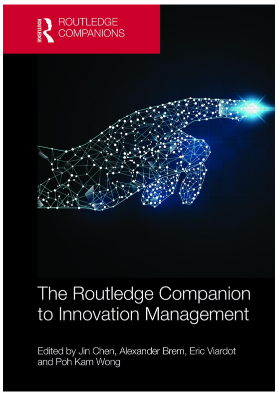

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Innovation in the digital age

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INNOVATION IN THE DIGITAL AGE

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Introduction

Today's industrial environment is marked by the increasing use of digital technologies (Yoo et al., 2012) such as artificial intelligence, automation, robotics, additive manufacturing, and human–machine interaction (McKinsey and Company, 2015). Embedded software and sensors are altering classical product characteristics, resulting in "smart products" capable of interacting through the Internet of Things (IoT). The interconnectedness of smart products allows data aggregation (Yoo et al., 2012; Nylén and Holmström, 2015; Porter and Heppelmann, 2014), thereby promoting the importance of "big data" analysis as well as cloud computing technologies (McKinsey and Company, 2015; Nylén and Holmström, 2015; MGI, 2013). In addition to their impact on products, digital technologies are helping to facilitate processes, for example, by accelerating innovation processes through digital simulation (Yoo et al., 2012; Nylén and Holmström, 2015). Integrating digital technologies into products influences competitive structures, blurs industry boundaries, and revolutionizes product as well as service innovation (Yoo et al., 2012; Nylén and Holmström, 2015; Porter and Heppelmann, 2014). New products require expertise from numerous knowledge fields (e.g. IT and manufacturing) that are potentially new to existing firms, which stresses the importance of collaboration across company as well as industry borders. Furthermore, customer focus and agile development methods determine success in today's dynamic industry environment (MIT Technology Review, 2014; Porter and Heppelmann, 2014; Bharadwaj et al., 2013; BMWi, 2016a).

For decades, researchers have been focusing on the innovation process and now conclude that innovation is a prerequisite for corporate success (Brown and Eisenhardt, 1995). However, beyond appreciating that technological innovation can have consequences across industry boundaries (Tushman and Anderson, 1986; Weiber, Kollmann, and Pohl, 1999), there is still little understanding of the role of digitalization as an enabler of significant innovation process changes. Hence, there is a knowledge gap concerning the influence of digitalization on innovation management.

Researchers and managers alike must identify the specific requirements that innovation processes have to fulfill in the future (Bharadwaj et al., 2013). In the innovation management literature, many authors acknowledge the beginning of an "innovation revolution" (Lee Olson and Trimi, 2012, p. 819) and stress the need for research into new types of innovation processes that are enabled by digital technologies and differ from traditional industrial innovation processes (Nylén and Holmström, 2015). Since innovation ecosystems are increasingly important, several authors have called for research into how firms can manage innovation collaboration effectively and how digital resources influence value creation in industrial ecosystems (Bharadwaj et al., 2013; Adner and Kapoor, 2010; Barczak, 2014).

This chapter builds upon the research of Yoo et al. (2012), who identified new requirements for innovation methods in the digital era, for example, that process speed needs to increase. As companies often still rely on classically linear innovation processes such as the stage-gate model (Cooper, 1990), digital technologies and the growing importance of early prototypes, as well as a customer focus, challenge such established methods (Nylén and Holmström, 2015; BMWi, 2016a). In this chapter, we will first discuss the impact of digital technologies on innovation in the automotive industry, which, though known for its innovativeness, still remains a very traditional industry sector (Henfridsson, Mathiassen, and Svahn, 2014). Following this, we will review the impact of digital technologies on innovation in service industries. In order to analyze the consequences of digitalization on the innovation process of the automotive and service industries, we first provide an overview in the second section of the theoretical perspectives that we use in our analysis of the two industries. In the third section, we present the research methods as well as the empirical data and then discuss the results and the ensuing theoretical model in the fourth. We conclude with managerial implications and contributions, as well as limitations of this study and offer suggestions for further research.

Theoretical background

Digital innovation process models in manufacturing

Innovations, defined as "a new technology or combination of technologies introduced commercially to meet a user or a market need" (Utterback and Abernathy, 1975, p. 642), are generated through an innovation process. Gruber and Marquis identify a process with six phases that transport ideas from generation to product launch (Gruber and Marquis, 1969; Cooper, 1976). Building upon their work, Cooper developed the *stage-gate model*, which divides the innovation process into stages and gates to support successful product commercialization. Varying between four and seven stages, a gate controls each stage as the checkpoint for a set of deliverables (Cooper, 1990). The model is often the subject of criticism because of its linearity (Becker, 2006) as well as its lack of agility due to its predefined process steps and early product definition (Bhattacharya, Krishnan, and Mahajan, 1998; MacCormack et al., 2012). Cooper modified the traditional model in 2014 by introducing the *Triple-A System*, which is more adaptive, flexible, and agile (Cooper, 2014).

Having originated in software development research, agile approaches to innovation are gaining importance throughout the industry. As a result of the introduction of the *Manifesto for Agile Software Development* in 2001, characteristics of agile systems such as the value of individuals and interactions, the importance of prototypes, customer collaboration, and a quick response to change (http://agilemanifesto.org) are now incorporated into traditionally linear industrial process models (Cooper, 2014; Sommer et al., 2015). Hybrid processes such as the *Industrial Scrum Framework for New Product Development* support increasing external cooperation and iterative product development by combining stage-gate and Scrum approaches. Scrum is an agile way of developing software based on the principles of transparency, inspection, and adaption. Using quick development intervals, teams are self-organizing and adapt to changes easily (Schwaber and Sutherland, 2016; Schwaber and Beedle, 2002). Using stage-gate and Scrum at different planning levels throughout the project, Sommer et al. (2015) identify company strategies to exploit the advantages of agile systems. While stage-gate mechanisms are often used for strategic management purposes, Scrum supports project execution within development teams. Hence, hybrid models are emerging as an alternative to traditionally linear stage-gate systems in order to succeed in an increasingly complex and dynamic industry environment (Sommer et al., 2015; Cooper, 2014). In addition to the need for a higher degree of agility, the identification of customer needs is gaining importance throughout the innovation process. The design thinking method, which follows the principle "innovation is made by humans for humans" (Brenner, Uebernickel, and Abrell, 2016, p. 8), is also increasingly present in practice. Focusing innovation activities on the human being (e.g. by direct observation), the method emphasizes technological solutions and prototypes to understand and solve customer problems (Brown, 2008; Meinel and Leifer, 2016).

Open innovation and ecosystems

Besides the emerging agile systems and changing classical innovation approaches, the development of the *open innovation* paradigm by Henry Chesbrough in 2003 also had a large impact on the development of formerly closed innovation process models. By developing ideas generated internally as well as externally while following external and internal paths to commercialize them, open innovation enables the exploitation of external knowledge for innovation purposes (Chesbrough, 2003). Numerous forms of open innovation tools have emerged to integrate external expertise, for example, the possibility for companies to solve a specific R&D problem by hosting innovation challenges (Terwiesch and Xu, 2008; Hüsig and Kohn, 2011). Furthermore, crowdsourcing as well as co-creation approaches, both enabled by the Internet and Web 2.0 technologies, actively integrate users into innovation activities (Prahalad and Ramaswamy, 2004; Rayna, Striukova, and Darlington, 2015; Saxton, Oh, and Kishore, 2013). Given the resulting inseparability of producing and consuming products in the digital era, researchers define a *prosumer* as an active user who plays the two roles of an innovator and consumer at the same time (Berthon, Pitt, and Campbell, 2008; Gawer, 2014; Rayna and Striukova, 2016).

