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Digital Transformation in Service Management

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The digital transformation of single companies and of entire service businesses is an omnipresent topic – not only in the academic discourse but also in the current public debate. The topic is often approached phenomenologically. We invited a group of well-renown scholars from different academic fields to share with us personal observations and interpretations of the digital transformation in service management in the form of individual commentaries that go beyond. The commentaries we received are based on different theoretical perspectives. They include motivations of why digital transformation makes service management research (smr) more relevant, they depict implications for service companies, and they outline research needs. This article conflates the submitted commentaries, and it is the first *SMR special research paper* – a paper type that will be continued in future issues to explore topics in a similar fashion that are likely to have a significant influence on the development of smr.

Introduction

Computing capabilities increased exponentially in power and relatively decreased in cost over several decades (Moore 1974), which led to today's broad spectrum of IT-based automation of work in companies, public administrations, and private households. Over the last at least sixty years, various job profiles, comprehensive management fields, and entire research disciplines emerged and sustained that are concerned with the practical improvement and with the academic investigation of the interplay of IT and how tasks are executed in organizations and/or the interplay of IT and their human users (Hirschheim and Klein 2012; Heinrich 2012).

Given this long-term nature of the trend towards increased IT-based automation (Mertens et al. 2017) and from the viewpoint of the editors of this journal, the attention that *digitalization* or a *digital transformation* of different businesses (Matt et al. 2015) receive as topics in the second part of this decade is astonishing. The SMR editors therefore strongly believe that the topic requires a more thorough review than it finds expression in the current public debates.

This "special" research paper, therefore, intends to offer in-depth reflections brought together through commentaries of respected scholars on the subject of *digital transformation in service management*. The authors either work in the field of service management, service science or information systems. The commentaries provide the authors' perspectives on, for instance, open research questions and open research areas related to a better understanding of this phenomenon.

Martin Matzner and *Marion Büttgen* (both are editors of this journal) provide the first commentary which unfolds their viewpoint on what the digital transformation of service is and in how far the digital transformation impacts service management. *Steven Alter* shares his observations on service systems that are derived from work systems theory. He argues why this perspective provides an important opportunity to advance the understanding of the operational impact and the service management challenges that are associated with digital transformation. *Haluk Demirkan* and *Jim Spohrer* stress the role played by digital, smart machines in digital transformation. They observe that the transitioning to service based on smart devices is underway for organizations, and specific approaches are required now to customize the organization's strategy and culture. *Albrecht Fritzsche* and *Irene Ng* explain how the service science approach offers a unique perspective on digital transformation, which is according to the authors because this approach turns its attention towards "the construct which will determine future industry". *Julia M. Jonas*, *Veronica Martinez*, *Kathrin M. Möslein*, and *Andy Neely* consider the research concept of co-creation in living labs. In the digital era, digital services become subjects of living labs. Furthermore, digital transformation helps create more and better interactions between the involved organizational entities and the living lab platform and/or co-creators.

Viewpoints on the Transformation Process

By Martin Matzner and Marion Büttgen

Digitalization and the *digital transformation* are terms that received huge consideration in the course of business, in discussions of the general public, and in the academic discourse (Brennen and Kreiss 2016). The attributed economic impact of digitalization is for instance underlined by the *Digital Transformation of Industries* project launched by the *World Economic Forum* which investigates how the digital transformation of various industries will progress (World Economic Forum 2018). Politicians and governments have also started to emphasize the importance of digitalization. In Germany, the 2018 coalition agreement of the newly formed government lists the topic as a dedicated item ("Offensive on education, research and digitalization") (Koalitionsvertrag 2018, in German). In such political agendas, the topic is handled as an abstract political goal ("get economy or society or workforce/pupils prepared for the digital age ...") with infrastructure questions ("broadband expansion") and educational needs discussed as required political measures.

The general public is complaining that experts emphasized that the topic is huge, complex and multifaceted, but apart from abstract statements they failed in precisely formulating what digitalization is about (Brost et al. 2018). Accordingly, the topic is discussed phenomenologically – both in public debate and in the academic discourse. Certain cases are repeatedly mentioned as examples to indicate supposed, abstract game-changing effects of digitalization on businesses including the recent case of *Amazon Go*.

Amazon opened a grocery store to the public that works without a checkout-line in early 2018 (Wingfield 2018), which has been made possible by using (digital) technologies such as computer vision and machine learning. An obvious consequence, in this case, is that a store without checkout lines renders cashiers redundant. Although Amazon claims that people do not lose their jobs but merely change roles, in other cases job losses caused by digitalization are conceivable. While *Amazon Go* certainly marks a significant change concerning the way people buy groceries it is not as innovative as it might seem based on the excessive media coverage. There are other examples of retailers, such as Metro AG, which discussed similar plans and decided to partially remove checkout lanes in their shops starting from the early 2000s (Retail Info System 2003).

