

# **SMEs' Approaches for Digitalization in Platform Ecosystems**

*Completed Research Paper*

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## **Abstract**

*Changing market dynamics and the rising influence of digitalization increase the demand for digital offerings. Companies innovate their business models and pool their competences in ecosystems to manage digital transformation successfully. In contrast to influential global players, small-and-medium enterprises (SMEs) face a different starting position. Due to their limited resources and weak integration in networks, their potential cannot be fully exploited yet. We take an explorative, qualitative research approach to investigate how roles in ecosystems and digitalization approaches of SMEs are related. The findings are based on eleven in-depth interviews with experts. The analysis suggests that the SMEs' roles in ecosystems set the frame for digitalization approaches. Depending on the role, different stages of digitalization are accessible and higher stages can be reached by strategic development in the ecosystem. The work contributes to the understanding of the construct "ecosystems" and its applicability in the context of SMEs' and their digitalization.*

**Keywords:** Platform ecosystem, Digitalization, Digital strategy, Small-and-medium enterprises (SMEs), Explanatory case study

## **Introduction**

Digitalization is attracting widespread interest along various industries and politics. It can be defined as "[the] ability to turn existing products or services into digital variants, and thus offer advantages over tangible product" (Parviainen et al. 2017). In contrast to digitization, which focuses on the standardization and automation of processes with the goal to cut cost, digitalization changes the firm's value proposition and organizational structure. This can lead to a new understanding in the value chain (Parviainen et al. 2017; Ross et al. 2017a). These fundamental changes within the firm's business model are also referred to as "digital transformation" (Matt et al. 2015). In this work, the term "digitalization" is used synonymously to "digital transformation".

Digitalization is facilitated by the improvement of information and communication technologies, like the spreading of the internet (Hartmann et al. 2016). The ability to store, process and analyze a steadily growing amount of data is the base for data-driven business models (Hartmann et al. 2016; Schüritz and Satzger 2016). Next to the technical framing conditions, the customers' demand for digital offerings is growing and services become a more distinguishing factor in relation to the original product (Abolhassan 2017). During the last years, various digital business models like Uber, AirBnB and Amazon have been established (Abolhassan 2017). Global players like Apple and Google revolutionize markets. They own the customer relationship, leaving suppliers with a backseat position (Bharadwaj et al. 2013).

In contrast to the positive showcases of digitalization, small and medium enterprises (SMEs) face different framing conditions on the way to digitalization. They often experience challenges when trying to innovate and their level of digitalization is still below industry average (Bley et al. 2016; Bogner et al. 2016; Sommer 2015). Barriers for successful digitalization within SMEs can be found in lacking innovation culture, limited time and human capital, financial constraints and limited managerial resources (Bernaert et al. 2014; Hewitt-Dundas 2006). These challenges are especially relevant in Germany, since 99.3% of all German companies belong to the category of SMEs and they are an important engine of growth for the economy (Statista 2015). From this perspective, Germany can serve as an information-rich showcase. It is crucial to think about suitable solutions to overcome the hindering factors for digitalization. Otherwise the countries' long-term economic growth might be endangered.

There is a considerable amount of contributions on strategies helping SMEs to manage digitalization successfully. For example, a change in the organizational structure by implementing a Chief Digital Officer is considered to be helpful (Becker et al. 2018). Moreover, scaling digitalization projects can leverage complexity and save resources (Coreynen et al. 2017). But digitalization cannot only be viewed from the internal perspective of single firms. Collaborations between firms set new resources free and lead to network effect. This results in new approaches for digitalization (Kowalkowski et al. 2013). Thus, integrating partners in digital strategies is an important initial step.

These forms of strategical alliances with partners can be conceptualized as "ecosystems". Ecosystems are defined as a construct of multiple firms such as suppliers, producers, competitors and customers, working together to maximize their mutual profit (Iansiti and Levien 2004; Moore 1996). Ecosystem roles describe the constellation of firms and the ways they cooperate (Iansiti and Levien 2004).

The question is, if there are interdependencies between the different positions of firms in ecosystems and their approaches for digitalization. Does a traditional supplier of spare parts have the same chances for digitalization as the orchestrating leader of an ecosystem? And are ecosystem roles the result of digitalization or are they an enabling factor? As research suggests, ecosystem roles provide different perspectives to create revenue and to push innovation (Weill and Woerner 2015). This first indicator for a relation between ecosystem roles and digitalization approaches will be analyzed in-depth.

Therefore, this work investigates the following research question: *What is the relation between different approaches for digitalization and ecosystem roles?*

To answer the research question, the work follows an exploratory, qualitative research approach. We conduct eleven interviews with executives from SMEs in different ecosystem positions. The interviews provide insights into the relation of digitalization and ecosystem roles from a practical perspective.

