and sophisticated (Quinn, 2011).

Cultural controls are revealed in three forms. Digital values seek to motivate uniqueness by use of technologies and incorporate boundaries of technology use, e.g., based on ethical concerns. Digital symbols are dedicated signs that signal to the general public, especially the interested public, and internally the priority that management assigns to technology. Both value categories operationalize well-established accounting concepts. Simons, 1995, describes values as belief systems to direct organizations, as is the case in the companies under analysis. Symbols, on the other hand, are visible expressions of innovativeness and modernity, and thereby influence employees' behavior (Schein, 2016). As a third cultural control category, I identified digital personnel to be a control measure highly valued by SME owner-managers. My study corroborates that of Malmi & Brown, 2008, by including Merchant & Van der Stede's 2012 selection of talent capable of technology usage as a cultural control measure. This categorization is based on some company owners' assessment that digital transformation at least partially involves a paradigm shift in corporate culture toward more transparency and agility. Furthermore, regarding personnel, SME owner-managers act with a high degree of self-reflection on their personal level of knowledge of technologies, being aware of themselves as a key resource driving digital transformation. This control perspective so far has not been tackled by existing management control frameworks, making the assessment of technological knowledge of management candidates an interesting field for further examination.

As stated before, *planning controls* were excluded from the research scope, as they are discussed in prior research on digital transformation strategies in great depth (see, e.g., Hess et al. (2016); Matt et al. (2015)). Still, I find at least some evidence among the cases under analysis in this study that the application of control measures always incorporates a portion of planning, both on 12-month action planning as well as at a long-term strategic level (Malmi & Brown, 2008). Planning toward digitalization thereby occurs on a rather informal, subjective, and estimative level than in an extensive goal setting and standard development sense (Flamholtz et al., 1985), which drives me to the conclusion that a dedicated planning process does not take place as part of the digital transformation itself, but is integrated into the regular corporate planning process. Exceptions to this are considerations relating to the management of risks arising from the ongoing digitalization process. Here, some cases show a structured and detailed framework with clear, action-oriented standards to-

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ward data theft and digital disaster recovery planning. Furthermore, I do not find any evidence that reward and compensation measures (see, e.g., Bonner & Sprinkle, 2002) are adopted by SMEs in digital transformation, either emphasizing individual use of digital technologies or regarding digital transformation of the overall organization.

I generally find the three groups of *administrative controls* of Malmi & Brown, 2008. Digital controlling procedures cover institutionalized processes and standard behaviors used to direct SMEs' digital transformation efforts. Yet my findings are limited to the use of standardized management procedures for decision making (Malmi & Brown, 2008; Simons, 1987). The characterization as procedures thereby is primarily based on the classification of my findings based on formalized, well-established financial accounting procedures. Not surprisingly, considering the size and structure of the cases under analysis, I do not find measures to be regarded as policies in the context of digital transformation. I regard trial-and-error circles as a digital controlling procedure, referencing what Merchant & Van der Stede 2012 call action controls. Focused trial-and-error circles represent a behavioral constraint, incorporating pre-action reviews and action accountability. As the cases under analysis reveal, they are one measure among a set of other formal procedures, primarily used in new product and new service development, or when reworking processes significantly, i.e., not just replacing process steps, but redesigning workflows, and when financial risk is limited and not affecting a company's existence. Once these conditions are met, business owners address the usefulness of experimental settings, but do not attribute them the power of a fundamental paradigm shift in management. No business owner will see anything fundamentally new in this.

The organization structure is adapted significantly throughout the SME digital transformation endeavors under analysis. In particular, digital lead user groups, digital distribution capacities, and critical interface management are organizational innovations that have been introduced to promote business transformation. This finding supports Malmi & Brown, 2008, in ascribing the organization structure a control function instead of a contextual variable. Similarly, focusing the formal lines of authority and accountability (Abernethy & Chua, 1996), the governance structure is impacted by digital transformation. Management team responsibility was excluded from analysis in this project, yet we focused on operational control activities explicitly targeting digital transformation activities. Preference-based job tasking, technological authorization management, and technology contractor management appear to be new concepts in MCS designs.

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I introduce "communication policy" as a new administrative control dimension, based on the importance that SME owner-managers ascribe to this aspect of digital transformation. Prior management control research mentioning rules, procedures, policies, operating manuals, next to job descriptions and other operational prescriptions used to be rather unspecific regarding the specific context and area of application (Macintosh & Daft, 1987; Simons, 1987). The setup of information flow and information infrastructure is considered elementary for success in dealing with technology by the cases under analysis in this study. Bottom-up communication, digital tool usage when communicating internally as well as with partners or customers, and technology dedicated meetings therefore represent control measures able to deliver a high degree of value added in digital transformation.