Beyond anecdotal evidence, the following three observations could indicate a disruptive change that exceeds a pure ongoing trend of increased IT-based automation: increased management awareness, financial markets expectations, and core technological developments.

Management awareness: In these days, the large corporations set up dedicated management board positions, create and expand specific departments and initiate strategy-development processes related to digital transformation on a large scale. Volkswagen AG is, for example, going to create a new executive board position for "digital and IT topics" while Deutsche Bahn AG has already appointed a new board member responsible for these topics (Deutsche Bahn 2018; Freitag 2017). According to Kawohl & Schneider (2017), 40 % of the companies listed in the German DAX index have already instituted CDOs or comparable positions whereby job content, responsibility, and acceptance of job holders within the organizations frequently still need to be clarified and ensured. The future will tell us if the mentioned measures were phenomena of misallocation of resources in consequence of an unjustified hype (Mertens et al. 2017) or not.

Financial markets expectations: According to Forbes (2017), among the world's 25 most valuable brands there are 10 brands classified as belonging to the area "technology". These 10 brands sum up to a brand volume of 649.20 bn €, while the other 15 brands are valued at 498.80 bn € as per this data. The quintessence is that impressive expectations on the future earnings of the technology companies exist in the financial market (irrespective of any methodological problems of classifying brands' value correctly).

Core technological developments: Beyond the pure ongoing increase in computational processing power we mentioned above, certain fundamental technological developments could be observed in the recent years. Outstanding among them, all humans participate today in a global IT network that connects all of them. The Internet of Things will soon use the same infrastructure to network virtually all physical items as "smart" objects to human users and other objects (Oriwoh et al. 2013). Evans (2012) called the resulting infrastructure an "Internet of Everything" that links smart objects, humans, and data via connected digital processes to deliver value.

Against the background of these observations, we now would like to attempt unfolding our viewpoint on what digitalization is and how it impacts service management. We shared some reflections in this journal's first issue article on future "Topics for Service Management Research" (Benkenstein et al. 2017), including the fundamental observation that digitalization impacts the nature of service management's core subject matter – the services. We, therefore, start with our thoughts on the digital transformation of services before we discuss these developments' impact on service management and service management research.

The digital transformation of services

In Benkenstein et al. (2017) we explained the digital transformation of services by reusing Porter's and Heppelmann's (2014) metaphor of three waves of IT transformation: Wave 1 relates to using IT as instrument to automate single activities; wave 2 refers to IT implementing and replacing increasing chains of processes and to the availability of digital infrastructures to coordinate activities and to cooperate; wave 3 was the digitalization of the product and/or service itself.

The *Business & Information Systems Engineering* journal recently published a catchword on robo-advisory (Jung et al. 2018), a topic whose genesis provides a good illustration of the three waves.[1] The service *robo-advisory* is a digitalized "wave-3" service that comprises the levels *customer assessment* and *customer portfolio management*, which are both executed by computer programs. The first level refers to online forms to find out about the current financial situation, the risk strategies, etc. of a certain customer; the second level is the automatic setup and potentially the ongoing maintenance of the portfolio according to data received from the assessment.

[1] "Catchwords" describe emerging technologies and important phenomena for the BISE community.

The catchword sees robo-advisory as a second step of digitalization in financial advisory. The proliferation of online banking and brokerage platforms was a previous large ("wave-2"-type) change. Before that "traditional advisory" was in place that already used IT as an instrument to assist in certain activities. Robo-advisory therefore represents what we in line with Beverungen et al. (2017a, p. 784) call a *digital service* and which they define – in variation of Vargo's and Lusch's (2007) definition of service – as the application of "digital competencies [...] for the benefit of another entity or the entity itself".

An important promotor for new digital services is digitally connected objects constituting the Internet of Things. Digitally connected objects become smart devices if they incorporate "technologies for sensing, actuation, coordination, communication, control, etc." (National Science Foundation 2016, p. 2). Then smart devices facilitate smart service systems (Beverungen et al. 2017a).[2] In these systems, smart objects allow to monitor, optimize, or remote control smart devices or smart devices can autonomously adapt to their environment (Beverungen et al. 2017b). A smart service is delivered to or via an intelligent object that is able to sense its own condition and its surroundings and thus allows for real-time data collection, continuous communication and interactive feedback (Wünderlich et al. 2015). The devices will provide companies with data on the products' uses which allows developing new data-based services, and smart devices will also develop into platforms to deliver services from the distance (Beverungen et al. 2017b) such as a smart heating control which allows the user to optimize its operation via an App and based on sensors. Another example is ambient assisted living, where a house or a person is equipped with sensors and actors monitoring the person's activity (Wünderlich et al. 2015). The manufacturer can deliver assistance in optimization as a service but also monitor its entire installed base from the distance and use aggregated data to gain product insights and to create new services.