The paper is structured as follows. First, the status quo of digitalization approaches of SMEs and ecosystem research is outlined. Two frameworks are introduced, one illustrating stages of digitalization and the other categorizing potential roles of SMEs in ecosystems. The qualitative research methodology, aiming to explore the relation between roles in ecosystems and approaches for digitalization, is then explained. It consists of purposeful sampling, eleven semi-structured interviews and a thematic analysis with two coding cycles. The results are described in a brief in-case analysis, followed by a cross-case comparison that gives insights into role-specific challenges and approaches. In the following discussion, the findings are outlined and compared with previous evidence. Limitations are pointed out, providing an outlook for future research. Scientific and managerial implications complete the picture.

## Related Work

### *Stages of Digitalization*

Following the earlier definition, the two concepts of digitization and digitalization can be distinguished (Ross et al. 2017a). The interplay between both constructs is discussed controversially, but most researchers see digitized processes as a prerequisite that enables digitalization (Ross et al. 2017b). Technology-driven digitization is considered to be a starting point for business model innovation (Hess et al. 2016; Planing and Pfoertsch 2016).

To measure the level of implementation of digitization and digitalization activities inside companies, various frameworks can be found. Due to the setting of this work, only frameworks for digitalization were considered. They were assessed regarding their applicability for SMEs, their practical relevance and their coverage of product and business model-related changes. As a result, we conceptualize the digitalization stages in this work as follows (see Figure 1).

Digitalization			
Value proposition not changed		Value proposition changed	
<b>Stage 0</b> No digital offerings	<b>Stage 1</b> Data-enabled improvements in old business model	<b>Stage 2</b> New product-related solutions in new business model	<b>Stage 3</b> Stand-alone services in new business model

**Figure 1: Stages of Digitalization (adapted from Schüritz et al. 2017)**

The first stage means no digital products are offered (Schüritz et al. 2017). The second stage covers improvements within the old business model, for example displaying real-time machine data of a running system. By providing this information, parameters can be adjusted according to given external factors, and the productivity of the machine can be optimized. Still, the value proposition is not changed. Next, the whole business model changes due to data-enriched products and services (stage 2) or due to new stand-alone services (stage 3). A data-enriched service built around an existing product could be predictive maintenance. A new stand-alone service could be an economic forecast for the development of a market based on collected customer data. These categories, not containing any information about the digitization level of internal processes, will be used to describe the digitalization approaches of the interviewed firms. (Schüritz et al. 2017)

Besides the theoretical conceptualization of stages of digitalization, their application to the area of SMEs is well explored. Many studies deal with the status quo of digitalization in SMEs (Bogner et al. 2016), their challenges and specific ways for digitalization (Kowalkowski et al. 2013). The unique framing conditions of SMEs increase the demand for suitable digitalization strategies (Mittal et al. 2018). Methods to overcome the SMEs' lack of knowledge and cultural acceptance gap can be found in an organizational re-structuring. An example for that is the implementation of the Chief Digital Officer who is responsible for digitalization projects (Becker et al. 2018). Resource-based restrictions can be overcome by starting with small, scalable digitalization projects which require less resources than a whole digitalization strategy (Coreynen et al. 2017). Digital projects can be limited to a certain area within the company first and spread within the whole company later. These small projects are less risk-intensive and can be run short-term (Hewitt-Dundas 2006). Next to limiting the scope of the planned initiatives, SMEs can collaborate with partners to bundle their resources. These value constellations can result in vertical collaboration, horizontal collaboration, shared platforms, or the acquisition of a smaller partner (Kowalkowski et al. 2013). The interplay of SMEs collaborating in ecosystems and their approaches for digitalization will be examined in detail in our work.

## ***Ecosystem Theory***

There is a considerable amount of literature on the topic of “ecosystems”. Different research streams in biology, business, knowledge, innovation, platform and IoT ecosystems exist. The idea of ecosystems originates from the field of biology and was adapted to the business context to describe the interplay of different firms, organizations and individuals (Moore 1996). Ecosystems are characterized by their interaction and balance between the partners, their self-organization, openness and mutual value creation (Boley and Chang 2007; Nischak et al. 2017). They can be distinguished from traditional supply chains. While companies in value chains clearly define the value proposition by themselves and aim for profit maximization for the own firm, companies in ecosystem co-create value and share their resources (Hearn et al. 2007; Peppard and Rylander 2006; Rainbird 2004). There are numerous investigations in the scope of ecosystems, ranging from internal ecosystems inside a single firm to multi-sided markets (Gawer 2009). The formation and further lifecycle of ecosystems have been well analyzed (Moore 1993; Rong and Shi 2014). Some scientists focus explicitly on the earliest phase by describing different modes of formation (Dedehayir et al. 2016). Furthermore, risk and control mechanisms between ecosystem partners have been a topic of great interest (Tiwana 2015). According to the players' position, role-specific strategies and risks can be defined (Adner 2006). Opportunity costs when entering an ecosystem can be decreased by providing trusts between the parties and by offering self-control (Dellermann et al. 2017). Different measures to assess the ecosystem's efficiency have been introduced, such as “productivity”, “robustness” and “niche”. (Iansiti and Levien 2004)