In addition to the growing importance of integrating external expertise by collaborating with users and other outside actors, the cooperation between innovation actors also increases. Using a collaboration approach, organizations build long-term networks consisting of suppliers, manufacturers, and competitors (Zineldin, 2004). In the literature, researchers refer to such networks as platforms or innovation ecosystems that enable the offering of customer solutions by combining individual products and services within a collaborative agreement (Adner, 2006; Adner and Kapoor, 2010; Gawer, 2014). Actors in ecosystems collaborate and conduct common innovation activities but are in a competitive relationship at the same time (Lee, Olson, and Trimi, 2012; Gawer, 2014). Given that no single company has the capability to offer the emerging solution individually, an ecosystem is a consortium for complementary product as well as technology and service development (Adner, 2006; Gawer, 2014).

The Apple iPhone with its App Store is an example of an industry platform, where Apple is the platform leader collaborating with its complementors, the app developers. Gawer (2014) argues that the roles played by platform agents evolve over time, and since the interaction between innovation and competition is dynamic, relationships between participants shift. Competitors ally or complementors become rivals, and users as prosumers actively innovate. These multimodal interactions change platform mechanisms, and ecosystems evolve as organizations move along the continuum (Gawer, 2014).

Key new technologies

Data is the most important raw material for digital innovation (Beutner, 2013; BMWi, 2016a). Digital technologies combine information, communication, computer, and network technologies. They offer the potential for new business models and trigger an innovation revolution (Bharadwaj et al., 2013; Lee, Olson, and Trimi, 2012).

New digital technology areas that are particularly relevant include big data analysis, cloud computing, and the Internet of Things (IoT). Big data analysis enables the analysis of vast amounts of generated data in order to draw valuable business conclusions (Bharadwaj et al., 2013). Cloud computing provides online access to IT resources and services (Marston et al., 2011; Porter and Heppelmann, 2014). Companies profit from lower entry barriers due to decreasing investments, and new business models emerge (DaSilva et al., 2013). Furthermore, cloud computing plays an important role with regard to the interconnectedness of products that results from embedded technologies and requires subsequent data processing (Porter and Heppelmann, 2014). The networking of products enabled by a reduction of sensor and technology costs, as well as ubiquitous access to scalable data processing (McKinsey Digital, 2015), has promoted the development of the IoT, which is expected to transform into the Internet of Everything (BITKOM and Fraunhofer, 2014). Since data is a central driver of the digital transformation and all of the earlier-mentioned technologies rely on it, this group is referred to as the *data cluster* of technologies, enabling data generation and processing for innovative purposes (McKinsey Digital, 2015). Furthermore, the data cluster builds the basis for several other important technological concepts like advanced robotics, augmented reality and virtual reality (AR/VR), and 3D printing that are used in products and processes in the digital era (Porter and Heppelmann, 2015; MGI, 2013).

Digital innovation in service industries

Even though services play an increasing role in advanced economies (Mina, Bascavusoglu-Moreau, and Hughes, 2014), the predominant understanding of innovation activities and processes comes mainly from studies focusing on new product development (NPD) in the manufacturing sector (Howells, 2010; Biemans, Griffin, and Moenaert, 2015). The theoretical work of Barras (1986, 1990), the highly influential "reverse product cycle" model, is often regarded as the starting point of service innovation research (Toivonen and Tuominen, 2009). During the last 30 years, the NSD research stream continued to evolve (Biemans, Griffin, and Moenaert, 2015). While some researchers believe that NSD is a mature field of research, the majority have come to the conclusion that the research field is still underdeveloped (Page and Schirr, 2008; den Hertog, van der Aa, and de Jong, 2010; Kuester, Schuhmacher, Gast, and Worgul, 2013; Biemans, Griffin, and Moenaert, 2015). Previous research on service innovation is characterized by different perspectives and priorities (Coombs and Miles, 2000; Droege, Hildebrand, and Forcada, 2009). Authors such as Barras (1986) and Pavitt (1984) focus on technological aspects of service innovation. Moreover, the assimilation view of service tends to disregard the specific features of services and assumes that the concepts and findings from the manufacturing sector can easily be transferred to the service industry (de Brentani and Cooper, 1992; Drejer, 2004). In contrast, the demarcation approach emphasizes the distinctive characteristics of services (den Hertog, 2000; Djellal and Gallouj, 2001) – intangibility, inseparability, heterogeneity, perishability (Parasuraman, Zeithaml, and Berry, 1985; Edgett and Parkinson, 1993; Moeller, 2010) – that make the transfer of knowledge from manufacturing to services difficult (Droege, Hildebrand, and Forcada, 2009). The synthesis stream, in turn, focuses on the increasing convergence between products and services and aims at connecting the findings from both fields of research (Droege, Hildebrand, and Forcada, 2009; Gallouj and Savona, 2009). Vargo and Lusch (2004, 2008) have argued for an alternative service-dominant (S-D) logic that is increasingly used as a foundation for systemizing innovation in general. Although these theoretical perspectives take up different positions regarding the development of service innovation, consensus exists concerning the importance of ICT in this context (Barrett, Davidson, Prabhu, and Vargo, 2015).

In the past, linear models of service innovation (Bowers, 1989; Scheuing and Johnson, 1989), which divide the NSD process into sequential activities, have been developed based on the NPD model from Booz, Allen, and Hamilton (1982). Typical stages of NSD models include, inter alia, the following: idea generation, screening and evaluation, business case, service development, testing, and launch (Bowers, 1989). Linear NSD processes contributed to the improvement of innovation activities by reducing uncertainty, providing clear guidelines, and eliminating trial-and-error iterations (Lenfle and Loch, 2010). However, they are not suitable for developing new services in the digital age. As the ability to respond to customer needs and market dynamics becomes increasingly important (Carlborg, Kindström, and Kowalkowski, 2014; Weber and Tarba, 2014), more agile methods for developing service innovations gain in significance (Wilson and Doz, 2011; Weber and Tarba, 2014).

Agile methodologies and design thinking

Sambamurthy, Bharadwaj, and Grover (2003) define agility as "the ability to detect and seize market opportunities with speed and surprise" (Sambamurthy, Bharadwaj, and Grover, 2003, p. 238). Although agile development methods have their seeds in the software industry, their principles are widely applicable to any innovation project in a dynamic environment (Lankhorst, 2012). The agile methodology is based on the fundamental assumption that the specifications and requirements of a new service offering are not predictable in advance. Therefore, no (or only a vague) definition of the project objective is necessary. The process is divided into short iterations and starts with the fast development of a first version of the new service product – the so-called "minimum viable product" – which is then discussed with customers. Agile processes are faster, easier, and more customer-focused than traditional NSD processes (Lankhorst, 2012; Link, 2014). Moreover, the design thinking approach, which emerged from design literature, increases in importance and should be integrated into service innovation research (Michel, Brown, and Gallan, 2008; Kimbell, 2011; Barrett, Davidson, Prabhu, and Vargo, 2015). Design thinking is a creative problem-solving approach that highlights the importance of putting the user's needs and preferences at the center of innovation activities (Michel, Brown, and Gallan, 2008; Meinel and Leifer, 2011). Design thinking and agile methodologies have various similarities such as the rapid development of prototypes, an iterative structure, work in small teams, and informal communication (Hirschfeld, Steinert, and Lincke, 2011).