The digital transformation of service management

On the basis of reflections about what the digitalization of services means and how an ongoing disruptive change of the (service) economy is indicated by managerial awareness, financial expectations, and core technological developments, we provide a framework for analyzing the impact of digital transformation on service management. Within this framework, we identify three important technologies that affect service management, from both a macro-perspective (i.e., the transformation of service industries and business models) and a micro-perspective (i.e., fulfilling service tasks and jobs).

[2] Notably, Jung et al. (2018) call robo-advisory a smart service although it does not include smart objects. Instead they characterize smart service as a result of increased IT-based automation using algorithms and intelligent software.

Of the leading *technological developments* in the recent decade, *artificial intelligence (AI)* is probably the most powerful source of innovation and will strongly influence service management in the future (Rust and Huang 2014). Characterized by the self-learning abilities of machines, which exhibit aspects of human intelligence, AI will affect service management in two main ways. First, it provides opportunities to increase the effectiveness and efficiency of service provision and customer interaction (Larivière et al. 2017; Marinova et al. 2017; Rust and Huang 2012), such as by using AI applications for medical diagnoses or intelligent chatbots to support customer interactions. Second, and as a consequence, AI threatens human service jobs in a wide range of industries, from bus drivers and call center agents to financial analysts and even lawyers and doctors (Huang and Rust 2018). *Robotics* represents another multifaceted technological field that is gaining relevance for service management (Colby et al. 2016), though so far mainly as a device to support or replace mechanical, repetitive work that does not require highly skilled knowledge workers. Because such service work is not very attractive to most employees, and those who perform it often suffer physical or psychological ill health effects, this option nevertheless provides considerable potential for reorganizing work and achieving productivity gains. In addition, advanced robots are gaining enhanced senses, dexterity, and functionalities, enabling them to perform a broader scope of manual tasks and thereby changing the nature of work across various service industries and occupations (Frey and Osborne 2017). In the growing area of elderly care, Čaiæ et al. (2018) e.g. show that – from a recipient's point of view – socially assistive robots might fulfill a larger variety of supporting functions, such as safeguarding, social contact, and cognitive support. In the recent past though, hardly any technology has gained as much attention and notoriety as *blockchain technology* also referred to as distributed ledger technology (DLT). Although mainly associated with cryptocurrency like bitcoin, blockchain technology has even greater potential to disrupt business and commerce (Zamani and Giaglis 2017), due to its core mechanics. It replaces a central server's signature with a consensus mechanism based on proof of work (Pilkington 2016) or similar consensus algorithm, without any mediation by financial institutions that serve as trusted parties (Zamani and Giaglis 2017). In many cases, service provision entails decentralized transactions, with multiple actors spanning service networks (Tax et al. 2013), such as e-commerce platforms, access-based services, logistics, or healthcare systems. Because blockchain technology ensures that each transaction is protected through a digital signature, sent to the public key of the receiver from the privately held key of the sender, it can enhance the safety and efficiency of service transactions and reduce the transaction costs for all parties involved. This might cause a disintermediation effect, by which existing intermediaries such as banks or notary services will be driven out of value chains (Zamani and Giaglis 2017). At the same time, cyber-mediation might arise, with new intermediaries entering the market and acting as DLT service providers (Manning et al., 2016).

On a *macro-level*, digital transformation affects service management because so many service industries are facing disruptive changes to their entire business. New players – often IT companies – emerge in traditional service markets and threaten established service providers (e.g., Amazon and Alibaba in retail, Uber, and Google in mobility, Airbnb in hospitality) (Perren and Kozinet 2018). With their digital business models and vast market coverage, they function as game changers, both in established markets and beyond traditional market boundaries. In several cases, they have successfully built new forms of competitive power, creating a *hub economy* with one or a few dominant players. Companies rapidly develop network orchestrating skills, with a goal of creating an ecosystem that connects customers to a range of services, other customers, and/or other providers (Larivière et al. 2017). Iansiti and Lakhani (2017, p. 87) refer to this development as the "digital domino effect," to describe a process in which more and more markets tip and the many players that traditionally competed in separate industries get reduced to just a few hub firms that capture growing shares of the overall economic value created (Iansiti and Lakhani 2017). Prominent examples of this digital domino effect emerge from the music business (which has tipped to Apple, Google, and Spotify), the computer and software market (losing ground to the cloud services provided by Amazon, Microsoft, Google, and Alibaba), home entertainment (dominated by Amazon, Apple, Google, and Netflix), and the e-commerce market (with Amazon and Alibaba gaining considerable worldwide market share) (Iansiti and Lakhani 2017). As these examples show, due to digital connectivity and network effects, formerly separate service industries increasingly conflate, with the same few players dominating this digital hub economy. In the future, a single app conceivably might be the digital hub of a whole economy; e.g. in China, most people already manage most aspects of their lives through WeChat (Chan, 2015). This far-reaching development will affect the directly involved companies but also will have severe consequences for the entire market structure, the competitive forces within these "new markets" (including providers on different levels of the service network), and consumers. Digitalization also drives servitization, which refers to the transformation process of shifting from a product-centric to a service-centric business model (Vandermerwe and Rada 1988). This transformation is often enhanced by technological developments that enable companies to offer additional services or substitute their products with services, such as cloud-based "software as a service" offerings that replace software products. The development toward an Internet of Things (IoT) also allows companies to offer novel services, such as remote control and predictive maintenance solutions (Beverungen et al. 2017b). Some traditionally product-based industries already have experienced a far-reaching shift in their business models due to digitalization (Brax and Jonsson 2009; Ng and Wakenshaw 2017; Wünderlich et al. 2015). For example, using IoT technology including big data, self-steering tractors, drones, and satellite imagery, the agricultural industry has altered its business models, toward precision agriculture solutions. Yet companies still face the notable challenge of deriving profitable new business models that rely on smart service provision (Reinartz and Ulaga 2008).