Besides this research on business ecosystems, the newer field of platform ecosystems emerged as a response to increasingly dynamic markets, faster production cycles and modern organizational forms (Razavi et al. 2010; Weill and Woerner 2018). The general understanding of ecosystems remains unchanged and a platform ecosystem can be defined “as a set of assets organized in a common structure from which a company can efficiently develop and produce a stream of derivative products” (Gawer and Cusumano 2014). From an economic point of view, one-sided, two-sided and multi-sided platforms or markets can be distinguished (Eisenmann et al. 2006; Staykova and Damsgaard 2015).

## ***Roles in Ecosystems***

In ecosystems, different roles for the firms help to define fitting strategies and to build up alliances. In the initial concept for strategic roles in business ecosystems, different types of players, their interaction and contribution to the system are explained. Stakeholders are categorized by the complexity of their relationships and the level of turbulence and innovation. Using these two axis, the profiles “commodity”, “niche”, “physical dominator” and “keystone” are generated. (Iansiti and Levien 2004)

This first model for ecosystem roles was updated and taken to the context of platform ecosystems. Having compared various frameworks for ecosystem roles regarding their content (focus on platform ecosystems, clearly defined roles, suitable for the application on SMEs) and their development (timeliness, popularity), the following framework is the most suitable one for the analysis. It combines the well-established dimension of “business design” (Dedehayir et al. 2016; Smedlund et al. 2018) with the recently arising focus of “knowledge about the end customer” (see Figure 2). For the business design, firms can either follow the ecosystem approach or the traditional value chain approach. On the y-axis, knowledge of the end consumer is considered to be “complete”, if the individual's demographics and purchase behavior is known (Weill and Woerner 2015).

Based on these dimensions, four roles are defined. Suppliers are members of a value chain. They do not exchange in-depth with their partners, but rather create the value by themselves. Suppliers do not sell their offerings directly, but purchase them to an omnichannel business which owns the contact to the end consumer. These omnichannel businesses are integrated into value chains and collaborate loosely with partners. Ecosystem drivers are platforms providers like Apple that integrate offers of third-party providers. They communicate directly with the end consumers and collect numerous information. In contrast to the ecosystem driver, modular producers do not know their end consumer because they sell their services through other platforms. Since modular producers offer plug-and-play solutions, they are very flexible and can adapt to various ecosystems. This framework is used for the classification of interviewed firms in the following work. (Weill and Woerner 2015)

Knowledge of end consumer	Complete	<b>Omnichannel Business</b> <ul style="list-style-type: none"> <li>▪ Owns customer relation</li> <li>▪ Integrated value chain</li> </ul>	<b>Ecosystem Driver</b> <ul style="list-style-type: none"> <li>▪ Provides branded platform</li> <li>▪ Plug-and-play 3<sup>rd</sup> party products</li> <li>▪ Customer knowledge</li> </ul>
	Partial	<b>Supplier</b> <ul style="list-style-type: none"> <li>▪ Sells through another company</li> <li>▪ Potential for loss of power</li> </ul>	<b>Modular Producer</b> <ul style="list-style-type: none"> <li>▪ Plug-and-play products/services</li> <li>▪ Adapt to any ecosystem</li> <li>▪ Constant innovation</li> </ul>
		Value Chain	Ecosystem
		Business Design	

**Figure 2: Roles in Platform Ecosystems (Weill and Woerner 2015)**

### *Ecosystems in the Field of SMEs*

A few contributions try to apply the ecosystem construct in the area of SMEs. The earliest contributions focus on European SMEs. Leading ecosystem drivers should serve as best-case practice to promote collaborating in ecosystems (Rathbone 2007). Besides the benchmarking, governmental programs should be established to support SMEs in forming ecosystems by providing knowledge and practical guidance (Nachira et al. 2007). Both papers approach the topic from a qualitative angle, but ecosystem roles are not considered.

Other researchers make use of case studies or quantitative studies with SMEs to evaluate the benefits of working in ecosystems. The findings suggest that platforms facilitate closer collaboration between the partners (Arnold and Voigt 2017). SMEs can improve their competitiveness by collaborating (Brink 2017). Furthermore, challenges in digitalization due to the lack of know-how can be overcome when working in an ecosystem (Arnold and Voigt 2017). The same is valid for the acquisition of required resource through partnerships (Kowalkowski et al. 2013).