Service innovation ecosystems

Scholars have emphasized the importance of building up ecosystems in order to develop innovations (Yoo et al., 2012; Gawer and Cusumano, 2014). In times of developing digital technology, decreasing communication and coordination costs lead to a geographical diffusion of innovation activities (Maznevski and Chudoba, 2000; Yoo et al., 2012). By utilizing the innovative capabilities of external actors, digital platforms, which support collective value creation and associated innovation ecosystems, enable a dispersion of innovative labor beyond traditional company or supply chain boundaries (Gawer and Cusumano, 2014). According to Lusch and Nambisan (2015), an ecosystem can be defined as a "community of interacting entities – organizations and individuals (including customers) – that coevolve their capabilities and roles and depend on one another for their overall effectiveness and survival" (Lusch and Nambisan, 2015, p. 161). It is becoming increasingly important for the success of service innovation activities to open up the innovation process to external actors and search for knowledge and ideas outside the organizational boundaries (Lopez-Vega, Tell, and Vanhaverbeke, 2016). Such practices include open innovation (Boudreau, 2010), online communities (Faraj, Jarvenpaa, and Majchrzak, 2011), and/or innovation challenges (Boudreau, Lacetera, and Lakhani, 2011).

What these diverse practices have in common is the importance of opening up the innovation process to external actors, as well as the promotion of more flexible and creative approaches towards service innovation. Currently, however, there is no contemporary NSD model integrating agile and creative methodologies as well as innovation ecosystems.

Case study 1: BMW

The automotive industry

The automobile is an example of the dual use of digital technologies. First, such technologies are embedded in the product itself and are increasingly being used throughout the product life cycle (Blümel, 2013). Connected services and location-based technologies alter the characteristics of the car as an enabler of mobility, whereby the combination of software and hardware plays an increasing role for new product development (Bongard, 2015). New competitors like Uber have entered the market for mobility without actually owning cars. Car-sharing business models are on the rise and challenge traditional car manufacturers in the face of digitalization. In this case, we focus on the following: (1) How and why does the innovation process in the automotive industry change in the face of digitalization and transforming product characteristics? (2) How and why do collaborations between OEMs, suppliers, and third parties change – for example, to what extent do innovation ecosystems emerge and how is the innovation process affected?

Company and industry data

The Bayerische Motoren Werke (BMW) AG, with its headquarters in Munich, is the parent enterprise of the BMW Group. The company was founded in 1916 as a manufacturer of aircraft engines before it first began producing cars in 1918. Today, BMW is a premium car manufacturer employing 122,244 people in 150 countries. The company celebrated its 100th anniversary in 2016 (BMW Group, 2015). With the publication "The Next 100," the BMW Group presented a vision for the next 100 years of corporate success in the digital era (BMW Group, 2016a).

After Volkswagen and Daimler, BMW ranks third among German car manufacturers in terms of the number of vehicles produced (Statista, 2017). With 20.6 billion Euro of R&D expenses in 2015, the automotive industry is Germany's strongest industry sector in terms of research investments (BMWi, 2016b). These investments drive product as well as process innovation throughout the economy.

Products and services

Products and services offered by the BMW Group cover the vehicle brands BMW (including the i-series of electric and hybrid models), MINI, and Rolls-Royce as well as BMW motor bikes. In addition, BMW has expanded into a number of services like DriveNow, ChargeNow, and ParkNow. BMW founded the car-sharing service DriveNow in 2011 as a joint venture with the car rental company Sixt. With ConnectedDrive, BMW offers digital services enabled by the interconnectedness of vehicles, drivers, and their environment through apps and driving assistance services. In 2015, 95 percent of new BMW cars were equipped with embedded technology to form a network. In addition, BMW provides mobility services to business clients, and the company runs a financial services department (BMW Group, 2016b).

Innovation management, process, and culture

At BMW, an independent innovation management department is responsible for the assessment and prioritization of ideas until projects reach the phase of conception. Development projects within innovation management are less cost driven and profit from a high degree of possible exploration by granting space for creativity. Furthermore, BMW has created a digitalization office as a new business unit to promote the development of innovative product-service systems and business models. The company has set up task forces apart from the main organization to address trends like big data and mobility services. Furthermore, the manufacturing unit in Regensburg founded the "InnoLab4," which is dedicated to research focusing on Industry 4.0.

Classically, the development of a new car model follows a linear stage-gate approach assuming a five-year product life cycle. Agile systems are used throughout the company, for example, when developing data services like the self-servicing car. For the development of this product, BMW used a beta version of an app within the UK market in 2016, where car owners of BMW and MINI vehicles tested its functionality. Based on generated user data, the app is designed to inform the driver if the car needs service, like a change of brake pads or oil filter. The system is capable of arranging appointments at the closest service station (based on Google maps) and can transmit data regarding necessary spare parts prior to the appointment in order to minimize waiting times for the customer. Testing user acceptance and behavior of this predictive maintenance concept for cars offers the opportunity to generate real-time feedback during the development process. BMW created the product with a high degree of agility and customer focus to meet user requirements.

In 2015, BMW introduced a new IT strategy (Computerwoche, 2015), which represented a paradigm shift. They replaced the traditional waterfall model with an agile system, thereby accelerating development times from nine to three months. The new concept relies on a questionnaire that identifies the possible rate of agility for each product. Based on individual product requirements, BMW chose one of three predefined development models for the further course of action. First, the possibility of using a classical waterfall model is still available if product characteristics call for a traditional approach. The second option consists of an agile model, and option three offers the opportunity to develop a product using the lean startup development model. The agile method uses a modified business model canvas that covers questions regarding the future customer base of the underlying product. Furthermore, product placement, strategic background, and involved business units are planned. The canvas builds the basis for financial resource allocation in order to develop a proof of concept directed at a dedicated use case. The innovation budget of the group IT is not designed to develop a solution for extensive implementation into the series; rather, it aims at evaluating a technology within a specific field in order to initiate learning processes. Within three months, group IT develops prototypes and finalizes a proof of concept.

In addition, BMW experimented with creativity tools during innovation activities and changed historically implemented rules in order to become more agile. For idea generation purposes, BMW used the design thinking method to iteratively approach user problems. In order to shorten development times, group IT has furthermore changed regulations with regard to the possibility of single sourcings and has implemented rules to facilitate collaboration with startups. Development teams are formed for each project individually, integrating representatives of business units for successful development.

With the existence of these various innovation approaches, BMW aims to satisfy changing requirements for development models. The company identified the need for a higher degree of dynamic reaction to changing user needs as well as volatile environmental and technical developments. Integrating customers into innovation processes is of rising importance for BMW. In addition to solving the problem of differing development cycles of software and hardware, BMW views innovative approaches as a key for future success. Existing vehicle architectures of a historically grown company like BMW have emerged through incremental changes over time. For example, because of the interaction of several dozen engine control units, changes in product architectures are challenging. Due to comparably long hardware life cycles, existing sensors in cars are often outdated and do not meet contemporary technological standards. Carmakers looking back at a long history are therefore currently undergoing a phase of migration, having to exploit technologies in existing models while at the same time developing new architectures that meet future needs.

BMW has traditionally had a strong innovation culture. The company demonstrates a strong innovation focus by using modern technologies such as wearable devices, robotics, and digital assistance systems throughout production processes. Furthermore, innovative technologies like virtual reality, as well as modern 3D printing methods facilitate manufacturing and simulation (BMW Group, 2016c). BMW uses VR and AR technologies for communication purposes (e.g. to consult experts on manufacturing problems that are occurring).

Collaboration partner and networks

To increase innovative capacity and make use of open innovation to integrate external innovation potential, BMW founded the *Startup Garage* in Garching (near Munich) in 2015. Startup companies can apply to participate in a 12-week program that covers four aspects: build, learn, network, and sell (BMW Startup Garage, 2016). Startups get the chance to create an automotive prototype based on their generic idea. The process facilitates learning, connects young entrepreneurs with BMW as well as its suppliers, and offers them an initial client. The car maker aims to create long-term supplier relationships with young entrepreneurs.