On a *micro- or company level*, digitalization affects service management related to performing single tasks and whole jobs, including the necessary leadership during digital transformations. According to Huang and Rust's (2018) theory of AI job replacement, service tasks require four types of intelligence, to varying degrees: mechanical, analytical, intuitive, and empathetic. They anticipate that "AI job replacement occurs fundamentally at the task level, rather than the job level, and for 'lower' (easier for AI) intelligence tasks first" (Huang and Rust 2018, p. 1). This prediction implies three key outcomes: First, tasks with increasing levels of intelligence will be replaced by AI over time, such that the more tasks can be replaced by AI, the fewer human workers will be needed. Second, different kinds of services will benefit to varying extents from AI; for example, services based mainly on human interaction will be more difficult for AI to replace. Third, AI applications in service provision might drive competitive advantages, in that firms that employ a cost leadership strategy will use more AI replacement, whereas firms with a quality leadership strategy will use more human labor and less AI (Huang and Rust 2018). Based on estimates using a Gaussian process classifier, Frey and Osborne (2017) come to similar results in that jobs that are characterized by originality, persuasion, negotiation or assisting and caring for others exhibit a lower probability of computerization. Human interaction also might grow more important, for both employee-customer and supervisor-employee relationships, in which case the job replacement effect might be mitigated by a kind of counterrevolution. Giebelhausen et al. (2014) show that infusing technology into service encounters leads to less favorable evaluations when those interpersonal exchanges are marked by employee rapport. Accordingly, it probably will be beneficial to replace tasks with no need for human interaction by AI or service robots. Then the remaining employee resources can be used to a higher degree to build rapport and empathy with customers, augmented by AI only where appropriate and applicable. Likewise, supervisors can focus more on their roles as coaches and mentors, instead of decision makers and instructors – roles that can be performed more easily by AI. As Chui et al. (2015) show, a significant percentage of the tasks assigned to even senior managers can be automated, though leadership in the sense of leading people probably cannot be replaced by AI.

Service Transformation Enabled by Digital: Smart Machines

By Haluk Demirkan and Jim Spohrer

Introduction

Escalating costs, mergers and acquisitions, new regulations, rapidly changing technology, increasing competition, heightened customer expectations, higher turnover, all mean that organizations must become more responsive to changing demands, innovative and efficient. For large businesses failures can drag on for many years and sometimes decades before the final death knell sounds. However, other business failures occur more suddenly, like driving off a cliff (e.g. Motorola, Lehman Bros, Firestone, RCA, Kodak, Lucent, Yahoo and Kmart).

This turbulence in today's business world requires organizations to be able to reallocate their available resources and/or acquire additional resources as their priorities and demands change (Fowler et al. 2000). To compete in the marketplace and maintain relevancy, companies need to innovate constantly. For the past decade, many organizations have focused on traditional product innovation methods to address the challenges of globalization and economic transformation. Most of them are still clinging to what we call the invention model, centered on structured, bricks-and-mortar product development processes and platforms. Today, if a customer is buying a product, that customer wants to "hire" a product to do a job – a service.

Influenced by the emerging field of service science, service capabilities have gained attention in the past few years, offering approaches to developing more flexible business processes that co-create value with customers (Prahalad and Krishnan 2008). For example, Macy's Lucy who assists shoppers in stores, and Lowe's LoweBot service customers as retail service robot. None of these would have been possible without growing knowledge of digital technologies (e.g. mobile, IoT, cloud, big data, cognitive computing, artificial intelligence, intelligence augmentation) design, execution, storage, transmission and reuse is creating opportunities to configure IT into service relationships that create new value by reducing costs, increasing efficiency and improving outcomes.