As a last group of controls, I identify *performance indicator-based control objects*. This dimension of MCS is related to cybernetic controls (Malmi & Brown, 2008). Green and Welsh, 1988, characterize cybernetic controls by five criteria. They enable quantification of an underlying phenomenon, activity or system, set standards of performance or targets to be met, comprise a feedback process that enables comparison of an outcome with the target, include an analysis of the variance arising from the feedback, and last allow modifications of the system's behavior or underlying activities. To enable this role, quantitative performance indicators are in use. As I am executing this research under the paradigm of interpretation, which allows me to include implicit actions undertaken by the empirical units of analysis, it occurs that not all performance indicators arising from this analysis are motivated in a purely cybernetic way. Sometimes, they lack, e.g., consistent standard or target setting and yet are only used as a source of information rather than as a formal control object. Similarly, other controls do not comprise a structured feedback process as well as variance analysis, but are only evaluated irregularly and on purpose. This leads me to denote them as performance indicator-based instead of cybernetic. Among performance indicator-based controls, a set of financial objects of control play the most prominent role that leads to calculating the impact of technology investments at the business and operating model level on profit earning capacity, thereby showing no great variance from classical financial measurement systems. A novel finding of my study is the consideration of a subsidy funding quota around digitalization in four of the eleven cases under analysis. This aspect so far is only covered by management control literature on farming (Ndemewah, Menges, & Hiebl, 2019), leaving headroom for further investigation in future research. Non-financial measurement

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systems can be differentiated in a more general category around operational objects of control, and more specific web-based objects of control. Operational objects of control cover the influence of technology adoption on internal business processes, e.g., time to select and adapt hard- and software and to get staff onboard, to realize benefits from increased employee motivation as well as from time-oriented process optimization. These controlling objects are related to the internal business, i.e., process dimension within balanced scorecard models (Ittner & Larcker, 1998; R.S. Kaplan & Norton, 1992). I therefore do not consider them as being novel concepts, but an operationalization and update of a well-established classical instrument of control.

As a new group of controls, I introduce web-related objects of control into MCS design, i.e., search engine positioning, the evaluation and management of web recessions, website convenience, and web journeys of customers. This special accentuation is based on the relative importance assigned by the cases under analysis to a sophisticated management of their web footprint for their success in winning new customers, triggering interest by business partners, and overall increasing sales. The integration of web traffic-related performance measures, e.g., focusing on website usability or customer traffic flows, is already discussed in academia (e.g., Karagozoglu & Lindell, 2004; Sterne, 2002). The high degree of diligence that owner-managers of SMEs put into this category of controls justifies great attention in the design of a digital transformation control system.

3.7 Contribution, Limitations, and Conclusion

This paper outlines options for designing a MCS capable of promoting successful digital transformation in SMEs. Case studies of successful companies in terms of digital transformation provide the necessary context to place the results in operational reality. In this way, I contribute to the detailing of the existing literature on MCS. The theoretical contribution is an empirically founded basis on which the components of MCS and their interrelations can be analyzed further. Also, from this starting point, the value added nature of MCS with regard to success categories in SMEs, not only in digital transformation, but also in a general business context, can be investigated in greater detail. As a practical contribution, this work provides companies and their management with a structured framework of control measures so that success in digital transformation is not a happenstance, but the effect of a deliberate approach.

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One could argue that this paper is just giving a list of arbitrary options instead of introducing a comprehensive, logically derived, and connected framework. My research strives for applicability in all companies entering digital transformation endeavors, independent of their current level of professionalization. Therefore, I do not develop a comprehensive digitally balanced scorecard approach (see, e.g., in a family business context: J. Craig & Moores, 2005) in order not to wag the dog with the tail. My aim is to offer a framework of potential control mechanisms suitable for digital transformation efforts, independent of the original state of MCS. A link to the balanced scorecard concept would limit the results to cases that have already reached at least a minimum level of management control practice. Nevertheless, the incorporation of digital perspectives into the balanced scorecard concept would be an interesting path for further research.

