

1 Introduction

This dissertation consists of three essays, each of which is aimed at a selected field of interest in the course of digital transformation in small and medium-sized enterprises (SMEs). All essays share a common basis regarding the introductory background of digital transformation and relevance for SMEs. Therefore, this introduction starts with an explanation of basic definitions and concepts in the debate of digitalization, e.g., by linking the publicly discussed concept of digitalization with the management task of digital transformation. In addition, the relevance of the presented studies is highlighted by brief numerical background information on the SME landscape in Germany and Europe. In section 1.3, I give an overview of the practical and theoretical background of the three essays. Section 1.4 outlines some overarching as well as essay-specific methodological principles, before I summarize results and contributions in section 1.5 and conclude this introduction by outlining the structure of this dissertation.

1.1 Introduction to digital transformation

“Now a third revolution is under way. Manufacturing is going digital. [...] Like all revolutions, this one will be disruptive. Digital technology has already rocked the media and retailing industries, just as cotton mills crushed hand looms and the Model T put farriers out of work.”
(see: theEconomist, 2012)

We experience “new types of automation, growing digital networks, artificial intelligence and its application in predicting and influencing human behavior, mass surveillance, robotics and man-machine interaction, and power shifts towards some state and non-state actors. [...] the increasing digitization is changing the foundations of our existence...”
(see: ZEIT-Foundation 2018, p. 1)

Digitalization has been an omnipresent phenomenon for a decade. At all levels and among all members of society, definitions, impact, challenges, opportunities, and threads are discussed. What is digitalization, and how does it relate to digitization or digital transformation, further catchwords around the ongoing debate? What does digitalization mean for members

of a society, but especially for companies, and its management? How are businesses affected and what do they have to consider to secure a superior position in their relative competitive environments? The present dissertation identifies relevant observations and discussions from a theoretical as well as a practical perspective with regard to three major fields of interest in digital transformation: strategies, management control, and network involvement. These aspects in general have been empirically or conceptually targeted by scholars, but existing literature neglects the specifics of small and medium-sized enterprises (SMEs), and is restricted in terms of its empirical contexts, e.g. by targeting only selected industries, staying purely conceptual, or relying on private secondary data only. By addressing such shortfalls, which I will specifically mention in the topic introductions in sections 1.3.1 to 1.3.3, I will expand existing knowledge, thereby delivering core empirical findings to contribute to scholarly and practitioner discussions to foster successful development of SMEs dealing with technology absorption.

Therefore, in this starting chapter, I will first lay out some necessary definitions to put the existing literature around digitalization into order. I will also give a brief introduction on the expected impact of the growing technology infusion in daily business to explain the imperative for executives of all companies to consider concepts and measures toward technology usage. By drawing on the existing literature, I will derive three relevant areas of interest to expand existing knowledge on digitalization in the context of SMEs.

Digital transformation is the managed adaptation of digitalization, emphasizing the change aspect when introducing technology into a company environment. Throughout this thesis, I treat it as a “probabilistic organizational change philosophy where digital technologies are used to fundamentally transform an organization’s business model and value network” (see: Riasanow, Setzke, Hoberg, & Krcmar, 2018, p. 11). This incorporates the maximum breadth of intra- and inter-organizational influences that technology absorption can have on a company, its business model, and its operating model. Included are changes in ways of working, roles, and business offering caused by the adoption of digital technologies in an organization, or in the operation environment of the organization in order to ensure sustainable value creation (Gimpel & Röglinger, 2015; Wiesböck & Hess, 2019). The related terms digitization and digitalization are often used synonymously, which leads to a lack of precision that may cause confusion. Digitization relates to the (pure) technical process of converting analog information into a digital format (Katz & Koutroumpis, 2013; Ne-

groponte, 1995). By bringing all types of information down to the lowest common factor, i.e., binary digits, digitization dematerializes information and decouples information from physical carriers and storage, transmission, and processing equipment (Tilson, Lyytinen, & Sørensen, 2010). Thus, digitization is not the same as, but the prerequisite for, digitalization, which summarizes “manifold sociotechnical phenomena and processes of adopting and using these technologies in broader individual, organizational, and societal contexts” (see: Legner et al., 2017, p. 301–302). Three waves of digitalization have been identified: The first wave focused on technologies replacing paper as a physical carrier with computers, leading to greater automation in work routines. The second wave gave birth to the internet as a global communication infrastructure, resulting in changes to firms’ value creation logics and new types of businesses, such as e-commerce or intermediaries. Today, we are experiencing the third wave, where the converging SMAC¹ technologies and continuing miniaturization, combined with ever-increasing processing power, storage capacity, and communication bandwidth, have made the vision of ubiquitous computing come very close to reality (Legner et al. 2017, p. 301–302).² These definitions point out the variety of influences that company executives have to consider with regard to technology adoption. Some adoptions are simple replacements of analog vs. digital data, comparable to writing and processing reports on a digital device. Other changes, considering their influence on products and sales channels, may raise the necessity for revolutionary-like actions compared with a company’s status quo. Discussion of the management of digitalization-incorporated change is thus not new. Tushman & Reilly, 1996, introduce the principle of “ambidexterity” for successfully dealing with technology-related change in corporate environments. They claim that companies need to combine elements of exploitation and exploration to master evolutionary and revolutionary change within a single company, while at the same time admitting that implementation is quite difficult in practice. The management of digitalization still remains as intangible from a theoretical as well as a practitioner point of view as executives struggle to narrow it down to a clear agenda. In the managerial discussion, some see technology at the center of the discussion, whereas others focus on customer behavior and engagement; for some decision makers, it represents a completely new way of doing business (Dörner & Edel-

1 Social, mobile, analytics, cloud computing; see El Sawy et al. 2016; Kohnke 2017.

2 For an illustrative example to show the difference between digitization and digitalization based on the Finnish modus of tax gathering, see Parviainen et al. 2017.

man, 2015). “The challenge isn’t just to recognize innovative technology but also to apply it to your existing business model. In some cases, this requires breaking the business model and coming up with an entirely new way of doing business.” (Earley 2014, p. 58).

The necessity to define a management approach toward digital transformation follows directly from the massive and radical impact that digital technologies can have on companies and the society to which they belong (Yoo, Boland, Lyytinen, & Majchrzak, 2012). New sectors, new products, and new services will emerge, including the creation of new job descriptions (Degryse, 2016). New production technologies will foster the use of innovative materials, and automation across production processes will move jobs from the factory to offices and support the roles of designers, engineers, information technology specialists, logistics experts, and digital marketing staff. Technology can make repetitive tasks obsolete (theEconomist, 2012). Customer centricity becomes an imperative by re-thinking business models based on customer expectations, physical products and services are enhanced with digital capabilities, new technologies make assets more durable and resilient as data-based analytics are transforming modes of maintenance, and all this together will require new forms of cooperation and organization (Schwab, 2015).