There is no doubt that computers are increasingly capable of doing things that humans could once do exclusively (Demirkan et al. 2016). Today smart machines are becoming like humans by recognizing voices, processing natural language, learning, and interacting with the physical world through their vision, smell, touch and other senses, mobility and motor control. In some cases, they do a much faster and better job than humans at recognizing patterns, performing rule-based analysis on very large amounts of data, and solving both structured and unstructured problems.

When we look at almost all innovative solutions, we see that they are about increasing employees' productivity and customers' satisfaction with new services, reduction in the cost of backstage and frontstage service activities and augmenting people. We call this move to agility through innovation as "service transformation enabled by digital – not digital transformation". This is primarily about value co-creation with customers through more services, and also value-creation with internal stakeholders through service capabilities. In the last two decades, service systems and networks have used digital technologies to scale up and accelerate the realization of value from knowledge with new service offerings.

Despite the multitudes of publications that can be found on service-dominant logic (Vargo and Lusch 2004), service-oriented technologies (Arsanjani 2004; Demirkan and Goul 2006; Demirkan et al. 2009; Spohrer et al. 2007) and service science (Bitner and Brown 2006; Chesbrough and Spohrer 2006; Vargo and Lusch 2004), several questions are still left open. What will be the implications of service transformation enabled by digital for institutions and workers?

Implications for Institution and Workers

The economy today is moving into a new era, underpinned by cyber-infrastructure, a new architecture of computing as well as both the new business models and institutional infrastructures they enable. Those changes are driven by the convergence of a number of historic developments:

Network Ubiquity. Global inter- and intra- connectedness create countless opportunities for collaboration. In roughly a decade, the Internet – the most visible evidence of an increasingly networked world – has reached over a billion people. It is linking people, businesses and institutions, as well as trillions of devices. It is facilitating and transforming transactions of all kinds – from commerce, government services, education and health care, to entertainment, conversation and public discourse.

New Business Models. The simultaneous emergence of the networked world, technology and open standards is enabling entirely new business designs that were not feasible before. Companies can now be far more flexible and responsive to changes in the economy, buyer behavior, supply, distribution geopolitical. That is because their business operations can be integrated horizontally, from the point of contact with customers through the extended supply chain, and be resourced horizontally, from the point of technology resources to human resources.

The Changing Nature of Innovation; Open, Rapid, Collaborative. The most important innovation occurring today is in the changing nature of innovation, itself. It happens much faster today and it diffuses more rapidly into our everyday lives globally; it is far more open as a way of breaking out of 'silos' and breaking through boundaries and collaborative for sensing, seizing and managing new levels of socio-economic transformation, based on opportunity sharing within and between multidisciplinary, multisector, multicultural researchers, practitioners and policymakers (Swink 2006).

The changing nature of workers. Today, more people are changing companies; more people are working as independent contractors; more graduates are becoming entrepreneurs; more people are changing organizational roles. The changing nature of workers will inevitably require corresponding workforces, who are "cathedral builders", rather than "the equivalent of bricklayers" (Irving 1998); who are not only "comprehensive problem solvers", but "problem definers" (Grasso and Brown 2010), who have a basic knowledge of adjacent and connecting fields so as to readily adapt to address the novel, complex problems that they will encounter, co-developing and communicating with, and co-leading multidisciplinary teams and fostering innovation. The new millennium ushers in a new age of global relations, science, technology and practice which is not sufficiently addressed by the conventional education. New era needs new types of professionals.

Social Systems. Social media is one of the most exciting examples of how consumerization and social presence are enabled with digital solutions. Through the social networking platforms, almost everyone can easily post content and almost everyone can read it. These solutions are conduits for interactions among employers, employees, customers, and essentially any other stakeholders. With social media, the locus of control is shifted to end customer significantly.

Services. Service economy and thinking are growing exponentially. Spohrer et al. (2007) defines a service as the application of competence and knowledge to create value between providers and receivers. Service systems are complex business and societal systems that create benefits for customers, providers, and other stakeholders, and include all human-made systems that enable and grant diverse entities access to resources and capabilities such as transportation, water, food, energy, communications, buildings, retail, finance, health, education and governance with unique characteristics (*Tab. 1*).

Service Orientation. "Service-oriented" means the independent elements are described, discovered, and negotiated for in terms of the "services" they provide. A fundamental premise is that organizations can co-create their offerings with customers, break siloed business processes into modular independent services that can be reused on-the-fly in loosely-coupled dynamic business service choreographies and they can source those choreographies by using virtual computing resources, or "out-tasked" to internal and external service providers (Demirkan et al. 2009).