As is common in qualitative research, the results obtained do not lay claim to be generalizable at an empirical level. Instead, the evidence presented from outstanding examples of digital transformation in SMEs was used to develop a range of arguments as to how MCS can be designed in order to foster successful implementation of digital technologies as well as execute digital transformation strategies. The focus on a clearly defined segment of the German economy and the incorporated collaboration with technology experts from the chamber of skilled crafts provided excellent access to the field and enabled a purposeful sampling approach at all stages of the project. Based on this analysis of successful examples of SMEs passing a digital transformation endeavor, I claim transferability and usefulness to the situation of most SMEs striving for a structured approach to tackle the challenge to stay competitive in the current digitalization environment. Still, this study is essentially based on the statements made by the owner-managers of the SMEs surveyed, who highlight the subject of control in the form of both explicit measures and implicit actions. Triangulation to confirm interview statements, e.g., with reference to cultural control objects, was possible, but as the internal decision-making area of the company was affected, many statements could not be assessed from a neutral or external point of view. Future scientific projects could, for example, take up the topic in the form of action research over longer periods of time in order to ascertain a connection between control measures and digitization success. Furthermore, the results of this study can also serve as a basis for large-scale descriptive studies in order to learn more about the dissemination and application of control measures in the course of digital transformations. As the progress of digital technologies across sectors may vary, as will the resulting necessity for companies to transform business

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and operating models, the usefulness of certain measures of control to support digital transformation is most likely to vary as well. Industry specifics are therefore another promising field of study.

Whether a company needs to introduce a dedicated digital transformation control system, or whether it needs to adapt already existing formal and informal control measures to incorporate viewpoints with essential importance in digital transformation cannot be decided from this study, which might be another interesting angle for further research. Yet, the cases under analysis in this study highlight the importance of structure and control in companies striving to benefit from digital technologies. Trial-and-error is thus nothing companies with an established and approved level of formality in their control systems have to be afraid of. It is an essential measure when developing new product and service offerings and establishing digitally enriched processes, but does not represent a complete paradigm shift in management control.

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3.8 Appendix essay II

Appendix 3-1: Cultural controls in digital transformation

Dimension	Theme	Concept	Description	Highlighting Examples
Cultural Controls (1/2)	Digital Values	Uniqueness	Describe explicitly or implicitly the company's core aspiration levels considering digital opportunities (Activities, client service, products, processes et al.)	– G: The great advantage of SME is the congruence of ownership and management; the values of the owner become part of the company's DNA. – I: We are highworkers – we are not engaged in crafts, we are engaging in highcrafts.
		Boundaries of technology usage	Describe explicitly or implicitly the company's limitations of the use of technology, e.g. based on ethical concerns	– G: When machines start to interact with humans, boundaries have to be clear. That is not a funny issue. – The individual business sense of every worker is important, despite digitally supported workflows.
	Digital symbols	Public presence	Present company fostering high technological standards in public and social media	– I: An attractive and convenient website, showing our abilities, is elementary today. – K: We are open to the public, give interested people insides to our plants, and use social media for attracting talent.
		Signaling hard-/software	Show high standards in technological equipment of workforce	– B: We need to show our clients highest technological standards, so they take us serious. – E: All workstations are equipped with high-level, design computers, symbolling progress.
		Elementary publications	Publish technology-specific books and brochures	– B: I have written down my findings in a book, triggering debates with practitioners and academic staff. – I: Printing brochures on high-value paper is an investment, but it is worth it.

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Dimension	Theme	Concept	Description	Highlighting Examples
Cultural Controls (2/2)	Digital personnel	Attraction of talent	Proof the ability to attract digital affine talent at necessary scale	– A: Employees today want to work in a digitally enriched environment, it means a lot to them. – J: Today we attract talent that values transparency and usage of digital tools.
		Technolo-gically knowledge-able leader	Show high personal level of ambition around technological advancements by owner/manager	– C: Most things I could do myself, I have acquired the necessary knowledge. – H: I read a lot, about business and technology. I have the personal ambition to understand everything.

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Appendix 3-2: Planning in digital transformation

Dimension	Theme	Concept	Description	Highlighting Examples
Planning	Digital risk management	Data theft prevention	Self-explanatory	– G: We carefully consider which data we give to partners outside the company. – I: We have to be in line with highest security standards – that is an essential prerequisite by our prototyping clients.
		Digital disaster recovery plan	Introduce measures to ensure company persistence in the case of major hardware, software or network outage	– D: Clients expect to know what happens when there occurs a fallout. This is a revolving task that needs to be updated regularly. – H: Cloud data in general is safer than data on company owned servers. Therefore, we can be sure that critical data can't get lost.