Economists have identified technological change as one key engine of economic growth (Galenson, 2010). The positive impact of exploitation and exploration of digital technologies alongside their incorporated business opportunities as well as inherent threats for companies and societies are broadly discussed. Thereby, most authors fundamentally agree on the positive effects of digital transformation on companies, e.g., increase in sales and productivity, increased flexibility, more accurate capacity allocation, growth resulting from larger markets, and deeper market knowledge. Positive effects on employment, increased market efficiency, a higher standard in the quality level of goods and services, and increased innovativeness can be added to the list of beneficial expectations (Atkinson & Kay, 2018). Companies that do not address higher quality and innovativeness are potentially disrupted by new competitors or established competitors that adapt more quickly to the new environment (Downes & Nunes, 2013). Several retailers have gone under or failed to deliver profits for years as online retailing has become self-evident for most buyers. Analog photography has turned from being the industry standard to a hobby for enthusiasts. Products are replaced, and service models are remodeled by digital access options based on customers’ increasing convenience. Therefore, potentially negative effects pose severe threats such as the large-scale substi-

tution of human work by machines and robots and the resulting social inequality caused by the disappearance of large numbers of medium-skilled jobs (Brynjolfsson & McAfee, 2014; Earley, 2014), sophisticated criminal cyber activities (Greengard, 2016), and potential defamation or simply false information via social media channels. The necessity to establish management practices to govern these complex transformations leads to an acknowledgment that digital transformation is a high-priority management task and that digital transformation can cause competitive distortions at an as yet unknown level of dynamics, which makes steady observation of technologies even more important for company owners. None of the presented developments is limited to large companies only, instead all companies face the challenge to find appropriate measures to meet future challenges. This dissertation is focusing on SMEs as a distinctive field of research. Therefore, in the next chapter I will define SMEs as a specific research unit and emphasize their relevance.

1.2 Relevance of small and medium-sized enterprises

Across Europe, SMEs are considered to be one of the most important sources of success for the economic development (European Commission, 2015). SMEs are mostly owner managed and combine high innovativeness with a national or international perspective on markets and high levels of social responsibility. The future of this successful model thus depends on the ability to recognize the most important trends at a strategic level and, at the same time, to formulate answers to them at the operational level (Astor, Rammer, Klaus, Klose, & Böllhoff, 2016).

The European Commission, as shown in Table 1-1, defines SMEs based on their “Staff headcount”, their “Annual turnover”, and their “Total assets”.³

3 Details to calculate the numbers are given in (European Commission, 2015). A further requirement to be considered an SME is to be an autonomous enterprise (see: European Commission 2015, p. 15–16). The “or-” link between “Annual turnover” and.

Table 1-1: *SME definition of the European Commission (European Commission, 2015).*⁴

Category	Staff headcount	and	Annual turnover [€]	or	Total assets [€] ⁵
Micro	< 10		≤ 2 Mio.		≤ 2 Mio.
Small	< 50		≤ 10 Mio.		≤ 10 Mio.
Medium-sized	< 250		≤ 50 Mio.		≤ 43 Mio.

For example, in Germany, there are in total 3,483,691 companies registered, of which 3,461,555, i.e., 99.4 %, are SMEs. Together, they account for ~2,315 EURbn in annual turnover, representing a 33.2 % share of all companies' value added. They employ more than 16.0 million people, providing a job to 52.0 % of the German nation's employed population (IfM, 2018). These numbers indicate the outstanding weight that SMEs carry in German economic prosperity on an almost equal level since years (IfM, 2016).

Among the different types of SME companies indicated in Table 1-2, i.e., micro, small, and medium-sized enterprises, based on their staff numbers, the vast majority (88.1 %) are micro companies with fewer than 10 employees. Nevertheless, because of their high number, they account for 25.2 % of yearly SME turnover and 24.8 % of total SME headcount. Small companies (9.6 %) represent 32.2 % of annual SME turnover and 35.4 % of SME headcount. Medium-sized enterprises (2.3 %) stand for 42.6 % of annual SME turnover and 39.6 % of SME staff headcount.

4 Details to calculate the numbers are given in (European Commission, 2015). A further requirement to be considered an SME is to be an autonomous enterprise (see: European Commission 2015, p. 15–16).

5 "Total assets" indicates that at least one of the values must be below the given boundary value by a company in order to be categorized accordingly.

Table 1-2: 2016: SME details (number of companies, annual turnover, staff headcount) (IfM, 2018).

Category	Number of companies	% of SME total	Annual turnover [€bn]	% of SME total	Staff headcount	% of SME total
Micro	3,050,074	88.1 %	584,02	25.2 %	3,989,676	24.8 %
Small	332,821	9.6 %	746,11	32.2 %	5,718,568	35.6 %
Medium-sized	78,660	2.3 %	985,46	42.6 %	6,353,046	39.6 %
SME total	3,461,555		2,315.59		16,061,290	
Large	22,136		4,652.69		14,797,798	
Total	3,483,691		6,968.28		30,859,088	

Across the European Union, 99.8 % of all enterprises are considered to be SMEs, employing 66.% of the total workforce and accounting for 56.4 % of value added (European Commission, 2019; Eurostat, 2020). These numbers clarify the paramount importance of ensuring a beneficial environment for SMEs for the successful economic development of Europe.

SMEs have a number of special features that make them a differentiated research area compared with large companies. Pfohl, 2006, elaborates a range of special SME characteristics based on a broad literature review. Their (1) *leadership* is dominated by the company owner, leading to relatively scarce professional knowledge about management techniques, scarce decision making in groups, limited headroom for counteraction in case of mistaken decisions, and poor strategic planning. SMEs' (2) *organization* is tailor-made hierarchical, focused on the owner-manager, who accumulates several roles and interacts tightly across interconnected staff, shows a low degree of formalization, and can therefore be regarded as highly flexible. (3) *Production processes* are marked by a low degree of work-sharing. Machinery is deployed universally and depends strongly on a small number of basic innovations, which finally leads to low economies of scale. SMEs' (4) *sales* are used to meet demand in small dimensions, incorporating a high degree of customization, in a limited regional and/or highly specialized segment. (5) *Research & development (R&D)* activities are usually not institutionalized in a department structure and are executed at short range, incorporating a high degree of intuition. Often, new products and services are developed to meet demand and are less based on a fundamental research ambition, due to limited time budgets from invention to monetization. Regarding (6) *funding*, most SMEs are owned by families and do not have access to capital markets, which leads to overall limited financial re-

sources and poor risk mitigation measures. A small number of employees, especially when it comes to academic background, are a specialty regarding SMEs' (7) *human resources*. Further differences arise in the areas of (8) *logistics*, (9) *procurement*, and (10) *waste disposal*, which I consider as having a lower impact regarding the forthcoming research projects.

Furthermore, as many SMEs are family-owned businesses, I expect many attributes considering the management of family firms worth mentioning. As one example, Carney, 2005, describes three dominant propensities that characterize governance in family firms: *Parsimony* refers to the fact that family firms make decisions keeping in mind the family's personal wealth. As people tend to be more prudent with their own money, they are likely to consider opportunities more carefully and to search for opportunities more efficiently. *Personalism* centers authority in an owner-manager, reducing internal bureaucratic constraints. They tend to avoid formalized management and transparency practices that inhibit the prerogatives of ownership, potentially resulting in the freedom "to engage in longer-term innovation practices and in building internal knowledge structures conducive to finding opportunities" (Patel & Fiet 2011, p. 1180). *Particularism* refers to an owner-manager's ability to include non-rational, calculative criteria in her/his decision making. Motives and goals may be driven by noneconomic considerations such as altruism, nepotism, or the wish to improve social status. Further characteristics of family businesses with regard to decision making in situations of high uncertainty include a high degree of risk avoidance (Kontinen & Ojala, 2010) as well as a paucity of slack resources (Fernández & Nieto, 2005).