Besides the contributions on the advantages of ecosystems for SMEs, firms can be mapped to ecosystem roles, including role-specific strategical elements (Bosch-Sijtsema and Bosch 2015; Smedlund et al. 2018). For example, SMEs can take the role as system integrator, being the sole supplier for its customers and bundling its subcontractors' capabilities (Kowalkowski et al. 2013). All in all, some works investigate the connection of ecosystems and SMEs. In most cases, the contributions cover roles for SMEs but lack digitalization approaches. This research gap is addressed in the research question.

### **Research Methodology**

As the relation of ecosystem roles and approaches for digitalization has not been investigated yet, a qualitative research approach is suitable to answer the research question (Miles and Huberman 1994). Following an explanatory case study approach, eleven semi-structured interviews with SMEs were conducted. Fitting companies were identified by purposeful sampling which aims to sample variant cases, illustrating subgroups and facilitating comparison (Miles and Huberman 1994). The database MARKUS (Creditreform), was used for finding matching SMEs. Filters helped to convert the sampling criteria into search terms in the database. The sampling criteria derive from the framework for ecosystem roles, digitalization levels and literature findings about SMEs. They were developed and evaluated together with experts from industry to ensure their adequacy.

The following sampling criteria were applied: the companies had to meet the quantitative definition for SMEs: a maximum of 500 employees and revenue to 50 mil. € (IfM 2016). The industry focus of the analysis was on plant and construction engineering firms, mainly located in the south of Germany. This industry is highly representative for the German economy. It is the second most profitable branch, after the automotive industry and the its potential for digitalization is not exploited (Lichtblau et al. 2015).

Applying these hard filter criteria led to 928 pre-selected companies. Further filters were defined to cover the dimensions of ecosystem roles and digitalization levels. The sample includes firms with different stages of digitalization and different positions within the value chain. Moreover, we aimed to represent every ecosystem role in the sample. Having applied this purposeful sampling approach, 145 fitting companies were identified and contacted via personalized e-mails and a newsletter. The response rate for the newsletter was 2%, for the personalized e-mails it was 2,5%. As the sample did not cover the role of ecosystem leaders first, intensity sampling was applied by filtering for firms from the ICT area. These firms represent information-rich cases for platform providers.

The interviews followed a semi-structured questionnaire which enables flexibility but assures the comparability of the results (Myers and Newman 2007). The questions covered the dimensions of digitalization levels and ecosystem roles, without mentioning the dimension “ecosystem” explicitly to avoid interviewee biases. After an internal pre-test, the interviews were delivered by telephone between April and June 2018. The interview partners were C-level managers, mostly CDOs or CIOs and, in some cases, CEOs. This selection ensured sufficient knowledge about digitalization activities and the firm’s strategy. One representative per company was interviewed. The planned duration of 30 minutes with a variation of up to 10 minutes was kept in all interviews. As all participants agreed, the interviews were recorded, transcribed and analyzed in an anonymous way, following common research practices in the field (Schüritz et al., 2017). The statements of the interviews were enriched and cross-checked with secondary data (e.g. companies’ websites, press releases and management reports) to ensure internal validity as recent studies in similar contexts recommend (Coreynen et al 2017).

For the well-established method of thematic analysis, two coding schemes were conducted, including memoing (Saldaña 2016). A mixture of descriptive coding and exploratory methods was selected. Descriptive codes could be derived without much abstraction from the interviews as a starting point. Next, exploratory methods helped to identify categories and to draw first connections between the codes. Platform-specific codes were added in the second coding cycle. The codes were used to classify the firms according to their ecosystem roles and their digitization level. The distinction between the business design “value chain” and “ecosystem” was conducted according to the following criteria. A firm’s business design was classified as “ecosystem”, if the value proposition is co-created with customers and partners, the firm exchanges competencies with others, the end customer is well-known and the focus is on the maximization of the network’s overall value (Hearn et al. 2007; Peppard and Rylander 2006; Rainbird 2004). In all other cases the business design was characterized as “value chain”. Table 1 illustrates the coding and use of references to the interviews in the following work.

Category	Quote	Source	Citation
Stage of digitalization	<i>“Talking about digitalization we are for sure at the very beginning.” [translated]</i>	Interview with company E, section 2 in the transcript	(E, 2)
Role in Ecosystem – Position in Supply Chain	<i>“[The role] is changing. Each new platform creates a new level between the customer and the supplier.” [translated]</i>	Interview with company C, sections 76f. in the transcript	(C, 76f.)

**Table 1: Example for Coding and Citation for the Cases**

## Overview of the Cases

### *In-case Analysis*

To provide insights into the single results of the interviews, the data are first analyzed following a case-oriented approach (see Table 2). Due to the sampling criteria, all firms have a background in plant and machine construction, ranging from producers of specialized machines to automation technology and platforms for machines. The firms differ in their size and their age. Different stages of digitalization can be identified according to the introduced framework, including all stages from 0 to 3. The position within the value chain varies as well, which leads to differing closeness to the end customer.