In addition to collaborations that emerge from the garage program, BMW organizes hackathons and is engaged in other cooperative structures with startups, one of them being the company nextLAP. Founded in 2014, the startup offers a cloud-based IoT platform and connected hardware for manufacturing and logistics. Having formerly worked for Audi, the two founders highly value close collaboration as well as direct communication with their clients as development partners. Following an agile innovation model, BMW and nextLAP form a common development team whereby engineers of the car manufacturer have the possibility to join the startup team in their lab in Munich.

Despite classical collaboration with suppliers and the growing importance of startup cooperation, BMW is also committed to using co-opetition strategies by working with competitors. In 2015, Nokia sold its maps and location service Here to the car manufacturers BMW, Daimler, and Audi, who all hold an equal share of the mapping business.

Agile process models

Due to the size of BMW as well as its product diversity, it is not possible to identify a single innovation process model that is used throughout all innovation activities. Consequently, product-specific differences in development models exist. Our analysis of the self-servicing car demonstrates that BMW uses agile methods for development purposes. The self-servicing car is enabled by an interplay of embedded intelligence like sensors, connectivity, and data analysis technologies, which is typical of smart products. Moreover, BMW uses a beta version of the app in order to optimize the product in close collaboration with its customers, whereby interaction of numerous knowledge fields is necessary (e.g. IT, after-sales and engineering). BMW uses linear stage-gate models when developing products showing traditional characteristics that require compliance with specific safety standards or meeting high-quality expectations of customers. The innovation process of the BMW group IT follows agile principles as far as underlying product requirements allow. Hence, individual innovation characteristics determine the choice of the process model, whereby smart products as well as software are developed within agile structures. Consequently, innovation process models vary when product characteristics vary. However, in order to construct innovation processes according to the varying individual product requirements, the BMW group IT defined a number of generic process frames that are subsequently optimized with regard to product needs.

The different process models vary, especially with regard to the level of agility in product requirements. Our analysis shows that products that are considered a "digital innovation" are more likely to be developed using agile methods. The need to combine several knowledge fields in order to develop emerging product-service systems by collaborating with customers is typical for digital innovation. Moreover, the use of customer feedback for learning purposes and iterative development steps characterizes these special innovation activities. To meet these requirements, BMW uses proofs of concept and collaborates with customers to achieve fast learning cycles.

Organizational impacts

Our case study results show that working on digital innovation required BMW to design interdisciplinary development teams in order to cover case-specific knowledge requirements. As explained earlier, the group IT unit of the company identifies the relevant individual requirements by using a modified business model canvas for each project. Furthermore, BMW implements interdisciplinary development teams. BMW also uses smaller business units, such as the digitalization office, to offer a higher degree of independence than classically hierarchical business structures allow.

Collaboration

By engaging in car-sharing platforms and offering product-service systems in the context of the digital service brand ConnectedDrive, BMW not only plays the role of a traditional car maker but also of a mobility service provider. Consequently, BMW is dependent on a number of different experts covering knowledge fields like software analysis, who used to play a less important role. Since technology and software know-how, as well as expertise on agile development, is often rooted in startup companies, BMW aims to integrate external knowledge into innovation processes. The establishment of the Startup Garage, as well as the organization of hackathons and the use of other open innovation methods, supports this approach. BMW promotes close collaboration in development activities by conducting explorative research projects with suppliers like nextLAP. As described earlier, BMW engineers are engaged in innovation activities at the startup lab building a joint development team across company borders. In addition to the growing relevance of customer and startup collaboration, co-opetition structures with competitors are gaining importance, as shown by the acquisition of the map service. This engagement on behalf of BMW shows the growing importance of innovation ecosystems consisting of suppliers, customers, and competitors.

BMW is increasingly seeking to gain deep insights into customer needs by using open innovation approaches as well as the design thinking method to identify user problems. Furthermore, close customer collaboration is gaining in importance in order to offer individually optimized mobility services. Direct interaction with the customer is therefore the key to gaining access to user data. Hence, BMW promotes direct user interfaces through ConnectedDrive services in order to generate (real-time) user data. Since ownership patterns are changing, car owners and car users are not always identical. To generate user data, BMW promotes direct customer interaction with digital services, since the identification of customer needs is key for future product success. BMW needs customer feedback in order to pursue agile development approaches. As in the case of the self-servicing car, product iterations developed in an agile way enable quick feedback loops

Case study 2: financial services in Germany

The industry

The financial services industry in Germany is also home to an increasing number of startup companies, so-called FinTechs (for financial technology), that capture niche markets by offering alternative solutions for banking services and by developing new business models. Digital technologies not only offer new opportunities for FinTechs but also for traditional banks (Drummer, Jerenz, Siebelt, and Thaten, 2016). In order to analyze the requirements and success factors of new service development processes in the digital age, we analyzed four companies, their business models, and their approaches to innovation. After describing these cases, we present our overall findings and a cross-case analysis (Eisenhardt, 1989; Yin, 2014).

Company profiles

The first company, which we call "New Entrant A," is a German digital bank that obtained its full banking license in 2009. With the help of the Internet and Web 2.0 technologies, the aim of the firm was to transfer the behaviors and practices that exist in Web 2.0 to the financial services industry. Within the last six years, Entrant A evolved from a small FinTech company into a continuously growing firm with currently about 120,000 retail-banking customers and 30,000 business customers. The firm offers all traditional banking services, including lending and deposit operations. Using the motto "banking with friends," the firm created a much-frequented online forum that allows its members to interact with each other as well as the bank. This forum has become a central element of the firm's innovation activities. Within this community, members discuss ideas for new services and have the opportunity to incorporate their own ideas and requirements. Furthermore, the firm conducts surveys about potential new services, and members of the community are actively integrated into the NSD process, for example, by testing new services.

Entrant B is a German FinTech company founded with the aim of enabling consumers to pay in cash at local retail stores such as supermarkets or drugstores for the products and services they buy online. Like many other FinTechs, the firm does not hold a banking license. Since the company's founding in 2011, the business model has developed further and is no longer limited to online retailers but also offers its services to customers of nine different industries, such as energy suppliers, telecommunications companies, travel portals, and insurance companies. For example, since going online in March 2013, customers can book flights online without a credit card using the payment infrastructure of Entrant B. Moreover, they can pay invoices, such as electricity bills, in cash. If customers decide to use the payment infrastructure of Entrant B, they receive an invoice with a barcode. This barcode can be scanned (and the invoice paid) in about 10,000 retail stores in Germany, such as the supermarket chains "Rewe" and "Penny," or the drugstore chain "dm." For each transaction, Entrant B receives about 1 to 2 percent of the transaction amount. We can identify three user groups: (1) "low-income" earners – this is the largest group – who depend highly on cash payment since they receive their main income in cash (e.g. waiters, taxi drivers, or construction workers) or have a bank account that is overdrawn; (2) people who do not have a credit card and therefore cannot book flights online, or teenagers who get their pocket money in cash and want to spend it on the Internet; and (3) security-conscious people who do not want to disclose their personal data online. Since October 2015, Entrant B – together with the Entrant A bank – has been offering its payment infrastructure to the bank's customers. Supplying customers with cash is a large cost factor for banks. Owning ATMs is expensive, and they do not generate revenue. Moreover, it is less convenient for customers to take a detour in order to find the next ATM than it is to combine their grocery shopping at the supermarket with depositing or withdrawing money. Therefore, the company aims to offer its payment infrastructure to customers of traditional banks. In the long term, the FinTech startup is striving to substitute the traditional bank branch by offering an alternative private payment infrastructure. The company developed a platform that offers a new way to process payments. This platform is increasingly becoming an ecosystem linking diverse actors.