All these attributes describe the specialties that characterize SMEs as a distinct field of investigation. One can argue that the presented characteristics are still very broad and far from ring-fencing a homogeneous group of companies in which to conduct research. I explicitly target this broadly defined set of companies in order to maximize the theoretical as well as practical implications resulting from my studies. In the essays, I will elaborate the specifics of the companies that supported this research and thereby narrow the context, so that the reader can judge the contextual explanation power at an individual level. The variety of SMEs provides the fruitful context for all three essays to follow, targeting strategies in the context of digital transformation (section 1.3.1), management control throughout digital transformation endeavors (section 1.3.2), and finally potential network types to enhance limited individual innovation resources (section 1.3.3).

1.3 Background and literature

1.3.1 Strategy drives digital transformation

“Strategy, not technology, drives digital transformation.”

(see: Kane, Palmer, Philips, Kiron, & Buckley, 2015)

The first essay⁶ focuses on digital transformation strategies as managements’ and SME owners’ starting point to succeed in digital transformation. Companies seek competitive advantages from digital transformation by incorporating technology in their established business and operating models (Main, Lamm, & McCormack, 2018). Still, there is no standard recipe for digital transformation implementation. Researchers agree that this requires a holistic approach, across the entire organization of a company, across all operational processes, resources, internal and external users in order to thereby bring about a significant change in the habits and working methods of employees (Henriette, Feki, & Boughzala, 2015; Loonam, Eaves, Kumar, & Parry, 2018). Whereas leaders in digital transformation tend to rely on elaborate digital strategies, less digitally mature organizations focus on selected technologies only (Kane et al., 2015). Yet there is a scholarly discussion on how an integrated digital transformation strategy should be designed. Advancing digitalization and information technology will have a strong, inevitable impact on the business level strategy (Drnevich & Croson, 2013). So previous literature has focused strongly on the relationship between business and IT strategy and the alignment of both.

Across company sizes, earlier researchers called for an IT strategy aligned with but subordinate to the business strategy (Henderson & Venkatraman, 1993; Hirschheim & Sabherwal, 2001; Hussin, King, & Cragg, 2002). Along with the recent spread of social, mobile, analytics, and cloud technologies (SMAC), academic focus has shifted toward an integrated, strategic view of business and IT (Bharadwaj, El Sawy, Pavlou, & Venkatraman, 2013; McDonald, 2012), targeting an optimum level of digital transformation at the level of each individual company (Grover & Kohli, 2013).

Academia has made the first steps in order to generalize about necessary actions in digital transformation, laying the groundwork to develop frame-

6 Essay is published: Trenkle, Johannes (2019). Survival in the digital age – A framework for formulating a Digital Transformation Strategy in SME. *Proceedings of the 19th International Conference on Electronic Business* (pp. 428–442). ICEB, Newcastle upon Tyne, UK, December 8–12.

works for the configuration of a digital transformation strategy, but mostly failing to follow a holistic approach. As an example, a digital business strategy for online music content providers should incorporate insights from analyzing the mechanics of building, maintaining, and monetizing content as well as different groups of platform and community users, taking into account the digital management of their mutual interactions (Oestricher-Singer & Zalmanson, 2013). These results show the importance of an integrated view on business and technology at a company strategy level. Further case study-based articles target digital business strategies and organizational implications within the publishing and newspaper industry. These specific industries were chosen as examples in which competitive pressure from digitalization-induced change started relatively early (Horlacher & Hess, 2016; Karimi & Walter, 2015; Lanzolla & Anderson, 2008; Øiestad & Bugge, 2014; Oliver, 2018). The results incorporate the concept of exploitation and exploration in a digital transformation strategy, besides a focus on necessary innovation capacities and capabilities such as resources, processes, and values. A single case study from the retail industry adds inter- and intra-company organizational change aspects to the list of digital transformation strategy ingredients (Hansen & Sia, 2015). El Sawy, Amsinck, Kræmmergaard, & Vinther, 2016, derive the ingredients for digital leadership from a single case study of a world-leading toy manufacturer: a distinct business strategy and business model, an enterprise platform, digital mindset, high-performance corporate IT and workplace environment. Their results point the way to an appropriate level of practical orientation in information strategy research, which is in line with further claims from academia (see, e.g., Teubner, 2013).

Matt, Hess, & Benlian, 2015, developed a digital transformation framework to guide companies holistically when developing and defining a digital transformation strategy. According to its universal structure, the digital transformation of every company can be built up along four key dimensions that are well coordinated with each other (Matt et al. 2015, p. 340–341):

Use of technologies: a company's strategic position and future ambition toward new technologies, as well as its ability to exploit them. The firm can choose whether it strives to achieve market leadership in terms of technology usage, creating the opportunity to set its own technological standards, or whether it relies on proven standards and limits its technology use to streamline business operations. The definition of a technological level of ambition is incorporating a decision on business risk—triggering a trade-off between the competitive advantages of becoming a technological mar-

ket leader and standard setter and the risk of technological failure and the imperative of investments in technological competences.

Changes in value creation: the influence of digital transformation strategies on the way a firm aims to add and create value. It contains an estimation of the steps of change in its classical, analog core business toward new, digital activities. It depicts opportunities to expand and enrich the current products and services portfolio as well as requirements for different forms of monetization or adjustments to firms' business scope if there is a change in addressed markets or customer segments.

Structural changes: modifications in a company's operations, i.e., structures, processes, and skill set. Exploitation and exploration of new technologies and digital activities may require structural adaptations, e.g., in the management setup. An assessment is important in this context whether it is mainly products, processes, or skills that are affected by change. It might be reasonable to integrate limited adaptations into existing corporate structures, whereas changes that are more substantial might be fenced better in a separate subsidiary within the firm.

Financial aspects: deliver transparency about the urgency to act in the face of declining margins in a firm's core business and about a firm's financial scope to invest in a digital transformation endeavor. Financial power fuels and limits every strategic transformation. In times of potentially disruptive change, lower financial pressure on the core business may reduce the perceived urgency to act, whereas companies already under financial pressure might lack external ways to finance a transformation. An open assessment of the financial situation is therefore considered a prerequisite for transformational success.

Matt et al. (2015), discussing their digital transformation framework, call for further research on digital transformation strategies, considering different industries as well as different firm sizes. The four categories have therefore been detailed further, based on case study insights from medium-sized to large media companies (Hess, Benlian, Matt, & Wiesböck, 2016), as well as insurance corporations (Wiesböck et al., 2017). As a result, the "use of technologies", "structural changes", and "financial aspects" dimensions show potential for generalization, at least in an environment of companies above 500 employees. Regarding the "changes in value creation" domain, single industry-focused studies are highly specific, with the results prohibiting any generalizing conclusions. Small companies with fewer than 500 employees or even smaller enterprises and their differentiating characteristics remain unaddressed within existing studies. Therefore, to my knowledge, there are no scientific studies yet focusing holistically on

the issue of digital transformation in SMEs. An analytical transfer of the existing results around digital transformation strategies to an SME setting is possible, but the specific conditions in SMEs are not sufficiently appreciated, and the results would not be equal to those of previous studies in terms of their empirical foundation and significance.