Role	Case	Industry	Size	Age	Level of Digitalization	Position in value chain
Ecosystem driver	A	Mechanical engineering / ICT	Small	Young	Stage 3	Modular producer
	B	Mechanical engineering / ICT	Small	Young	Stage 3	Modular producer
	K	Packaging machines	Medium	Old	Stage 2	Contact to end customer
Omnichannel Business	C	Materials handling	Large	Intermediate	Stage 1	Contact to end customer
	E	Special machine construction	Small	Intermediate	Stage 1	Contact to end customer
	G	Packaging machines	Large	Old	Stage 2	Contact to end customer
	I	Assembly technology	Small	Intermediate	Stage 1	Contact to end customer
	J	Special machine construction	Large	Old	Stage 2	Contact to end customer
M P.	D	Automation technology	Large	Old	Stage 2	No contact to end customer
Suppliers	F	Component manufacturer	Medium	Intermediate	Stage 0	No contact to end customer
	H	Component manufacturer	Small	Intermediate	Stage 0	No contact to end customer

old: < 1950, intermediate: 1951-2000, young: > 2001

small: < 200, medium: 201-500, large: > 501 employees

**Table 2: Overview of the Interviewed Firms**

Company A: The firm is a joint venture, founded by different players from engine and plant construction. Since hardware becomes a commodity in the industry, digital offerings get more important and a platform for device management and predictive maintenance is offered (A, 22, 24, 26, 28).

Company B: This company is a platform provider for predictive maintenance which was established as a start-up of another engine and plant construction company. But “being born with the DNA of a manufacturing firm instead of the DNA of an IT company”, partners were integrated into the ecosystem to acquire missing knowhow (B, 10).

Company C: The SME works in the field of bulk and materials handling and offers machines that are equipped with sensors, for adjusting parameters to given external factors (C, 28). Platform providers change market dynamics and endanger the firm’s business model as they position themselves at the customer interface and try to take the contact to the end customers over (C, 81).

Company D: Producing electric and pneumatic components for process automation, company D is offering predictive maintenance solutions and tracing solutions (D, 12). These solutions are no stand-alone services, but they enhance existing products (D, 21-24). The company’s position is about to shift from a supplier to a provider of modular solutions (D, 44).

Company E: This SME is a machine constructor, focusing on special machines. Data sovereignty is at the customer and therefore after-sales services are difficult to realize (E, 58). The collaboration with the partners is of operative nature, so the current role is “omnichannel business” (E, 4).

Company F: Manufacturing components for machines in the fields of automotive, airspace, health and machine tools, SME F focuses on the digitization of internal processes. No digital products are available yet (F, 2, 19). As the firm offers engineered-to-order products, they collaborate with the customers on the next value creation stage, but the end customer is not known (F, 64, 66).

Company G: As a producer of packing machines, company G is a classic machine manufacturer. Platform solutions are evaluated carefully but not yet implemented, due to financial risks and since “nobody knows if the platform that is hyped today, will exist tomorrow” (G, 54). Today, the firm owns the end customer relationship but there is a threat of losing the relationship to third-party platform providers that position themselves between firm G and end customers (G, 34).

Company H: This firm is manufacturing sheet metals and components. Since the company does not produce independent products, options for digitalization are limited and dependent on the customers' wishes (H, 21, 117). As traditional supplier, company H does not own the contact towards its end customers (H, 21).

Company I: For the system supplier of assembly technology and material handling engineering, digitalization implies equipping its products with sensors that improve the efficiency of the machines (I, 24-28). Platform solutions are observed but not implemented yet, due to high financial uncertainties and great competition in the market (I, 85, 89).

Company J: Company J is positioned in the field of vacuum technology, providing predictive maintenance solutions (J, 8). Challenges of digitalization were overcome by founding two start-ups (J, 16). The firm joined an association for platforms and is now offering flexible interfaces for different environments as an integrator of systems (J, 42).

Company K: SME K produces cutting machines for B2B customers. Using sensors, production data can be enhanced by environmental data (K, 10). Moreover, a platform for company-specific products was introduced by collaborating in an ecosystem as "digitalization was much too complex to manage it alone" (K, 38). The SME positioned itself as leader of a niche ecosystem.

## **Results**

### ***Cross-case Analysis***

Based on the case-oriented analysis, three ecosystem drivers, five omnichannel businesses, one modular producer and two suppliers were identified. The firms differ in their digitalization levels and their approaches for platforms. While ecosystem drivers reach the highest level of digitalization, suppliers are assigned to a low stage of digitalization. In the following paragraphs, the roles' similarities and differences are analyzed in depth.