Service Transformation. Service thinking has transformed traditional products and services by adopting manufacturing concepts such as division of labor and knowledge, standardization, and coordination of production and delivery to enable new forms of value creation and consumption. Manufacturing firms like GE, IBM, Xerox, and Rolls Royce have seen an increasing percentage of their revenue come from service offerings, rather than simply the sale of products (Demirkan and Spohrer 2016). Apple is another good example of a manufacturing company that has successfully transitioned to services (Harmon et al. 2011).

Customer contact	The higher the customer contact, the higher the instantaneous demand for a service, and this will increase the immediate impacts on customers.
Simultaneity	Production and consumption, as we known from microeconomics, cannot be completely separated from each other. Thus the consumer becomes a co-creator of a service.
Demand fluctuation over time	The variability of demand necessitates a higher degree of capacity management because the service offerings need to be produced concurrent with their consumption.
Customization	Services are customized based on consumer needs and the competitive environment in which providers offer services and consumer purchase them.
Complexity	Simultaneity of production and consumption of services occur in highly complex service systems due to interaction of people, processes, technology and shared information.
Experience	Understanding and embracing the changing customer, and helping the customers achieve success that they were otherwise unable to deliver on their own.

Tab. 1: Foundational characteristics of services

Service Transformation Enabled by Digital: Smart Machines. Now, we are at an urge of another transformation. Some people call this "digital transformation." We call it "service transformation that is being enabled by digital and mostly smart machines." According to many studies, digital transformation is revolution of business and organizational activities, processes and models to leverage the utilization of a mix of digital technologies (Demirkan et al. 2016). When we review some of the most successful digital transformations (*Tab. 3*), we see that "service" is on the core of all.

This revolution provides the means to improve the efficiency, effectiveness, sustainability, and innovativeness of product and service offerings through the design and provisioning of new types of service offerings, the design and delivery of outcome-targeted customer experiences, reductions in the cost of backstage and front-stage service activities, the integration of customers into service creation and delivery and improvement in customer-perceived service quality (*Tab. 2*).

The overall goal of any transformation, including service transformation, is to increase the productivity and creativity (decision making, connectivity, innovation, and augmentation) of individuals and organizations. Transformation will let organizations address market needs much more quickly than used to be possible, enabling higher levels of collaboration for sharing information much faster. Smart machines – cognitive computing – is transdisciplinary in nature and focuses on computing methodologies and systems that can implement autonomous computational intelligence to various applications such as expert systems, robotics, autonomous vehicles, medical diagnostics, machine vision, translation, employee performance evaluations, planning and scheduling, marketing analytics, remote maintenance monitoring, and others too numerous to mention here (Spohrer and Banavar 2015).

Cognitive assistants like IBM Watson, Apple Siri, Microsoft Cortana, Amazon Alexa, Google Now and Facebook M are becoming part of our daily lives by performing tasks for us
American Express is a financial institution with lots of smart data usage. American Express built a machine-learning mobile phone application to provide customized recommendations for restaurant choices
Putting IBM Watson To The Test For Cancer Care. By being a complement to an oncologist, not a replacement, IBM Watson is accelerating patient DNA analysis and helping to personalize treatment options for cancer patients
Lucy automates labor-intensive tasks and converts data assets into a quickly-searchable source of insights—freeing marketers to focus on complex, higher-level functions. Lucy is a cognitive problem solver
Gluru organize online documents, calendars, emails and other data and have AI pre-sent you with new insights and actionable information
x.ai coordinate schedules as a personal scheduler by using AI
CrystalKnows help you know the best way to communicate with others
RecordedFuture leverages natural language processing at massive scale in real time to collect and understand more than 700,000 web sources
LegalRobot automates legal document review in ways that can serve people and businesses
Spotify suggests weekly new music based on the user's preferences and behavior
Lowe's LoweBot is able to able to answer simple questions to customers, freeing up time for employees to focus on more important projects
IBM's cognitive call centers improve customer satisfaction and agent retention
Cafe X opens in San Francisco, bringing robots to the coffee shop
Amazon Go becomes the first checkout free grocery store
Robot suits started to help individuals to achieve a perfect golf swing
Microsoft demonstrates an app that helps the blind see
Smart prosthetic arm and hand with sense of touch
Wearable robotic glove restores independence for stroke victims
Google's driverless cars and trucks
many more…

Tab. 2: Sample list of service transformation enabled by digital

Companies that achieve the right balance between humans and machines may become more creative, as well as more efficient, while those that replace too many processes, existing technologies, and people with cognitive computing will risk their unique cultures, their customer relationships, and their business models.