Hence, this essay seeks to enlarge the existing literature on digital transformation strategies in an SME context, as I raise the research question: *How does the SME context influence core elements of a digital transformation strategy?* Following a theoretical categorization by Helsén et al., 2017, I take a research view between “contingency theory” and a “situation-specific approach” to elaborate theory in the field of digital transformation strategies. Explicitly targeting SMEs, I expect that a digital transformation strategy must be tailored to each organizations’ context, but at the same time is constructed from a range of categories that can be generalized across various firms. The target is to find a set of guiding questions that a SME—represented by its management—can follow in order to define its digital transformation strategy along an empirically derived path of question and answer options. This structure proved to be a promising way to present results based on the already mentioned examples from industry-specific, large corporation environments (Hess et al., 2016; Wiesböck et al., 2017). The hereby identified strategic questions are enriched by answer options, identified by analyzing the experience of SME managers who successfully handled digital transformation in their companies. This procedure intends to provide a twofold, value-added approach: extending existing scholarly research on digital transformation as well as bridging the gap to practical, everyday business challenges. Focus is therefore not on the timely process of digital transformation, but on the variety of strategic considerations of the management, as well as visible occurrences in the companies.

After defining a digital transformation strategy in a first step, it all comes down to execution to become a digitally successful enterprise. Scholars provide an array of empirical evidence, that management control measures might support decision makers in SMEs to manage digital transformation journeys in a performant way. Therefore, the second essay, which I will introduce in section 1.3.2, targets “digital transformation control”.

1.3.2 Management control as a success lever throughout digital transformation

“The ability to plan business decreases. Accordingly, it is indispensable to continuously check the validity of the premises underlying the planning and the business model and to develop a controlled trial-and-error culture”
(see: Schäffer & Weber, 2016)

The management of digital transformation remains a challenge for leaders in companies of all sizes. The bandwidth of potential influences includes adaptations of company’ visions, methods of value creation, structures, and finances (Matt et al., 2015). I assume that any support managers can get throughout this complex change process is warmly welcomed, building the logical bridge toward management control systems (MCS), i.e., systems, rules, practices, values, and other activities that management puts in place in order to direct employee behavior (Malmi & Brown, 2008).

Yet the definitional challenge remains around the variety and breadth of the term management control, especially in the SME context. Scholars, when analyzing MCS in the context of SMEs, include classic literature in the field of management accounting, enclosing organizational rules and routines (see: López & Hiebl, 2015; e.g., Burns & Scapens, 2000; Johnson & Kaplan, 1987), the multidimensionality of a balanced scorecard approach (R.S. Kaplan & Norton, 1992), 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). The breadth of investigated objects and phenomena points toward the particular German concept of “controlling”, a coordination function within a company’s leadership system to align planning, control, management information, organization, and human resources management (see e.g., Küpper et al., 2013).

This viewpoint is also supported in the existing literature. Some examples are mentioned here in order to show the variety of aspects under consideration when analyzing MCS in SMEs. De Lema & Duréndez, 2007, analyze the adoption of management control tools in a sample of family vs. nonfamily firms, taking a particular financial focus, and look at management accounting systems, cash budgets, and financial analysis. Within their implementation, they see a database for gaining transparency on full costs and therefore delivering decision support for financial planning and control systems. Finding that family firms make less use of such analytical tools, they conclude that a more structured approach may provide benefits for family firms, yet lacking further detail. Gunawan, Ellis-Chadwick, &

King, 2008, add performance indicators to the discussion that fit especially to online activities. This includes financial aspects as well as nonfinancial activities, including logistical processes such as delivery and returns as well as web excellence performance indicators such as website popularity and customers' online shopping experience. The resulting selections of around 30 performance indicators on web retailing and 30 dimensions of performance indicators remain highly specific to online retailing and neglect, e.g., the structural or cultural aspects of management control. Budgeting and incentive scheme design from a SME perspective have been identified, among others, as further differentiating aspects within the scope of management control (Jorissen, Laveren, Martens, & Reheul, 2005). Various potential measures of cash management usage as part of performance management have been shown by Howorth & Westhead, 2003.

Across the variety of potential measures, scholars have identified in general three motives of SME managers in introducing MCS measures: a wish to increase *business performance*, a higher level of *professionalization*, and a higher degree of *rationality in taking decisions*. The following paragraphs give background on these motivations.

SMEs implement MCS in general driven by the wish for *performance optimization*. Performance thereby captures managers' perceptions of their firms' competitive position (Duréndez Gómez-Guillamón, Ruíz-Palomo, García-Pérez-de-Lema, & Diéguez-Soto, 2016), product profitability improvements, and cost reductions (Adler, Everett, & Waldron, 2000), improved product development performance (Davila, 2000), or overall financial performance (e.g., J. Dekker et al., 2015; Sharma & Bhagwat, 2007; Songini & Gnan, 2015). In the case of a high degree of management autonomy, as is the position in owner-managed SMEs, MCS usage leverages financial performance, measured by sales growth, return on sales, gross profit, and net profit as well as return on equity and return on investment (Kallmuenzer, Strobl, & Peters, 2018). In order to explain the provenance of positive performance impacts, there is evidence that the adoption of management control techniques improves SMEs' ability to control costs, measure performance, determine investments, and fix prices, thereby allowing SMEs' resources to be optimized (Laurinkevičiūtė & Stasiškienė, 2011; Villarmois & Levant, 2011).

Amat, Carmona, & Roberts, 1994, show that SMEs, like all other companies, develop over time on an institutional level, striving for *professionalization*. This ambition is credited to challenges from external factors such as competition and the social and political environment, as well as internal

factors such as the need for profitability, adjustments in control and authority. Amat et al., 1994, show that this continuum of recurring tensions provides the origins for simple, partially formalized MCS, setting the basis for an ongoing increase in professionalization regarding management practices. Paternalistic management practices, based on direct supervision and nonfinancial controls, can be replaced by standardized processes and financial controls (see also: Giovannoni, Maraghini, & Riccaboni, 2011). Craig & Moores, 2005, highlight the ability of a balanced scorecard model, adapted to the special conditions in family firms, to support successful company development. They find that objectives in the fields of systems and structures, employee friendliness, knowledge-sharing, openness, and familiness encourage a professional management style, vital for firms' development. In order to formalize the discussion on the process of professionalization itself in SMEs, Dekker, Lybaert, Steijvers, Depaire, & Mercken, 2013, introduce four types of family firms (Autocracy, Domestic Configuration, Clench Hybrid, and Administrative Hybrid), based on their degree of usage of multidimensions of management control instruments. From this typology and the dimensions used, Dekker, Lybaert, Steijvers, & Depaire, 2015, show that especially the professionalization measures "non-family involvement", "implementing human resource control systems", and/or "decentralizing authority" result in a positive effect on a firm's performance. Nevertheless, professionalization does not appear on its own. It requires family members' adequate education in management accounting or business, a family's esteem for the associated information, and finally willingness to professionalize management control (Hiebl & Mayrleitner, 2017). Given these prerequisites, management control measures can act as a sort of common language to drive SMEs' process of professionalization (Giovannoni et al., 2011).