#### *Ecosystem Drivers*

Ecosystem drivers have multiple reasons for establishing platform solutions. They face rising competition (A, 4; B, 6; K, 20), want to acquire new markets (B, 26), improve their data foundation (K, 56) and their customers ask for new digital solutions (K, 18). Hindering factors as lacking knowledge (A, 16; B, 10; K, 32) and not standardized interfaces (A, 54) can be solved by collaborating with partners (A, 15, 54; B, 44). These forms of collaboration improve the firms' development times (A, 22) and help to establish trust between the parties (A, 38; K, 38). With this trust, customers can be convinced to provide access to their data, which was a barrier before (K, 48).

Multiple factors need to be considered when deciding for the role as platform provider. If the firm has a high demand for control (B, 10) and owns sufficient financial resources (B, 44), these factors support the development by the firm itself. In contrast to this, a great amount of already existing platforms implies strong competition in the field and reduces the need for a new solution (B, 40). Only, if the requirements for the platform are very specific, a new platform is justified (B, 10). Being positioned in a small niche reduces the likelihood of implementing an own solution successfully (A, 62). In summary, the ecosystem drivers mostly do not strive for their leading role inside the market to gain power over other companies. Establishing a platform is rather a necessity on the way to the highest level of digitalization (B, section 10). The platform helps the ecosystem drivers to prepare for the next steps of digitalization.

#### *Omnichannel Business*

Omnichannel businesses have similar motivating reasons for digitalization. They face rising competition (I, 14) and a market-driven demand for digital offerings (C, 4, 26; G, 7; I, 14). Next to these external factors, the companies see the chance to improve the quality of their products through digitalization (E, 22; J, 8). Despite their demand for digital transformation, diverse challenges are faced.

Digitalization requires high, risky investments (E, 42, 118). Internal data management and standards have to be defined (C, 4; G, 28; I, 18). Moreover, organizational and cultural barriers are of high relevance (C, 107; I, 59; J, 74). They are mastered by re-organization within the companies (C, 45) and by sharing experience with partners (C, 16; I, 44). The difficulty of lacking employees and knowledge (C, 117; E, 8, 32) can be solved partly by collaborating with other firms (C, 51; G, 50). Customers are valuable to improve the knowledge about market dynamics (C, 53; E, 24; G, 44; J, 30). Furthermore, partnerships with customers increase trust (C, 32; J, 62), enabling an easier access to the customers' data. Otherwise, lacking data and a low willingness to pay can be barriers (C, 36; I, 30, 38; J, 62).

The topic of platform solutions is discussed controversially. Advantages are seen in an increased competitive ability (C, 96), and in new possibilities to interact with customers (C, 100; I, 78). However, uncertainty about the customers' demand (J, 66), unclear definitions of the topic (C, 79; G, 52) and limited time and knowhow (C, 61) let omnichannel businesses shy away from platforms. On top of that, being in an industrial niche limits the options (J, 38) as there are already many competing offerings (G, 54; J, 46; I, 89).

Omnichannel businesses face the threat of losing their crucial contact to the end customer due to third-party providers that position themselves at the customer interface (C, 77, 100; I, 78, 85; G, 34). Though SMEs in this role often do not aim to develop an own platform, becoming part of a platform could be a promising strategy to keep the contact to the end customer.

### *Suppliers*

This category senses many advantages in digitalization, like rising demand of the customers (H, 10), a strong competition (H, 109) and the chance to improve the quality of their products (H, 49). Nevertheless, the challenges outweigh the benefits. The situation of missing technical standards (H, 67) and lacking knowledge and employees (F, 30) can be improved by collaborating loosely with supply chain partners (F, 36; H, 25). In contrast to omnichannel businesses, suppliers do not know their end customers and there is less room for collaboration. Moreover, a supplier-specific challenge lies in the nature of their products. These firms manufacture components which provide less potential for digitalization than complete machines, according to the firms' evaluation (H, 21).

Due to lacking customer data and not-predestined products, suppliers often only reach low stages of business model digitalization. Some aim for new products providing the possibility for direct contact with the end customer (compare H). Following this path, the firms could reach the role of omnichannel businesses and higher digitalization levels, which are enabled by customer data. Another solution could be aiming for the role as modular producer (compare D).

### *Modular Producer*

Modular producers face similar challenges like suppliers, due to lacking knowledge about the end customer. The analyzed case is actually a former supplier that slowly takes the role as modular producer (D, 42). Still, the customers are mostly unknown, but the firm can benefit from the established ecosystem. Interfaces and technical standards between partners and customers are defined and data are exchanged which increases the potentials for digitalization (D, 6, D, 58). Thus, modular producers are more likely to reach higher levels of digitalization than suppliers. Their position within the value chain is shifted in the direction of the end customer and value co-creation approaches get more in scope (D, 10, 36). In particular, their position in an economic niche increases the need for collaboration as most digitalization offerings could not be realized on their own (D, 58).