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Appendix 3-3: Administrative controls (1/4) in digital transformation

Dimension	Theme	Concept	Description	Highlighting examples
Adminis-trative controls (1/4)	Digital controlling procedures	Life cycle planning	Schedule machine/software reinvestments along with technological improvement opportunities	F: We always evaluate future reliability when evaluating technology investments. I: All replacement investments are driven by technological improvements.
		Real-time budget/actual comparison	Use digital enabled tools and instruments for real-time performance indicator checks	J: We always know where we stand, e.g., comparing order intake and sales. K: I use our management cockpit twice or three times a day to see our current situation and headroom for optimization.
		Scenario analysis in make-or-buy situations	Compare the value from internal vs. external provision of knowledge and resources toward technology	A: With regard to products and services, we always evaluate whether it might be advantageous to rely on external providers. H: If there is no employee who is able to take care of our website, we would engage an external servicer. It depends on the expected costs.
		Target costing	Set product prices according to customers' willingness to pay	C, G: We carefully research the enforceable market price in the R&D phase of a new product.
		Trial-and-error circles	Enable experimental settings for developing the company's offering or processes, incorporating external (customer) and/or internal (employee) user experience	G: In case of really new products that never existed before, experiments are absolutely necessary. E: In cases where no relevant financial investment is necessary, we just introduce a service and see how customers react. K: Robots were really new for us. We are carefully analyzing the benefits, trying different process alternatives, before rollout on a larger scale.

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Dimension	Theme	Concept	Description	Highlighting examples
Adminis-trative controls (2/4)	Communi-cation policy	Bottom-up com-muni-cation	Foster upward feedback re-garding acceptance, bene-fits and improvements re-garding use of technologies	H: It is important to ask the employees: "How do you like…?" They have the best knowledge. I: There is no explicit hierarchy. Everybody communicates face to face.
		External digital tool usage	Communicate with part-ners (suppliers, customers) using digital tools	I: Via conference calls and desk sharing, co-working across our value chain became normality. K: In discussions with my suppliers, we just connect via team viewer and problems can be solved instantaneously.
		Internal digital tool usage	Communicate internally using platforms for com-munication and knowledge sharing	D: We use an internal social media platform to share knowledge, documents, client information, etc. K: An internal database helps us to simulate production process-es across departments.
		Technology ded-icated meetings	Regularly hold meetings as platforms for exchanging innovative ideas	A: For us, communication is extremely important. Meetings among the leadership team as well as involving every single em-ployee take part every week. H: Technology issues are collected throughout the entire compa-ny and discussed at least once a month among the whole team.

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Dimension	Theme	Concept	Description	Highlighting examples
Adminis-tra-tive controls (3/4)	Organization structure	Digital lead user groups	Give a limited number of employees the objective to get used to new technologies to spread technology around company	C: When introducing a new tool, I pick a group of employees, let them try it, and ask for feedback before a company-wide roll-out. H: I always involve groups of employees who are interested in technological gadgets before large-scale investments.
		Digital sales capacity	Ensure sales resources understand digital channels and digitally enriched products	B: We hired a young, knowledgeable saleswoman—our clients believe her. H: Offering highly innovative products requires dedicated sales efforts—clients have to be convinced by a professional.
		Headcount in IT positions	Account for adaptations in IT-related headcount, e.g., by reassignments or new hires	C: Investing in technology itself is not enough; I often need to hire staff who can handle the technology. H: At some point of complexity in processes, or products, I needed to hire especially dedicated staff.
		Critical interface management	Design organizational interfaces along changed workflows, e.g., production preparation, production, sales	D: As clients place their order directly in our ERP, our process design must take care of this. I: Throughout our workflow from design to production, people need to know technological requirements and limitations.

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Dimension	Theme	Concept	Description	Highlighting examples
Adminis-trative controls (4/4)	Governance structure	Preference-based job task-ing	Let employees enjoy a high degree of freedom toward individual use of technolo-gy	A: We ask our employees about their preference to become ex-perts in the use of selected machinery. H: As soon as an employee shows interest, e.g., in coding, I try to let her or him develop in that direction.
		Techno-logical authorization management	Delegate decisions regard-ing technological aspects to knowledgeable specialists among staff	C: At some point, it becomes too much complexity for myself. I need a professional who takes over responsibility. J: We have given more responsibility to the employees in the field. Orders, service documentation, etc. So there was a whole host of changes, which, I think, have led to a little bit of every-one coming back to a certain level.
		Technology con-tractor manage-ment	Assign the management of IT contractors (fully or par-tially) to operative employ-ees without a formal man-agement role	E: An external professional is supervising our IT. He is almost part of the management. I: It does not make any sense for me to control everything. I trust my people. If someone has a technical problem, he calls the con-tractor himself.