An increase in leadership *rationality* is another beneficial finding related to the use of MCS in a SME context. Assuming the individual firm-optimized level of graduation, i.e., an adequate level of calibration with regard to calculative controls, family-centric controls, procedural controls, and especially pragmatic and minimal controls, the use of MCS "[...] can foster economic rationality and thereby reduce familial affectivity" (El Masri, Tekathen, Magnan, & Boulianne, 2017, p. 179). El Masri et al., 2017, argue that it is about every SME on its own deciding whether it wants to strengthen a business or a family identity, relying pervasively on either rational control measures or minimal, pragmatic measures, and call for a company-specific calibration, an important aspect in facilitating the attain-

ment of objectives by the adequate use of management control instruments.

A partially independent body of literature focuses on the benefits that SMEs can realize by the use of MCS. These include facilitated decision making (Chand & Dahiya, 2010; Duréndez, Madrid-Guijarro, & García-Pérez-de-Lema, 2011; Villarmois & Levant, 2011), improved quality of strategic analysis (Chand & Dahiya, 2010; Garengo & Bernardi, 2007; Peel & Bridge, 1998; Tapinos, Dyson, & Meadows, 2005), better integration of the business plan and key performance indicators (Manville, 2007), resource optimization (Laurinkevičiūtė & Stasiškienė, 2011; Villarmois & Levant, 2011), overall quality improvement (Chand & Dahiya, 2010), and faster adaptation to the surrounding environment (Amat et al., 1994; Laurinkevičiūtė & Stasiškienė, 2011). I consider all these aspects to be highly appreciated in the context of digital transformation. Nevertheless, recent publications emphasize future research opportunities concerning MCS in SMEs, e.g., targeting regional setting, firm size including constraints and performance outcomes, various adaptation aspects of management control measures in SMEs in contrast to large enterprises, staff related topics, or the role of networks (e.g., López & Hiebl, 2015; Quinn et al., 2018). The role that MCS can play in a digital transformation journey appears to be a new, yet open aspect. This fact is somewhat surprising as technology and technology usage appear to be one of the most commonly examined independent variables in management control research around SMEs (Chenhall, 2003; Otley, 2016). This study aims to show the variety of MCS able to support successful digital transformation in a SME setting. Given this explorative research setting, I expect that the manifold technological opportunities “would require controls to encourage flexible responses, high levels of open communication within the work force and systems to manage the interdependencies. Traditional, mechanistic MCS based on financial controls would not seem to suit these circumstances.” (Chenhall, 2003, p. 139).

Lately, practitioners have seen a potential paradigm shift in management control, incorporating agile methods in the spectrum of management control measures. “We’ve always done it this way’ is a deadlocked attitude that doesn’t work. Rather, it is necessary to set up an agile digitization roadmap that allows quick decisions and a demand-oriented reaction to new market requirements – in the sense of a trial-and-error approach that allows for mistakes.” (Haberich, 2018). Academia has also put the trial-and-error concept on the research agenda (see, e.g. Schäffer & Weber, 2016). Therefore, I investigate the role that trial-and-error plays as part of management control procedures from an empirical perspective.

In line with essay I, in essay two I also follow a research view of “contingency theory” and “situation-specific approach” (Helsen et al., 2017). I search for a system of controls that might support SMEs’ digital transformation efforts. Within a set of universal control categories that can be generalized across companies, I expect that every SME manager must design an individual control system for a company. Therefore, I strive for maximum variance throughout my analysis, presenting a construction kit, from which both academic addressees can derive pointers for further analysis and practitioners can find support in designing an adequate MCS. I answer the question: *How should a digital transformation control system be designed?*

In addition to the application of control measures, integration into networks plays a significant role for the success of SMEs in digital transformation. With this I am anticipating a result from essay I at this point. Together with my co-author, I therefore dedicate essay III to standardizing the discussion about networks and network types, since existing literature examines different levels and characteristics of networks and does not enable a directed, comprehensive analysis and discussion of network types.

1.3.3 Networks to promote digital transformation

“Even very good technologies will flounder if they do not connect effectively to outside complementary technologies, while seemingly inferior ones may overtake them if they are better connected. The need for effective connections requires firms to collaborate with others in their ecosystem, as well as to compete with them.”

(see: Chesbrough, 2003, p. 60)

SMEs are lagging behind large companies in terms of digital transformation (BMW, 2018). This situation is dangerous regarding their future viability, as innovation in business and operating models, especially digital innovation, is key to staying competitive (Nambisan, Lyytinen, Majchrzak, & Song, 2017), also for SMEs. SMEs need to overcome shortfalls in innovation power and handling environmental pressure (Agostini & Nosella, 2019), as well as limited resources and special IT know-how (Mieke, 2008). Nevertheless, barriers to embarking on innovation activities have increased in recent years, e.g., estimated high economic risk, innovation costs, and a lack of financial resources (Rammer, Gottschalk, Peters, Bersch, & Erdsiek, 2016). Sydow, 2001, found that these obstacles can be overcome by collaborative activities and networks, as they can reduce the need for capital as well as the strategic risk. Valkokari & Helander, 2007, conclude that part-

nership in cooperative activities and networks is an appropriate measure to compete and innovate in changing business environments.

Casals (2011) structured previous literature supporting the high relevance of networks for SMEs as well as their need and motivation to collaborate by providing a SME cooperation framework. The reasons to collaborate are divided into external reasons, i.e., the industry environment, and internal reasons that refer to the firm. Internal reasons include learning and exchange of experience, access to external sources of innovation, and the search for complementary resources including R&D activities. External reasons can include the desire for internationalization as well as for creating new business opportunities. The achievement of these collaboration objectives is sought through a variety of different collaboration approaches, including innovation networks. Policy makers therefore put support for collaboration on their agenda and offer public funding as well as various support programs to promote engagement in networks (Rammer et al., 2016) in order to foster technology transfer at the interface of industry and research and integrate SMEs into initiative programs (BMW i, 2020). To strengthen competitiveness, networking, innovation power, and employment among SMEs is the objective of a set of promotions and (financial) support programs (Buhl, Sedlmayr, & Meier, 2019).

We⁷ find existing literature on innovation networks to use heterogeneous methods and target heterogeneous purposes and aspects, which makes it impossible to compare existing network types and derive universal guidance for SMEs. To illustrate this aspect, we provide a brief review of existing literature. Friese, 1998, found a broad, cross-disciplinary use of terms related to networks, such as collaboration, network, and cluster, depending on the perspectives of each author. Aspects that influence the existing literature can be summarized by questions that potential members ask when they have to decide whether to participate in a network.

“Why should companies participate in a network?” Organizations, especially companies, exchange resources and gain a competitive advantage via network participation that they could not obtain alone (Child, Faulkner, & Tallman, 2005; Sydow, 2001; Wissema & Euser, 1991). Motivation for participation is derived from two directions (Casals, 2011). Collaboration via networks can be fostered by companies’ objectives to minimize costs, referencing the Transaction Cost Approach (Williamson, 1981). On the other

7 Essay III is based on a joint research project by Carl-Philipp Beichert and myself. I refer to both of us when using ‘we’ in the context of essay III. Each author’s contribution is declared in Appendix 4-2.

hand, referencing the Resource Based View, collaboration is a way to bundle individually limited resources to develop a long-term competitive advantage, thereby opening internal resources toward external knowledge (Loasby, Pfeffer, & Salancik, 1979; Williamson, 1981). We follow the second view and see collaboration as a measure to reduce uncertainty of resource availability in line with Sydow, 1992. SMEs thereby gain the opportunity to increase strategic flexibility and to reduce capital requirements by accepting the risk of a loss of strategic autonomy and an increase in coordination costs (Sydow, 2001).