Incumbent Bank A is a traditional bank with about 4 million customers in Germany. The firm has been focusing on the private banking market for more than 90 years. Important distribution channels include branch operations, telephone, Internet, and mobile. Its digital as well as its innovation strategy is part of the overall "omni-channel banking" strategy. The bank incorporates "digital" into the very core of its activities, and usability and customer-centricity are central elements of the innovation activities. The bank does not just create its own innovative solutions but is specifically looking for partners to develop new services.

Incumbent Bank B is one of the largest financial service providers in Germany, serving about 14 million private and corporate clients. The firm has a very dense branch network and is in contact with its customers via branch operations, online, or by telephone. The digitalization activities are comprehensive and embrace several innovation initiatives such as the so-called "campus" – an idea lab that aims to show the firm's employees new methods and tools for being innovative in their everyday lives – or the "idea fabric" – a meeting point for cross-functional teams that work for about four months on innovative tasks and new ideas.

Case study results

Based on our literature analysis, the aspects of acceleration, agility, and customer-centricity (Yoo et al., 2012; Carlborg, Kindström, and Kowalkowski, 2014; Weber and Tarba, 2014; Porter and Heppelmann, 2015) have been identified as the requirements for successful service innovation processes in the digital age. The case of Entrant A shows that the acceleration of innovation activities is a key component of the firm's strategy. Whereas many companies only bring innovations to market that are completely finalized, Entrant A usually introduces products that are "initially incomplete" in order to accelerate the pace of innovation. New features are added later as soon as they are ready for deployment. Entrant B follows the same principle. An accelerated innovation process is necessary for the two established banks as well due to fast and flexible startups that have more financial resources at their disposal than in the past. Banks A and B emphasize the importance of accelerated processes and are trying to deploy new features more often. Entrants A and B both highlight the increasing impact of agility in innovation processes. For them, it is important to continuously reconsider the decisions taken and implement agile development methods as the required pace of innovation can only be realized by agile methodologies. Banks A and B also stress the relevance of agile processes, but for them, the term agility not only describes agile innovation processes but also a specific mind-set. Bank B's manager responsible for digital experience and innovation management states:

> Agility starts in the minds of the firm's employees. It is important to overcome thinking barriers and to encourage them to try various things. This is the basis for agile processes. The evolutionary history has already provided proof that it is not the strongest that is going to survive but the most adaptive.

In contrast to young companies that are digital in nature, established banks struggle with the organizational change. Agility can only be realized when the whole organization is changing. This is in line with Teece (2014), who emphasizes the importance of continuously transforming established behavioral patterns. In his opinion, this ability shows the true value of dynamic capabilities.

Customer-centricity is the third requirement. Entrant A sees customers as the key innovation drivers so that a clear customer focus is important in order to develop innovations that users value. The firm has structured its innovation process in a way that allows the integration of customers into innovation activities. The community forms a central element of the firm's innovation activities and shows the customer-centricity of the firm. Although customers sometimes do not know in advance which products they might value in the future, the analysis of our four cases shows that all firms incorporate customers into innovation processes as they recognize the importance of customer-centricity. The requirements of acceleration, agility, and customer-centricity are equally important for successful NSD processes of entrants and incumbents.

According to the literature, linear innovation processes are less useful in times of technological change so that agile methodologies are gaining in significance (Sethi and Iqbal, 2008; Wilson and Doz, 2011). Entrants A and B designed similar innovation processes that were both a combination of linear and agile proceedings. The so-called "fuzzy front end" of innovation activities, which includes all activities starting with the first impulse for a new idea until the concept is implemented (Menor, Tatikonda, and Sampson, 2002; Alam, 2006), is structured formally and is divided into the stages of idea generation, scoping, and the development of a business case. However, agile elements such as iterations and feedback loops are already established within these three stages. With the start of the development process, a completely agile approach consisting of multiple "sprints" is used. In contrast, Banks A and B use two different innovation processes: a classical linear process for the "back end," and for incremental innovations and a more agile process – equal to the approach of Entrants A and B described earlier – for the development of the "front end" and more radical innovations. In order to realize front-end applications, Bank A often cooperates with partners such as digital design agencies.

The literature also indicates that new forms of innovation practices such as open innovation (Boudreau, 2010), online communities (Faraj, Jarvenpaa, and Majchrzak, 2011), and innovation challenges (Boudreau, Lacetera, and Lakhani, 2011) improve innovation activities. Our cross-case analysis showed that all four companies use all of these approaches. Whereas open innovation, co-creation, and online communities are used to generate new ideas and to discuss and test new services with different stakeholders, innovation challenges are mainly used to find new talent and to build up partnerships with entrepreneurs. Bank B's responsible manager for digital experience and innovation management states: "Hackathons help in the building up of a network of innovators and entrepreneurs. As we want to build up an ecosystem, finding partners is important for us. Innovation challenges help to get in contact with developers and start-ups."

Our literature analysis indicates that the increasing prevalence of digital technology has heightened the role of platforms (Yoo et al., 2012). Entrant A's "community platform," which is described earlier, is the key element of the firm's innovation strategy. The firm is not only using this platform itself but is selling it to other companies. In addition, Entrant A pursues a clear platform strategy. The firm is opening up its banking infrastructure so that other companies can be integrated into the platform and have the possibility to offer their services to Entrant A's customers. The firm therefore not only creates innovations itself but also offers its customers a platform that incorporates the services of other companies. Moreover, Entrant B also focuses on developing a platform with a focus on offering a new way to process payments. Furthermore, Bank B built up a so-called "co-creation platform" in order to integrate customers into innovation activities. About 4,000 persons use the platform, which in addition to customers incorporates noncustomers, FinTechs, and the firm's employees. For Bank B, the "spirit transfer" is of primary importance. Moreover, FinTechs or other stakeholders have the opportunity to use the platform infrastructure (for free) to build or further develop their business. Although Bank A does not focus on platform development, it acknowledges the relevance of digital technology platforms.

Furthermore, ecosystems are an important success factor for the development of innovations in the digital age. Entrant B's co-founder and managing director stated:

> Platforms and ecosystems are the value of the future. They drive innovation. As it is increasingly difficult to develop innovations on one's own, building up ecosystems that promote and foster new ideas is becoming more and more important. The perfect example is Apple: Most of the people do not buy the iPhone because of its hardware but because of the software and the available applications – this means because of the ecosystem around the iPhone. With our infrastructure, we are also building up a platform that brings together diverse actors in an ecosystem.

Moreover, Bank A is currently building an ecosystem around the topic "contactless payment" together with partners from several industries. The firms cooperate in order to realize an innovation based on near field communication technology. Bank A's Chief Marketing Officer states: "In the digital age, diverse players enter the market for financial services so that innovation ecosystems gain in importance because one company alone would not be able to realize some of the innovation projects." In order to create a stable ecosystem, it is important to generate "win-win-win" situations for all stakeholders. Otherwise the cooperation efforts will not be successful.

A process model for digital innovation

Based on the results of our case studies, we developed the process model shown in Figure 14.1. The figure shows two directions of influence that digitalization exerts in both manufacturing and service industries.

First, digital technologies are used throughout the process while conducting innovation activities. As stated in the proposition in Group 4 in the figure, technologies have the potential to accelerate development activities and can facilitate communication as well as collaboration. These principles build the basis of the generic framework for digital innovation since successful development builds upon the exploitation of this potential.

Second, firms can use digital technologies within products. As explained earlier, firms can alter product characteristics for successful digital innovation. Once firms identify the characteristics, they must choose a suitable process model. Firms can optimize the process according to individual needs, thereby achieving the highest degree of agility possible for the underlying project. Developing digital innovation includes using proofs of concept, early prototypes, and collaborative development structures, if possible. Firms form interdisciplinary teams and sometimes consider the possibility of separating business units. They provide innovation space and promote innovation with new values. Collaboration ecosystems emerge, innovation activities focus on user needs, and close customer cooperation is put into practice. Given the adaptability of innovation activities, the presented framework shows a generic process for digital innovation that is based on the influence of digitalization on products and processes.