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Appendix 3-4: Performance indicator-based control objects (1/3) in digital transformation

Dimension	Theme	Concept	Description	Highlighting examples
Performance indicator-based control objects (1/3)	Financial objects of control (1/2)	Charge out rates	Adjust charge out rate changes caused by digital improvements	H: Technology eases access to day, night, and holiday surcharges to calculate charge out rates more precisely. J: Charge out rates become transparent. Then we must write an invoice and clients sometimes are surprised by the actual amounts.
		Labor costs	Calculate changes in labor expenses due to changed skill and job requirements	G: Technology professionals demand salaries way above what we are used to paying. H: It is a question of volume whether it pays off to hire a digital design expert—they are expensive."
		Marketing expenses	Calculate expenses for digital vs. offline marketing	A: We were able to decrease our marketing expenses by 80 % due to a shift from offline to online marketing. H: A job ad in local newspapers is charged at 1,000 EUR, without the opportunity to influence dissemination. That is why we are shifting activities to social media.
		Total IT investments	Pay attention to necessary investments in digital technology	B: Over the course of the last years, we invested 1.2 EURmn in technologies. I: Of course we calculate the necessary investment.
		Running IT costs	Pay attention to necessary monthly or yearly costs, e.g., updates, service charges, rental charges, etc.	E: A lot of software companies are offering lease contracts at affordable prices. Therefore, we are taking into account monthly expenses. I: It's a vicious circle. Once you play along in the high-end sector, customer expectations trigger an investment spiral.
		Sales	Calculate expected influence of technological improvements on sales	D: Turnover is a very convincing figure to calculate the benefits of technology investments—not on a single investment perspective, but strategically. H: Digital improvements must result in higher sales.

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Dimension	Theme	Concept	Description	Highlighting examples
Performance indicator-based control objects (2/3)	Financial objects of control (2/2)	Profit earning capacity	Calculate financial benefits from technology investments	A: The new machine must yield higher performance, e.g., from lower costs or new product opportunities. J: Profit-earning capacity is an important aspect, not in the short run, but long term.
		Subsidy funding quota	Rely on, e.g., scientific government subsidy programs granted for technology investments	G: Government and scientific subsidies are necessary; without them nothing would happen. J: We just applied for a government funding program.
	Operational objects of control (1/2)	Adaptation time	Take into account transition periods for systems to work, and for organization and staff to get used to technology usage	A, D, E, J, J: Adaptation period of staff to technology usage C, D, I, J, K: Data handling including data transmission speed D, J: Future viability of software providers D, J: Software selection time
		Employee motivation	Emphasize employees' positive associations with routine use of technology	D: I see the expenses associated with a tool, and I can relate it to acceptance by the staff, they like it, and I see it is no longer dispensable. K: There are always people who do not feel comfortable with change in workflows. They need to see the benefits to be in, e.g., increased production speed.
		Processing time	Control essential influence factors on the value creation process	D, J, K: Failure rates A, C, E, F, H, J, K: Interface complexity—frequency of manual entries of same data B, E, G: Logistics—shipping times A, C, D, F, G, I, J, K: Production/assembly time per object/order C, H, I, J: Time from service/product provision & invoicing

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Dimension	Theme	Concept	Description	Highlighting examples
Performance indicator-based control objects (3/3)	Operational objects of control (2/2)	Scalability of current activities	Judge the ability to increase scale in current activities based on technological improvements	D, E, G, H: Flexibility in personnel deployment A, E, F, H, I, J, K: Workload of machinery
	Web-based objects of control	Search engine positioning	Watch and steer placement in relevant search engines	A: Of course we look at web rankings and play around with search engine optimization and marketing. H: It is important that we are found by clients. We are very active in this direction.
		Web recessions and valuations	Screen and interact on online commentaries, judgments, ratings, reviews, etc.	D: If a potential customer nowadays is interested in a company, he/she reads recessions. I: Also business clients look online for valuations and experiences from peers. The search engine ranking in that case is not too important.
		Website convenience	Scrutinize customers' and partners' experiences when entering the company website and relate improvements in user experience	A: We regularly get feedback from customers that their attention was caught by our website; they appreciate structure and information density. I: Especially for new clients, the website is extremely important. They not only appreciate the final product, but also our technical equipment.
		Web journeys	Measure discoverability and web journeys by defined target groups via digital channels	H: On Facebook, it is very easy to see which information was considered valuable, e.g., via likes. I: Applicants, but also young engineers from existing and potential customers, appreciate the sort of information and pictures they get via social media channels.

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