“What is a network?” All networks we consider for our study consist of three or more organizations linked through multilateral ties. The connections are targeted to facilitate the achievement of a common major goal (Provan, Fish, & Sydow, 2007) or a bundle of different objectives (Morschett, 2003), e.g., access to new or complementary knowledge, marketing, an increase in economies of scale, and risk sharing (Mariti & Smiley, 1983). To coordinate efforts toward a network’s objective, some degree of coordination is required. Across networks, scholars find a combination of market and hierarchy, i.e., competitive and collaborative elements (Sydow, 1992), or even claim that networks represent an independent form of coordination (Powell, 1990). In order to overcome this objection, researchers suggest classifying networks via typologies (Provan et al., 2007; Provan & Kenis, 2008) that share market- and hierarchical-oriented characteristics (Friese, 1998; Sydow, 1992). In order to realize the desired, competitive advantages for the network members, this implies complex reciprocal, collaborative rather than competitive and relatively stable relationships, whereas the entities involved are legally independent, but economically dependent enterprises and organizations (Sydow, 1992). Further distinguishing factors, we consider, include, e.g., formality of formation (Cross, Nohria, & Parker, 2002; Van Aken & Weggeman, 2000) and organization structure (Sydow, 2001).

What is the focus of a network? We focus on networks that have specialized in R&D activities in a broad sense as a decisive factor to foster the competitiveness of companies by leveraging product innovation and market success of new products (Hottenrott & Lopes-Bento, 2016; Schilling, 2013). The involved partners combine their different skills and knowledge bases. A collaboration via networks offers the opportunity to unlock tacit knowledge and use it to support technological innovation toward products, processes, or services (Powell, 1990; Van Aken & Weggeman, 2000).

“What types of networks exist?” In our study, we follow Provan et al., 2007, and Provan & Kenis, 2008, to differentiate networks based on ty-

pologies. So far, the literature lacks a consistent typology of networks grounded in empirical data, which makes it difficult to compare existing studies with each other and limits the significance of the results for decision makers in practice. Case study and interview-based typologies do not allow for generalization (see, e.g., Bau, Bentivegna, & Forster, 2014; Provan et al., 2007). In our study, we reference academic predecessors by relying on their identified network characteristics including the direction of value creation (Hagenhoff, 2008; Killich, 2011; Morschett, 2003; Payer, 2008; Schmidt & Kiefer, 2003), geographic concentration (Eckert, 2009; Hess, 2002; Killich, 2011; Morschett, 2003; Payer, 2008; Schmidt & Kiefer, 2003), intensity of collaboration (Killich, 2011; Schmidt & Kiefer, 2003), firmness of commitment (Hagenhoff, 2008; Killich, 2011; Schmidt & Kiefer, 2003), duration (Eckert, 2009; Hagenhoff, 2008; Killich, 2011; Morschett, 2003; Schmidt & Kiefer, 2003), goal identity (Eckert, 2009; Killich, 2011), and functional involvement (Eckert, 2009; Hagenhoff, 2008; Hess, 2002; Killich, 2011). Further aspects that we include cover network governance (Provan & Kenis, 2008), network structure (Child et al., 2005; Glückler, Dehning, Janneck, & Armbrüster, 2012; Schuh, Kampker, & Rittstieg, 2011; Sydow, 2001), type of control (Sydow, 2001), positioning of the actors in the value chain (Achrol & Kotler, 1999; Bau et al., 2014; Dussauge & Garrette, 1999; Gereffi, Humphrey, & Sturgeon, 2005; Hess, 2002; Sydow, 2001), local and regional focus (Cooke, Gomez Uranga, & Etxebarria, 1997; Inkpen & Tsang, 2005; Payer, 2008; Porter, 1998; Schuh et al., 2011; Sydow, 2001, 2010), and purpose and common objectives of the actors (Bau et al., 2014; Lyytinen, Yoo, & Boland, 2016; Priestley & Samaddar, 2007; Wissema & Euser, 1991; Yoo, Lyytinen, & Boland, 2008).

As a result of our literature review, we find various network characteristics that help to describe and differentiate network types, yet a compelling typology that agglomerates all these different aspects is missing. We target this research gap and ask: *What are the predominant types of formal inter-organizational innovation networks and how can they be characterized?* To answer this research question, we consider network attributes from existing studies and apply qualitative and quantitative methods. Thereby, we take up Provan et al. (2007), who call for a study that combines existing insights with an empirical analysis at network level. We combine the previously mentioned attributes and a large data set that we build from an analysis of a selection of formal inter-organizational innovation networks to derive a comprehensive typology with a solid empirical foundation.

1.4 Methodologies

Across the three essays in this dissertation, I applied different research approaches supporting the elaborated research questions. Whereas essay I and essay II both rely on qualitative research designs, essay III mobilizes a mixed methods approach, combining a qualitative content analysis and a quantitative cluster analysis. An in-depth description of the methodologies applied throughout the three essays in this dissertation is given at the level of each study. Therefore, within 1.4, I will provide summaries of the applied methodologies and give reasoning and background.

1.4.1 Essays I and II

The general assumption leading the two studies is that techniques and measures that proved useful for leaders in terms of digital transformation may be reasonable blueprints to be adopted by comparable companies in comparable contexts, all facing the opportunities and challenges of technology adoption. Therefore, both studies aim to comprehensively show the variety of potential decisions and measures that have proved to foster a successful mastering of digital transformation in the cases under analysis (van de Ven, 2007). The absence of prior research in my specific fields of interest results in great difficulty in formulating *a priori* hypotheses (Ferreira & Merchant, 1992); a deductive research design in the sense of a positivist approach (Morgan & Smircich, 1980) is accordingly ruled out. Nevertheless, the given research backgrounds provide basic literature and guidance for further studies. Therefore, my studies use the concept of abduction for a strived theory elaboration, i.e., “a creative inferential process aimed at producing new hypotheses and theories based on surprising research evidence” (see: Timmermans and Tavory, 2012, p. 167). In both studies, I mobilize a case-based research design that “investigates the contemporary phenomenon [of digital transformation; author’s note] in depth and within its real-life context [SMEs that successfully mastered steps of digital transformation; author’s note]” (Yin 2014, p. 16). The fact that digital transformation is a multi-faceted phenomenon and therefore requires “description, interpretation and explanation” (Lee et al. 1999, p. 164) when analyzing data supports this chosen approach.

To clarify the necessity to rely on acts of interpretation (J. W. Creswell & Creswell, 2018), I give an illustrating example from essay II. If I ask a SME owner-manager “Did you apply symbols to clarify the high priority of

digital technologies toward your staff?”, from my experience, he will most likely say “No”. But if I walk around the production side and see modern, especially design-oriented, workstations at all workplaces and I ask the owner why he chose exactly the given models, he might answer: “Well, we wanted to create a modern, innovative working environment, so employees feel inspired to support our digital progress.” This example shows that he implicitly establishes symbols without keeping a control dimension in mind. I came across similar scenarios many times across data collection and analysis phases; therefore data structures (Gioia, Corley, & Hamilton, 2013) in the appendices of the papers are designed to shed light on this aspect and help the reader to follow my analyses.