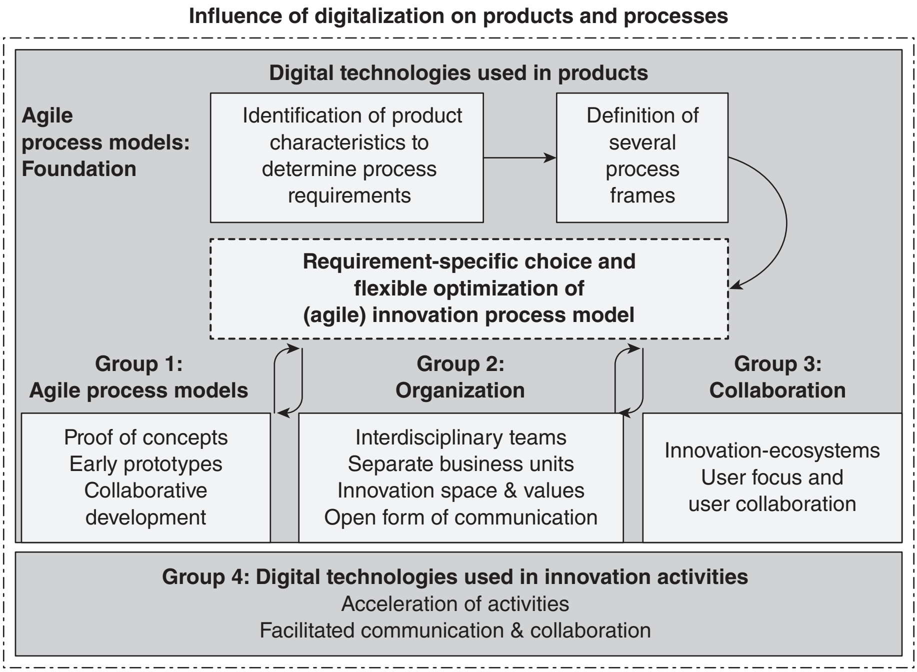

Figure 14.1 The generic innovation process for digital innovation

Conclusion

Managerial recommendations

Internal changes in methods

From our study, we identified several managerial implications as options for future digital innovation success in practice. First, companies should define digital innovation processes individually with regard to the requirements of each project and the possible degree of agility. To facilitate this approach, companies should define a choice of several frame processes that can be individually adapted and optimized according to project needs. Second, companies should develop early prototypes, create proof-of-concept studies, and collaborate with users. Third, firms should critically analyze product portfolios for possible alternative strategies to meet customer needs. Fourth, firms should create development teams individually with regard to project requirements. Fifth, companies should consider the option of temporary as well as permanent organization changes in order to allow space for creativity. Finally, firms must develop values and open communication to promote digital innovation.

External cooperation

For successful cooperative activities for digital innovation, firms must develop a common understanding of innovation when choosing collaboration partners. Innovation success can be promoted by the participation in a digital innovation ecosystem consisting of startups, competitors, and customers. In addition, firms should consider open innovation methods to increase innovation potential. Building interfirm development teams, using techniques like design thinking, and implementing digital services to interact with customers directly are important tools for digital innovation success. Lastly, firms can use digital technologies in order to accelerate innovation activities, to gain insights on customers by data analysis, and to facilitate communication as well as coordination.

Limitations, contribution, and future research

With our research, we tried to identify the impact that digital transformation has on the innovation processes of the automotive industry and financial services. We addressed an existing research gap with regard to the integration of a digitalization perspective into innovation management literature that was identified by Bharadwaj and Noble (2015). Our empirical results show changes to traditionally linear innovation systems arising due to digital technologies. By summarizing two directions of influence that digitalization exerts on products and processes within a generic innovation process for digital innovation, our study adds insights to necessary changes in innovation approaches. Our study also contributes to research by Cooper (2014) and Sommer et al. (2015), who developed hybrid innovation processes that combine agile and linear models. Furthermore, we addressed the call for a dynamic tool to support companies in their digital innovation efforts stated by Nylén and Holmström (2015). By doing so, our study amplifies the results of Yoo et al. (2012), who identified changing process requirements in a digital world. Future research should focus on the development of these models.

In addition to innovation process alterations, we identified organizational success factors for digital innovation with regard to company structure and culture. Analyzing these organizational and cultural changes in more detail is an opportunity for research. Given the complexity of the previously mentioned intertwining research fields, future research projects should be interdisciplinary to generate further valuable insights. Collaboration of science and practice will be necessary to enlarge the existing knowledge base and develop strategies for long-term innovation success in the digital era.

References

Adner, R. (2006). Match your innovation strategy to your innovation ecosystem. *Harvard Business Review*, April, pp. 2–11.

Adner, R. and Kapoor, R. (2010). Value creation in innovation ecosystems: how the structure of technological interdependence affects firm performance in new technology generations. *Strategic Management Journal*, 31(3), 306–333.

Alam, I. (2006). Removing the fuzziness from the fuzzy front-end of service innovations through customer interactions. *Industrial Marketing Management*, 35(4), 468–480.

Barczak, G. (2014). From the editor. *Journal of Product Innovation Management*, 31(4), 640–641.

Barras, R. (1986). Towards a theory of innovation in services. *Research Policy*, 15(4), 161–173.

Barras, R. (1990). Interactive innovation in financial and business services: the vanguard of the service revolution. *Research Policy*, 19(3), 215–237.

Barrett, M., Davidson, E., Prabhu, J. and Vargo, S. L. (2015). Service innovation in the digital age: key contributions and future directions. *MIS Quarterly*, 39(1), 135–154.

Becker, R. (2006). Re-thinking the stage-gate process – a reply to the critics. *Management Roundtable Inc.*, 1–5.

Berthon, P., Pitt, L. and Campbell, C. (2008). Ad lib: when customers create the ad. *California Management Review*, 50(4), 6–30.

Beutner, E. (2013). *Virtuelle Produktentwicklung*. Vogel Industrie Medien/VM.

Bharadwaj, A., et al. (2013). Digital business strategy: toward a next generation of insights. *MIS Quarterly*, 37(2), 471–482.

Bharadwaj, N. and Noble, C. H. (2015). Innovation in data-rich environments. *Journal of Product Innovation Management*, 476–478.

Bhattacharya, S., Krishnan, V. and Mahajan, V. (1998). Managing new product definition in highly dynamic environments. *Management Science*, 44(11, Part 2 of 2), S50–S64.

Biemans, W. G., Griffin, A. and Moenaert, R. K. (2015). New service development: how the field developed, its current status and recommendations for moving the field forward. *Journal of Product Innovation Management* (First Online), August 25, 1–16.

BITKOM, Fraunhofer (2014). Industrie 4.0 – Volkswirtschaftliches Potenzial für Deutschland, December 1st, 2016. www.bitkom.org/noindex/Publikationen/2014/Studien/Studie-Industrie-4-0-Volkswirtschaftliches-Potenzial-fuer-Deutschland/Studie-Industrie-40.pdf.

Blümel, E. (2013). Global challenges and innovative technologies geared toward new markets: prospects for virtual and augmented reality. *Procedia Computer Science*, 25, 4–13.