Conclusions

Today, business and societal organizations continually try to innovate and work on projects to improve efficiency, quality and speed of their operations, through new service offerings and networks that adapt their resource base to changing needs. In other words, they attempt to manipulate what are perceived of as the controllable variables within their service systems with digital technologies (Demirkan and Spohrer 2014). In many cases, each of these experiments with strategies to catalyze their local innovation economies, they are often working in isolation from one another. They often discover that these manipulations do not achieve desired outcomes and/or create unwanted side-effects – mainly because their service environment is much more complex than they anticipated. Changes to the scale of service delivery may impact service quality in unanticipated ways, the introduction of a new service may create demand for different or even more services and service innovations may unintentionally shift the market from a product to a service quality focus rather than outcome. Unanticipated consequences result in unnecessary costs, lack of responsiveness and missed opportunities for social innovation and value. Reduced fragmentation and complexity, improved efficiency and higher levels of agility in service systems can only be achieved when multiple, complex trade-offs are carefully balanced (*Tab. 3*). So, we think that maybe it's time to rethink services transformation – from new organizational and technical vantage points.

Systematize	Customize
Cost	Effectiveness
Consistency	Variance
Standardized	Differentiated
Independent	Interdependent
Available	Convenient
Speed	Accuracy
Secure	Open
Stable	Dynamic
Progression	Scaling

Tab. 3: Examples of Tradeoff Challenges

A system view of service management and digital transformation

By Steven Alter

The intersection between service management and digital transformation

Abstract discussions of digital transformation as an umbrella term for digitization and automation typically clarify little unless underlying ideas are defined. A similar issue applies to service management because different observers have quite different ideas about the meaning of service and service management.

This brief commentary applies work system theory as the core of actionable ideas about service management and digital transformation. It presents ideas from series of papers related to service and service systems (Alter 2008; 2012; 2017a; 2017b). Overall, it tries to go beyond hype about digital transformation by summarizing practical ideas that can be used in service management in a world that relies increasingly on digitization and automation.

Basic definitions

Describing the intersection between service management and digital transformation requires a series of definitions, including three among a larger set of portrayals of service (Alter 2012; 2017a) that are useful in different management settings (*Tab. 4*).

Service systems

Other than service improvisations consistent with the first portrayal of service, services are performed by service systems. Concepts for summarizing and analyzing service systems are provided by a subset of general system theory called work system theory (WST) plus extensions of WST. (Alter 2013; 2017a; 2017b). WST consists of three components, #1, the definition of work system, #2, the work system framework (WSF – nine elements of a basic understanding of a work system) and #3, the work system life cycle model (WSLC – model of how work systems evolve through iterations involving planned and unplanned change). Graphical representations of the WSF and WSLC are not included here due to space limitations.

Definition of work system (or service system). Every service system is a work system, i.e., a system in which human participants and/or machines perform work (processes and activities) using information, technology, and other resources to produce specific product/services for specific internal and/or external customers.

Work system framework. A basic understanding of a work system (a service system) requires attention to the WSF's nine elements: #1, customers of the service system

Digitization	A societal trend and/or a localized change involving increasing application of computerized devices that capture, transmit, store, retrieve, manipulate, or display information.
Automation	A societal trend and/or a localized change involving increasing application of computers and other machines in performing work, sometimes with people using machines and sometimes with machines performing complete activities or functions. Automation may involve people using machines in new ways and may involve machines performing work activities that never were done before, sometimes because those work activities could not be done by people. Automation may or may not prove beneficial for people whose work is affected.
Digital Transformation	In business and society and within enterprises, increasing application of digitization and/or automation that has important impacts on structure or characteristics of individual work, internal processes, communication, infrastructures, business ecosystems, and product/services for internal and/or external customers.
Definitions and Portrayals of Service	**Service as acts for the benefit of others**. *Service is activities or groups of activities performed to produce or facilitate benefits for others.* (Alter 2017a). This portrayal can be applied when trying to create or improve almost any system in an organization because almost any systematic activity in an organization can be viewed as a service for internal and/or external customers. **Service as outcomes**. *A service is an outcome provided for internal and/or external customers.* This portrayal supports the use of service catalogs produced by IT groups and by other organizations that need to rationalize and communicate the range of services (such as funds transfer or Internet) that they provide for their customers. **Service as exchange or value co-creation**. *Service is an exchange of value, and hence is co-created.* This is the basic idea of service dominant logic (Vargo and Lusch 2004; 2008; 2016).

Tab. 4: Definitions of digitization, automation, digital transformation, and service

(who receive and benefit from the service system's product/services; #2, the product/services that are produced; #3, processes and activities within the service system; #4, participants who perform activities within the system (who may include customers); #5, information used or produced by the system; #6, technologies used by the system; #7, surrounding environment (including culture, practices, organizational politics, competitive issues, etc.); #8, infrastructure shared with other service systems, and #9, strategies. The term product/service is used because distinguishing strictly between products and services is much less useful in practice than continuous design dimensions based on characteristics often associated with products versus services. Examples of those dimensions include tangible versus intangible, commodity versus customized, produced vs. co-produced, durable versus perishable, transactional versus relational, value transferred versus value co-created, and so on.