Similar methodologies were already applied in the field of research by preliminary studies, that direct my research interest. Regarding essay I, in-depth, single case studies yield points of reference for large organizations, especially in B2B and retail environments (e.g., El Sawy et al. 2016; Hansen & Sia 2015). More comprehensive digital transformation frameworks focus on large companies in specific industries, e.g., media and insurance (Hess et al., 2016; Wiesböck et al., 2017). The possibility of generalizing the existing results and therefore the transferability to a SME setting are low, but the methods proved useful in generating interesting insights. Regarding essay II, qualitative methods were also mobilized in the form of various single and multiple case studies (López & Hiebl, 2015).

In essay I, units of analysis are digital transformation mechanisms in SME; in essay II, I search for measures of management control that are mobilized throughout the digital transformation journeys of SMEs. As both are rarely empirically observable, my empirical units of analysis in both cases are examples of SMEs that successfully mastered digital transformation. In essay I, I draw on evidence from seven SMEs, taking an in-depth view of their strategic considerations throughout digital transformation journeys. Essay II relies on data concerning 11 SMEs, gathered within two consecutive rounds of interviews, tracing their digital transformation efforts and taking an in-depth view of their management control usage throughout their digital transformation endeavors. Multiple cases thus add confidence and robustness to my findings (Miles, Huberman, & Saldaña, 2014; Yin, 2014). Narrative sections within both essays deliver dense description, which I regard as necessary to interpret the results in the given context (Pratt, 2009). Context, stories, and meaning are intended to promote an audience’s understanding of the applicability of the obtained results (Langley, 1999, p. 696–697).

For sampling, I applied preselection criteria (Eisenhardt, 1989; Miles et al., 2014), guiding a purposeful sampling approach. Essay I relies on critical case sampling, i.e., cases that are “rich in information because they are unusual, special or make a point quite dramatically” (see: Fletcher & Plakoyiannaki, 2009, p. 179), whereas essay II combines critical case sampling and theoretical sampling, i.e., cases that are supposed to fit to “emerging concepts in order to explore the dimensional range or conditions along which the properties of concepts vary” (see: Fletcher & Plakoyiannaki, 2009, p. 179). I selected all cases from the German skilled craft sector. Being considered a unique German phenomenon without clear boundaries regarding its sectorial limits, skilled craft companies provide services as well as manufacturing goods (Glasl, Maiwald, & Wolf, 2008). In all, 98 professions belong to the skilled craft sector, being explicitly listed in the German “Trade and Crafts Code” (HwO, n.d.). Based on an evaluation of the employee numbers across the sector, I consider craft businesses to be typical representatives of SMEs. Membership of the chamber of skilled crafts is mandatory for all businesses that belong to this sector. I selected the cases in close cooperation with a group of technology experts from the chamber of skilled crafts of Munich and Upper Bavaria, as they are in close contact with technology leaders in the sector. They also helped me to approach the companies and therefore worked as door openers and a means of prioritization, which was important owing to the significant time constraints of the company owners. The cases “permit logical generalization and maximum application of information to other cases [...]” (Patton, 1990, p. 182). In the sample companies, IT was used (a) for fundamentally altering traditional ways of doing business by redefining business capabilities and/or (internal or external) business processes and relationships, and/or IT was used (b) to dramatically change how tasks are carried out, and is therefore recognized as being important in enabling the firm to operate in different markets, serve different customers, and helped to gain considerable competitive advantage by doing things differently (Dehning, Richardson, & Zmund, 2003; Lucas, Agarwal, Clemons, El Sawy, & Weber, 2013, p. 372).⁸ Additionally, the companies may have re-

8 In the original set of criteria by Dehning et al. (2003) as well as Lucas et al. (2013), a third criterion for IT to be considered transformational targeted potential strategic acquisition activity. This aspect was excluded for this study.

ceived public funds for their digital transformation efforts.⁹ The scope of digital transformation as the investigated phenomenon is thus not limited. Some cases have specialized in the production of highly individual woodworks, leveraging the opportunities provided by automated production. Others have completely digitized their operating model, being far ahead in terms of digital transformation from the current standards in their respective fields and realizing gains in efficiency and quality. Again, others make use of robotics in their production facilities, or they have invented highly technical clothing.

The main sources of data were interviews with the owner-managers of the SME under analysis. The decision to focus on the owner-manager as reference person to describe digital transformation is based on the central role s/he and her/his personal perception role played in a SME's leadership (Pfohl, 2006). As far as possible, I collected multiple types of data as a basis for triangulation. Triangulation is considered a central element in qualitative research in order to improve its quality (e.g., Flick 2014; Easterby-Smith et al. 2008; Guba et al. 1981). Denzin, 1978, developed a systematic approach to triangulation and distinguishes four different types of triangulation: different data sources, different investigators, different theories, and different methods. I applied triangulation based on different data sources and different investigators. The interview data were triangulated by information from the SMEs' websites, social media channels, books written by the owners, company brochures, media articles, and guild information materials. Junior researchers, who accompanied my onsite visits to the companies, wrote down their impression and understanding of each company's development in case reports, which contributed to the dense case descriptions.

1.4.2 Essay III

We draw inspiration for our essay from previous research on innovation networks and clusters (Bau et al., 2014; Delgado, Porter, & Stern, 2016) and combine it with a mixed method approach (Täuscher & Laudien, 2018). Therefore, we conduct a qualitative content analysis followed by a

9 In 2017, the government of Bavaria introduced the so-called "Digitalbonus", a public funding program where SMEs were able to apply for financial support via grants or credits in their efforts in digital transformation. For more information, see <https://www.digitalbonus.bayern/>.

quantitative cluster analysis. We use a directed content analysis to compile a comprehensive data set (Hsieh & Shannon, 2005) and subsequently apply a hierarchical clustering approach using Ward's linkage method to analyze the results of the first method (Ward, 1963). In order to identify networks in a structured manner, we used a large online listing of networks provided by "Clusterplattform Deutschland" (BMW, 2020), a comprehensive online directory of formal inter-organizational innovation networks in Germany.

We translate qualitative information about networks and clusters into numerical data via qualitative content analysis for further quantitative analysis (Potter & Levine-Donnerstein, 1999). First, codes, i.e., network characteristics, are derived from theory and previous research findings. Over the course of the study, characteristics that appear to be less appropriate, difficult to interpret, or can only be determined based on a highly subjective assessment are removed, which leads to a continuous adaptation of the coding during this process (Hsieh & Shannon, 2005). We generate our data set based on publicly available information on the websites of the identified networks and corresponding information provided by "Clusterplattform Deutschland" (BMW, 2020). Networks or characteristics are removed from the data set in case of insufficient information availability. In order to reduce elements of subjective interpretation during the coding process, the coding of qualitative information is partly counter-checked by the co-authors.