BMW Group (2015). Annual report 2015. November 7, 2016. www.bmwgroup.com/content/dam/bmw-groupwebsites/bmwgroup_com/ir/downloads/de/2015/12784_GB_2015_dt_Finanzbericht_Online.pdf

BMW Group (2016a). Company homepage: Zukunftsthesen. November 7, 2016. www.bmwgroup.com/content/bmw-groupwebsites/bmwgroup_com/de/next100/zukunftsthesen.html

BMW Group (2016b). Company homepage: Marken und Dienstleistungen. November 7, 2016. www.bmwgroup.com/content/bmw-groupwebsites/bmwgroup_com/de/marken.html

BMW Group (2016c). Company homepage: innovation, www.bmwgroup.com/content/bmw-group websites/bmwgroup_com/de/innovation/unternehmen.html.

BMW Startup Garage (2016). November 7, 2016. www.bmwstartupgarage.com

BMWi (2016a). Digitale strategie 2025. September 1, 2016. www.bmwi.de/BMWi/Redaktion/PDF/Publikationen/digitale-strategie-2025,property=pdf,bereich=bmwi2012,sprache=de,rwb=true.pdf

BMWi (2016b). Automobilindustrie Branchenskizze. November 15, 2016. www.bmwi.de/DE/Themen/Wirtschaft/branchenfokus,did=195924.html

Bongard, A. (2015). From the editor: core competencies. *Automotive IT International*, 3.

Booz, Allen and Hamilton (1982). *New products management for the 1980s*. New York: Booz Allen & Hamilton Inc.

Boudreau, K. (2010). Open platform strategies and innovation: granting access vs. devolving control. *Management Science*, 56(10), 1849–1872.

Boudreau, K. J., Lacetera, N. and Lakhani, K. R. (2011). Incentives and problem uncertainty in innovation contests: an empirical analysis. *Management Science*, 57(5), 843–863.

Bowers, M. R. (1989). Developing new services: improving the process makes it better. *Journal of Services Marketing*, 3(1), 15–20.

Brenner, W., Uebernickel, F. and Abrell, T. (2016). Design thinking as mindset, process, and toolbox. In Brenner, W. and Uebernickel, F. (Eds.), *Design thinking for innovation: research and practice*. Springer International Publishing, pp. 3–24.

Brown, S. L. and Eisenhardt, K. M. (1995). Product development: past research, present findings, and future directions. *The Academy of Management Review*, 20(2), 343–378.

Brown, T. (2008). Design thinking. *Harvard Business Review*, 86(6), 84–92.

Carlborg, P., Kindström, D. and Kowalkowski, C. (2014). The evolution of service innovation research: a critical review and synthesis. *The Service Industries Journal*, 34(5), 373–398.

Chesbrough, H. W. (2003). The era of open innovation. *MIT Sloan Management Review*, 44(3), 35–41.

Computerwoche (2015). Die IT-Strategie von BMW. February 06, 2015. November 8, 2016. www.computerwoche.de/a/die-it-strategie-von-bmw,3102626.

Coombs, R. and Miles, I. (2000). Innovation, measurement and services: the new problematique. In Metcalfe, S. J. and Miles, I. (Eds.), *Innovation systems in the service economy: measurement and case study analysis*. New York: Springer, pp. 85–103.

Cooper, R. G. (1976). Introducing successful new industrial products. *European Journal of Marketing*, 10(6), 301–329.

Cooper, R. G. (1990). Stage-gate systems: a new tool for managing new products. *Business Horizons*, 33(3), 44–54.

Cooper, R. G. (2014). What's next? After stage-gate. *Research Technology Management*, 57(1), 20–31.

DaSilva, C. M., et al. (2013). Disruptive technologies: a business model perspective on cloud computing. *Technology Analysis & Strategic Management*, 25(10), 1161–1173.

De Brentani, U. and Cooper, R. G. (1992). Developing successful new financial services for businesses. *Industrial Marketing Management*, 21(3), 231–241.

den Hertog, P. (2000). Knowledge-intensive business services as co-producers of innovation. *International Journal of Innovation Management*, 4(4), 491–528.

den Hertog, P., van der Aa, W. and de Jong, M. W. (2010). Capabilities for managing service innovation: towards a conceptual framework: den Hertog, Pim; van der Aa, Wietze; de Jong, Mark W. *Journal of Service Management*, 21(4), 490–514.

Djellal, F. and Gallouj, F. (2001). Patterns of innovation organisation in service firms: postal survey results and theoretical models. *Science and Public Policy*, 28(1), 57–67.

Drejer, I. (2004). Identifying innovation in surveys of services: a Schumpeterian perspective. *Research Policy*, 33(3), 551–562.

Droege, H., Hildebrand, D. and Forcada, M. A. H. (2009). Innovation in services: present findings, and future pathways. *Journal of Service Management*, 20(2), 131–155.

Drummer, D., Jerenz, A., Siebelt, P. and Thaten, M. (2016). FinTech – challenges and opportunities: how digitization is transforming the financial sector. Dusseldorf: McKinsey.

Edgett, S. and Parkinson, S. (1993). Marketing for service industries – a review. *The Service Industries Journal*, 13(3), 19–39.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Review*, 14(4), 532–550.

Faraj, S., Jarvenpaa, S. L. and Majchrzak, A. (2011). Knowledge collaboration in online communities. *Organization Science*, 22(5), 1224–1239.

Gallouj, F. and Savona, M. (2009). Innovation in services: a review of the debate and a research agenda. *Journal of Evolutionary Economics*, 19(2), 149–172.

Gawer, A. (2014). Bridging differing perspectives on technological platforms: toward an integrative framework. *Research Policy*, 43(7), 1239–1249.

Gawer, A. and Cusumano, M. A. (2014). Industry platforms and ecosystem innovation. *Journal of Product Innovation Management*, 31(3), 417–433.

Gruber, W. H. and Marquis, D. G. (1969). *Factors in the transfer of technology*. Cambridge, MA; London: MIT Press.

Henfridsson, O., Mathiassen, L. and Svahn, F. (2014). Managing technological change in the digital age: the role of architectural frames. *Journal of Information Technology*, 29(1), 27–43.

Hirschfeld, R., Steinert, B. and Lincke, J. (2011). Agile software developpment in virtual collaboration environments. In Plattner, H., Meinel, C. and Leifer, L. (Eds.), *Design thinking: understand, improve, apply* (1st ed.). Berlin, Heidelberg: Springer, [u.a.], pp. 197–218.

Howells, J. (2010). Services and innovation and service innovation: new theoretical directions. In Gallouj, F. and Djellal, F. (Eds.), *The handbook of innovation and services: a multi-disciplinary perspective*. Cheltenham: Edward Elgar, pp. 68–83.

Hüsig, S. and Kohn, S. (2011). 'Open CAI 2.0' – computer aided innovation in the era of open innovation and Web 2.0. *Computers in Industry*, 62(4), 407–413.

Kimbell, L. (2011). Designing for service as one way of designing services. *International Journal of Design*, 5(2), 41–52.

Kuester, S., Schuhmacher, M. C., Gast, B. and Worgul, A. (2013). Sectoral heterogeneity in new service development: an exploratory study of service types and success factors. *Journal of Product Innovation Management*, 30(3), 533–544.

Lankhorst, M. (Ed.) (2012). *Agile service development: combining adaptive methods and flexible solutions*. Berlin, New York: Springer.

Lee, S. M., Olson, D. L. and Trimi, S. (2012). Co-innovation: convergenomics, collaboration, and co-creation for organizational values. *Management Decision*, 50(5), 817–831.

Lenfle, S. and Loch, C. (2010). Lost roots: how project management came to emphasize control over flexibility and novelty. *California Management Review*, 53(1), 32–55.

Link, P. (2014). Agile Methoden im Produkt-Lifecycle-Prozess – Mit agilen Methoden die Komplexität im Innovationsprozess handhaben. In Schoeneberg, K.-P. (Ed.), *Komplexitätsmanagement in Unternehmen*. Wiesbaden: Springer Fachmedien Wiesbaden.