Despite their lacking knowledge about the end customer, modular producers can benefit from product digitalization by being part of a strong network. This can be an attractive option for SMEs which want to take advantage of platform solutions without taking over the full responsibilities. On the other side, control effects arise when joining existing platforms since the firms become dependent on an ecosystem driver. These effects, though not discussed in the interviews, need to be considered in the decision for or against this role.

### Summary of the Roles' Profiles

When analyzing the SMEs' approaches for digitalization and their roles in the ecosystems, one important finding is, that all roles face similar barriers on their way to digitalization in the initial phase. In every interview, cultural barriers, lacking knowledge, lacking customer data, missing standards and the specificity of the product were named as factors slowing down digitalization projects. The starting position regarding potential difficulties for digitalization is independent from the single roles.

The difference between the roles is how effectively the challenges can be managed. While ecosystem drivers and modular producers overcome most of the obstacles by establishing an ecosystem, the network of omnichannel businesses is weaker and does not solve all problems to the same degree. For the suppliers, most barriers remain. For example, all interview partners mentioned the challenge of lacking customer data which is hindering them from providing data-enhanced services and products. The modular producers and ecosystem drivers can establish trust towards their end customers by collaborating in the network so that they could win valuable data. They are the base for reaching the next stage in digitalization. Omnichannel businesses have close contact towards their end customer, but still cannot always convince the customer to share the data. Since the suppliers do not know their end customer and cannot establish indirect connections through a network, the difficulty remains. Without data, it is difficult to offer product-related services. Furthermore, the suppliers' main challenge lies in the specificity of the offered components that often contain only limited potential for digitalization.

As the case studies suggest, the mentioned challenges arise from the firms' industry background, their innovation culture and their position in the value chain. These factors have an influence on the achievable stages of digitalization. In the following table, the role-specific levels for digitalization are illustrated based on the analysis of the firms (see Table 3). A (partly) filled circle stands for stages that can be partly or fully reached.

Stages of digitalization	Value proposition not changed		Value proposition changed	
	Stage 0	Stage 1	Stage 2	Stage 3
Roles in ecosystem	No digital offerings	Data enabled improvements	Product-related solutions	Stand-alone digital services
Supplier	●	◐	○	○
Omnichannel Business	●	●	◐	○
Modular Producer		●	●	◐
Ecosystem Driver		●	●	●

○ Stage is not reached   ◐ Stage is partly reached   ● Stage is fully reached

**Table 3: Role-specific Digitalization Approaches**

According to the case studies, suppliers are often restrained to process digitization since the described challenges cannot be solved. Basic improvements of their components, like the integration of a sensor to track the parts, are feasible. However, without a suitable environment, higher degrees of digitalization are difficult to reach. Omnichannel businesses are more likely to reach the next step of new value propositions, though their focus is on data-enabled improvements. The interviewed omnichannel businesses do not question their business model but they prefer incremental improvements of their products. In contrast to that, modular producers have at least established the first digitalization stage of data-enabled improvements. Without any digital advanced solutions, they could not execute their role. Since modular producers offer product-related plug-and-play solutions, the majority of their offerings is still connected to existing products. Thus, the second stage is most common. Again, a minimum level of digitalization is required to take the position of an ecosystem driver. These actors offer stand-alone digital solutions changing the former value proposition essentially. Hence, ecosystem drivers reach the highest digitalization stage, potentially disrupting existing markets.

## **Discussion**

The results indicate that ecosystem roles have an influence on the approaches of SMEs for digitalization. The roles set the framing conditions for digitalization, leading either to higher levels in the case of modular producers and ecosystem drivers, or to lower levels in the case of suppliers and omnichannel businesses. Collaborating in ecosystems assists in overcoming initial challenges of digitalization. Customer data can be exchanged, knowledge can be acquired, and resources can be shared. In short-term perspective, the exploitation of the role-specific potential is the best option for SMEs. In long-term perspective, roles can be developed strategically, unleashing new options for digitalization.

The work contributes to the understanding of SMEs' roles in ecosystems and their influence on the firms' digitalization options. The ecosystem construct is classified as enabling factor for digitalization. Companies have to follow pathways in the ecosystem to make new digitalization options accessible. The findings address the research stream of digitalization of SMEs, the research stream of ecosystems and most importantly, their connection. Regarding the digitalization of SMEs, the finding of suppliers focusing on digitization and reaching only low levels of digitalization, is supported by studies, stating that manufacturing SMEs rather digitize their processes than develop digital offerings (Bley et al. 2016; Bogner et al. 2016; Sommer 2015). Most of the mentioned challenges overlap with the barriers in literature. The aspect of lacking customer data and trust is explicitly emphasized in the interviews, whereas it appears only as a side effect in literature.