The quantitative analysis aims to identify groups of networks with similar features in the previously generated binary data set (Backhaus, Erichson, Plinke, & Weiber, 2018). We secure analyzability of our sample by conducting a frequency analysis, eliminating doubled characteristics, and checking for critical correlations (Everitt, Landau, Leese, & Stahl, 2011). Based on previous studies, we decide to use hierarchical agglomerative clustering (HAC) (Bau et al., 2014; Delgado et al., 2016; Täuscher & Laudien, 2018) and follow the approach suggested by Backhaus et al. (2016). Therefore, we first select a distance measure and linkage method that determines how the algorithm combines the objects in our data set into clusters. We find that the Euclidean distance measure in combination with Ward.D2 as the linkage method deliver the most meaningful results (Ward, 1963), both aiming to maximize homogeneity within the clusters and generate clusters that are as different as possible (Backhaus et al., 2018). We apply various methods to indicate an optimal number of clusters (Everitt et al., 2011; Han, Kamber, & Pei, 2012; Kassambara, 2017) and find an optimal number of 11 clusters for our analysis.

1.5 Results and contributions

My empirical investigations about digital transformation in SMEs that constitute the core of my dissertation yield important results toward the academic as well as practitioner communities. Based on qualitative methods in use, my investigations may also serve as a foundation for future research (Peirce, 1934; Timmermans & Tavory, 2012). In the next paragraphs, I summarize the main results and contributions.

Essay I deepens our understanding of SME development options in the context of digital transformation. A digital transformation strategy is the starting point for a successful digital transformation. Empirical work dealing with digital transformation strategies currently focuses on selected industries and large companies with at least 500 employees (e.g., Hess et al., 2016; Wiesböck et al., 2017). The specific characteristics of small and micro enterprises (Pfohl, 2013) are not considered, which poses a severe threat for the future viability of European economies (European Commission, 2015). In order to close this research gap, I have collected case studies of selected SMEs that have been particularly successful in mastering digital transformation. As a result, I develop and enrich an existing strategic decision framework, considering specific, cross-sectorial SME characteristics (Matt et al., 2015). This creates a multifaceted space of potential strategic development directions.

The results imply that SMEs' success in digital transformation does not result from chance and luck but can be structured along the generally applicable categories of "use of technologies", "changes in value creation", "organizational aspects", and "financial aspects". The categories are mobilized in the form of strategic questions and associated decision options to guide owners of SMEs successfully through the process of digitally transforming their companies. The questions intend to guide SME proprietors and managers through development options, based on which specific adjustments to the business and operating model can be individually determined. This expands the academic understanding of areas of strategic decision making options in the currently tense and dynamic field of digital transformation. The essay thus provides many starting points for further empirical research to investigate specific decision levers and their interplay. The strong foundation in the case study data makes the work equally useful for owners and decision makers in SMEs who are currently confronted with the challenges of progressive digitalization.

Essay II combines existing conceptualizations of MCS, the innovative aspect of agile methods, and the management of digitalization to elaborate

configuration options of a digital transformation control system. So far, all these aspects have been treated separately by scholars. They cover MCS and measures in generic conceptualizations (e.g., Malmi & Brown, 2008), demand the mobilization of trial-and-error as a selected, agility-enabling measure to deal with dynamic market environments caused by progressing digitalization (e.g., Schäffer & Weber, 2016), and treat digital transformation strategy development as outlined in Essay I. Nevertheless, relying on literature that confirms potential benefits for SMEs from management control usage, e.g., performance increase (e.g., J. Dekker et al., 2015) and adaptability to uncertain environments (e.g., Amat et al., 1994), I deduce that the use of MCS can promote successful digital transformation. In order to investigate this nebulous, yet untreated, research gap, I first collected case studies that are successful in terms of digital transformation, conducted an analysis of their use of MCS, and then went back into the field to collect more case studies that are also successful on their journey to digital transformation, but are also known to take a structured approach in their efforts.

My study makes several contributions. First, I structure the existing literature regarding potential benefits of MCS usage in SMEs. Second, I empirically find overall four categories of management control measures applied in the cases under analysis. Throughout their digital transformation journeys, SMEs make use of cultural controls, planning, administrative controls, and performance indicator-based controls. I am therefore able to advance the MCS as a package framework by Malmi & Brown, 2008, toward controls with a special focus on digital transformation. I do not find a unidirectional link between strategic considerations and the establishment of management control measures (Merchant & van der Stede, 2007). SME managers tend to iterate strategic considerations based on observations from management control measures, also incorporating informal and subjective observations, which favors adaptability to the ideas of Malmi & Brown, 2008. Trial-and-error turns out to be used as one control procedure among others, not giving it the power of a radical shift in management control paradigms (Schäffer & Weber, 2016). For practitioners in charge of managing a SME, my collection of management controls can deliver a blueprint to refine existing MCS or may even be used as a starting point to establish a MCS in the case that individual digital transformation drives a SME's organizational complexity.

Essay III establishes an empirically grounded, generic typology of formal inter-company networks with a special focus on R&D and innovation. Therefore, we first review existing research on the distinguishing character-

istics of networks. Based on the identified attributes, we conduct a directed, qualitative content analysis to compile a comprehensive data set as a basis for further quantitative analysis (Potter & Levine-Donnerstein, 1999). To develop a typology from the compiled data set, we applied a cluster analysis using HAC to account for similarities and differences across the identified network attributes. Based on the results of the cluster analysis, we identified 11 different types of networks, which we tried to name distinctively according to outstandingly different attributes: Avid Persuaders, Value Chain Drivers, Collective Facilitators, Niche Specialists, Lateral Thinkers, Transnational Opportunity Seekers, Financially Resilient Connectors, Local Trend Sponsors, Regional Activists, Associated Industry Supporters, and Dynamic Research Groups

Our typology adds a holistic, empirically grounded conceptualization to the existing literature that is dominated by theoretical considerations (e.g., Sydow, 1992) or small-scale empirical analyses (e.g., Bau et al., 2014). It highlights that typologies are a suitable model to differentiate several forms of inter-company networks (Provan & Kenis, 2008). From this, multiple avenues for further research can be derived, e.g., toward analysis of network performance at the individual member as well as the network level. The essay furthermore provides practical orientation. For policy makers, it leverages understanding of the network universe, which we consider crucial when supporting networks as a decisive source of innovation among SMEs. For SME managers, it provides orientation when searching for a suitable network engagement.

1.6 Dissertation structure

Three essays targeting digital transformation in SMEs together form this dissertation. The essays emerge from different, independent research projects, all led by different research topics, whereas especially essay II builds on the findings and partially encloses data of essay I, and the motivation for essay III stems from findings from the project directing essay I. All projects have in common that they are fully based on or encompass the use of qualitative research methods. As selected concepts, especially regarding the definition of digital transformation as well as the specifics of SMEs, are provided repeatedly, the sequence of the review of the essays is not specified. In Chapter 2, which consists of Essay I, I draw a framework for formulating a digital transformation strategy in SMEs. Chapter 3 comprises Essay II, where I give an overview of management control measures that

serve as ingredients to develop a digital transformation control system, based on measures which have proved useful in SMEs that have successfully mastered digital transformation. Essay III in Chapter 4 targets formal, inter-company innovation networks and identifies common, empirically grounded network types. In Chapter 5, I conclude the dissertation by summarizing the contributions and main findings, elaborating limitations, and suggesting avenues for future research.