Lopez-Vega, H., Tell, F. and Vanhaverbeke, W. (2016). Where and how to search?: Search paths in open innovation. *Research Policy*, 45(1), 125–136.

Lusch, R. F. and Nambisan, S. (2015). Service innovation: a service-dominant logic perspective. *MIS Quarterly*, 39(1), 155–175.

MacCormack, A., et al. (2012). Do you need a new product-development strategy? *Research Technology Management*, 55(1), 34–43.

Manifesto for Agile Software Development (2001). Manifesto for agile software development. August 4, 2015. www.agilemanifesto.org

Marston, S., et al. (2011). Cloud computing – the business perspective. *Decision Support Systems*, 51(1), 176–189.

Maznevski, M. L. and Chudoba, K. M. (2000). Bridging space over time: global virtual team dynamics and effectiveness. *Organization Science*, 11(5), 473–492.

McKinsey & Company (2015). Digital manufacturing: the revolution will be virtualized. November 15, 2016. www.mckinsey.com/business-functions/operations/our-insights/digitalmanufacturing-the-revolution-will-be-virtualized

McKinsey Digital (2015). Industry 4.0 How to navigate digitization of the manufacturing sector. November 10, 2016. www.mckinsey.de/files/mck_industry_40_report.pdf.

Meinel, C. and Leifer, L. (2011). Design thinking research. In Plattner, H., Meinel, C. and Leifer, L. (Eds.), *Design thinking: understand, improve, apply* (1st ed.). Berlin, Heidelberg: Springer [u.a.], pp. xiii–xxi.

Meinel, C. and Leifer, L. (2016). Design thinking for the twenty-first century organization. In Plattner, H., Meinel, C. and Leifer, L. (Eds.), *Design thinking research: taking breakthrough innovation home*. Springer International Publishing, pp. 1–12.

Menor, L. J., Tatikonda, M.V. and Sampson, S. E. (2002). New service development: areas for exploitation and exploration. *Journal of Operations Management*, 20(2), 135–157.

MGI (2013). Disruptive technologies: advances that will transform life, business, and the global economy. January 14, 2015. www.mckinsey.com/insights/business_technology/disruptive_technologies

Michel, S., Brown, S.W. and Gallan, A. S. (2008). An expanded and strategic view of discontinuous innovations: deploying a service-dominant logic. *Journal of the Academy of Marketing Science*, 36(1), 54–66.

Mina, A., Bascavusoglu-Moreau, E. and Hughes, A. (2014). Open service innovation and the firm's search for external knowledge. *Research Policy*, 43(5), 853–866.

MIT Technology Review (2014). The internet of things. March 31st, 2015. www.technologyreview.com/businessreport/the-internet-of-things/free/.

Moeller, S. (2010). Characteristics of services – a new approach uncovers their value. *Journal of Services Marketing*, 24(5), 359–368.

Nylén, D. and Holmström, J. (2015). Digital innovation strategy: a framework for diagnosing and improving digital product and service innovation. *Business Horizons*, 58(1), 57–67.

Page, A. L. and Schirr, G. R. (2008). Growth and development of a body of knowledge: 16 years of new product development research, 1989–2004. *Journal of Product Innovation Management*, 25(3), 233–248.

Parasuraman, A., Zeithaml, V. A. and Berry, L. L. (1985). A conceptual model of service quality and its implications for future research. *Journal of Marketing*, 49(4), 41–50.

Pavitt, K. (1984). Sectoral patterns of technical change: towards a taxonomy and a theory. *Research Policy*, 13(6), 343–373.

Porter, M. E. and Heppelmann, J. E. (2014). How smart, connected products are transforming competition. *Harvard Business Review*, November, 65–88.

Porter, M. E. and Heppelmann, J. E. (2015). How smart, connected products are transforming companies. *Harvard Business Review*, October, 1–19.

Prahalad, C. K. and Ramaswamy, V. (2004). Co-creation experiences: the next practice in value creation. *Journal of Interactive Marketing*, 18(3), 5–14.

Rayna, T. and Striukova, L. (2016). From rapid prototyping to home fabrication: how 3D printing is changing business model innovation. *Technological Forecasting and Social Change*, 102, 214–224.

Rayna, T., Striukova, L. and Darlington, J. (2015). Co-creation and user innovation: the role of online 3D printing platforms. *Journal of Engineering and Technology Management*, 1–13.

Sambamurthy, V., Bharadwaj, A. and Grover, V. (2003). Shaping agility through digital options: reconceptualizing the role of information technology in contemporary firms. *MIS Quarterly*, 27(2), 237–263.

Saxton, G. D., Oh, O. and Kishore, R. (2013). Rules of crowdsourcing: models, issues, and systems of control. *Information Systems Management*, 30(1), 2–20.

Scheuing, E. E. and Johnson, E. M. (1989). A proposed model for new service development. *Journal of Services Marketing*, 3(2), 25–34.

Schwaber, K. and Beedle, M. (2002). *Agile software development with scrum*. Prentice Hall.

Schwaber, K. and Sutherland, J. (2016). The scrum guide. August 2, 2016. www.scrumguides.org/docs/scrumguide/v2016/2016-Scrum-Guide-US.pdf- zoom=100.

Sethi, R. and Iqbal, Z. (2008). Stage-gate controls, learning failure, and adverse effect on novel new products. *Journal of Marketing*, 72(1), 118–134.

Sommer, A. F., et al. (2015). Improved product development performance through agile/stage-gate hybrids. *Research Technology Management*, 58(1), 34–44.

Statista (2017). Größte Automobilhersteller in Deutschland nach Fahrzeugproduktion 2015. February 14, 2017. https://de.statista.com/statistik/daten/studie/246827/umfrage/automobilproduktion-deutscher-hersteller/.

Teece, D. J. (2014). The foundations of enterprise performance: dynamic and ordinary capabilities in an (economic) theory of firms. *Academy of Management Perspectives*, 28(4), 328–352.

Terwiesch, C. and Xu, Y. (2008). Innovation contests, open innovation, and multiagent problem solving. *Management Science*, 54(9), 1529–1543.

Toivonen, M. and Tuominen, T. (2009). Emergence of innovations in services. *The Service Industries Journal*, 29(7), 887–902.

Tushman, M. L. and Anderson, P. (1986). Technological discontinuities and organizational environments. *Administrative Science Quarterly*, 31(3), 439–465.

Utterback, J. M. and Abernathy, W. J. (1975). A dynamic model of process and product innovation. *Omega*, 3(6), 639–656.

Vargo, S. L. and Lusch, R. F. (2004). Evolving to a new dominant logic for marketing. *Journal of Marketing*, 68(1), 1–17.

Vargo, S. L. and Lusch, R. F. (2008). Service-dominant logic: continuing the evolution. *Journal of the Academy of Marketing Science*, 36(1), 1–10.

Weber, Y. and Tarba, S. Y. (2014). Strategic agility: a state of the art. *California Management Review*, 56(3), 5–12.

Weiber, R., Kollmann, T. and Pohl, A. (1999). Das management technologischer Innovationen. In Kleinaltenkamp, M. and Plinke, W. (Eds.), *Markt- und Produktmanagement*. Springer, pp. 75–179.

Wilson, K. and Doz, Y. L. (2011). Agile innovation: a footprint balancing distance and immersion. *California Management Review*, 53(2), 6–26.

Yin, R. K. (2014). *Case study research: design and methods*, 5. Auflage. Los Angeles: Sage.

Yoo, Y., et al. (2012). Organizing for innovation in the digitized world. *Organization Science*, 23(5), 1398–1408.

Zineldin, M. (2004). Co-opetition: the organisation of the future. *Marketing Intelligence & Planning*, 22(7), 780–790.