Stressing collaboration in ecosystem as an approach to overcome barriers of digitalization is a relatively new suggestion, in contrast to the often mentioned internal factors of on the companies (Becker et al. 2018; Coreynen et al. 2017). Until now, many researchers underline the importance of implementing scalable projects that are adjusted to the firms' capabilities instead of analyzing ways of collaboration. Hence, results about the interplay of digitalization and ecosystem roles provide a new perspective.

In the area of ecosystem, most findings are consistent with previous research. The difficulty of defining the ecosystem's borders is supported by the interviews as well as by literature (Gawer 2009). Firms work with different stakeholders. For some, this includes just collaborating with suppliers, for others it means integrating customers and competitors. Without clarifying the frame of the ecosystems, analysis cannot be conducted, and roles cannot be assigned. Moreover, the characteristics of the ecosystem's roles are confirmed in this work. As researchers report, roles are highly volatile and not every role has to be filled, whereas in some cases, companies take several roles (Dedehayir et al. 2016; Pierce 2009). This matches the study's outcomes very well. Some companies are in the transition between different roles. Others hold multiple roles at the same time since only some departments changed their position.

In contrast to these agreements, some theory-driven aspects about ecosystems are not explicitly covered in the findings. For example, the formation and development of ecosystems over time cannot be observed. Most of the analyzed ecosystems are still very young and longitudinal observations were out of scope. Moreover, control and power distribution between the different players are highly relevant in literature (Dellermann et al. 2017; Tiwana 2015), whereas the topic is barely touched in the interviews.

Overall, the concept of ecosystem is not seen as a topic of strategic importance in most interviewed SMEs. Though researchers analyzed this field for more than 20 years, its practical relevance is still low. Thus, we aim to bridge the gap and highlight the relevance of the topic for SMEs. Still, it needs to be considered, that these results describe the relation between roles in ecosystems and stages for digitalization in a qualitative way based on the findings of the case studies. We do not claim any correlations between the two constructs but value the results as solid starting point for conceptual research models that can be tested in a quantitative way.

## **Contribution**

In comparison to global players that own the customer relation and work in strong networks, SMEs struggle on their way to digitalization. Their digital maturity is below average, and the companies are working on strategies to improve their competitive ability. Next to internally defined strategies for digitalization, the analysis of the firms' ecosystem is an essential factor to be considered.

The work contributes to the understanding of SMEs' roles in ecosystems and their influence on the firms' options for digitalization. It opens a great field for practice-oriented research. Against the popular opinion in SMEs, ecosystems are not just a theoretical idea, but a necessity on the way to digital transformation. First, a practical implication could be to rethink the handling of ecosystems in the SMEs' everyday-life as a crucial control lever for the SMEs' competitive ability. Not only strategies for the firms' development need to be defined, but also strategies for the growth of the whole ecosystem are required. The integration of partners in strategic decisions is highly recommended.

Second, approaches for digitalization need to fit the companies' roles. Building up digital capabilities and envisioning digital value propositions is not enough on the way to digitalization. The approaches have to match the firms' role. Firms have to be aware of their current position in the ecosystem to understand their options for digitalization. Having clarified their current position, capabilities can be developed more precisely. In short time, the role-given potential can be exploited more efficiently.

Besides the contribution in the practical field, the work succeeds in giving preliminary explanations about the relation between roles in ecosystems and strategies for digitalization. Despite the vast amount of literature on ecosystems, digital potentials for different roles have not been identified yet. The connection of both constructs offers a solid base for further research.

Despite its high degree of alignment with literature findings, the research underlies some limitations, which have to be considered when interpreting the results. Starting with the research design, the study is suitable for exploring the relationship between ecosystem roles and digitalization approaches, but it does not serve for analyzing robust correlations. Though the questions were formulated in a neutral way, biases of the interviewees cannot be fully rejected. The results are restricted to a small amount of cases in one country. A greater and more evenly distributed sample size would improve the database and add credibility of the results. Furthermore, there are conceptual limitations of ecosystems. Despite the clearly defined coding scheme, the distinction between the business design of value chain and ecosystem could not always be conducted selectively. The concepts are partly interwoven, and the results depend on the individual definition of these concepts.

The limitations raise new questions for future work. First, improvements of the current research design could be implemented. The analysis of a larger sample promises a broader database and therefore would decrease the risk of detecting causal relations by coincidence. A comparison of SMEs from different branches could help to assess if the findings are still valid. Second, the research design could be extended. Combining the qualitative study with an additional quantitative research design would offer insights into the distribution of the roles and significances could be tested. Data from a longitudinal study could help to comprehend the change of roles over time. Clearly defined pathways for the development in ecosystems could then provide practical guidance for companies. Third, the scope of the analysis could be widened by including digitization activities and external influences. The design of a robust research model based on the explored relationships is recommended.

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