Work system life cycle model. A basic understanding of how a work system (a service system) evolves over time calls for attention to iterations involving four phases: #1, operation and maintenance of an existing version of the system; #2, initiation of a defined project; #3, development of resources needed for implementation in the organization (including acquiring or updating software); #4, implementation of the new version of the system in the organization. Planned change is represented by the cycle from initiation to development, implementation, and operation of a new version. Unplanned change such as adaptations, workarounds, and experimentation occurs primarily during operation and maintenance.

A service system view of how digital transformation challenges service management

Service management (SM) is fundamentally about designing, improving, and operating service systems. A service system lens helps in visualizing operational impacts and SM challenges related to increasing digitization and automation within firms, between firms and their customers, and within product/service offerings. This section uses elements of the WSF and WSLC to identify SM challenges that are exacerbated by digital transformation. Comments organized around the nine elements of the WSF focus mostly on service systems in operation. Comments organized around the four elements of the WSLC focus mostly on planning and implementation. Overall, using the WSF and WSLC as lenses affords more actionable SM insights than abstract discussions of the nature of digital transformation.

Customers. Digital transformation applies equally to the operation of service systems and to their internal and external customers. Product/services increasingly need to fit the value creating practices of internal and external customers. The primary SM challenge here is the lack of visibility concerning customer practices, especially for external customers.

Product/services. Customer-facing innovation constitutes an SM challenge both in product/services and in communication and collaboration with customers (a type of service). Both areas call for fitting the form, content, and delivery of product/services with whatever is most useful and convenient for customers.

Processes and activities. The long history of IS development is replete with software that fits poorly with current or proposed processes and activities. The SM challenge starts with making sure that service processes and activities take full advantage of available digitization and automation capabilities that may be ignored, purposely bypassed, or otherwise not integrated into business processes. The challenge is especially difficult for semi-structured or unstructured processes or activities whose substantial interpretive flexibility provides little oversight about whether old work patterns persist without attaining benefits from IT-enabled innovations.

Participants. Many managers and service system participants are fully aware of the lack of skills and attitudes needed to take full advantage of computerized capabilities. Both managers and participants may be frightened about personal obsolescence and about being bypassed by a new generation of digital natives who can use computers to do the same work more efficiently and effectively. The training and involvement challenges start with basic digital literacy and ability to use computerized tools appropriately. Deeper issues concern understanding why IT-enabled service systems were designed to operate in certain ways and recognizing conditions under which workarounds may be beneficial and necessary or may be detrimental (Alter 2014).

Information. Capabilities related to accessing, using, and protecting information become more important and more complex with increasing degrees of digitization. The SM challenge of protecting digitized information in service systems is obvious from widely publicized examples of information theft including email records. Access and use of digitized information is less challenging in highly structured service systems where information usage is governed by formal scripts or activity patterns. The benefits from information availability are realized less often in less structured service systems whose participants require information literacy and insight.

Technologies. An obvious SM challenge involves what to do when technologies go down or operate incorrectly due to bugs, design flaws, or sabotage. Another challenge involves assuring whole hearted use of technologies that seem far less friendly and powerful than technologies in users' pockets or in their home computers.

Environment. Service systems that fit poorly with surrounding organizational culture, practices, demographics, and technological trends may still operate, but usually are less successful than comparable service systems that fit with their environment. Thus, identifying and reconciling misfits related to digitization and/or automation proves to be an important SM challenge.

Infrastructure. Even a highly localized infrastructure failure can have major consequences, such as widely reported IT problems that disrupted operations at United and Delta Airlines in 2017. A key SM challenge is the lack of control because essential enterprise and ecosystem infrastructure is typically owned by other organizations and shared with other service systems.

Strategies. A service system lens is useful in the area of service strategy because it encourages going beyond bland generalizations. For example, a service strategy may rely on using big data to optimize customer experiences. That will work only if use of big data is integrated into service systems that are staffed adequately and are supported with appropriate technologies.

WSLC – Operation and maintenance. The nine WSF elements mentioned above provide a lens for understanding service system operation. The WSLC includes the possibility of unplanned change through adaptations and workarounds, many of which are directly related to digital assets and/or activities that use digital assets. The SM challenge is to make sure that adaptations and workarounds are not detrimental, either internally or to customers.

WSLC – Initiation. Visualizing realistic possibilities for digitalization and automation initiatives can prove challenging because it is often difficult to imagine fundamental changes in service systems while also taking into account the above issues concerning each WSF element.

WSLC – Development. An SM challenge here is to assure that the technology developed or acquired fits with operational plans and goals for the service system being supported. This may require direct involvement of service system participants in the development effort, from initial specifications to testing.

WSLC – Implementation. An SM challenge here is to make sure that the implementation effort identifies and addresses both problems and opportunities that may not have been anticipated. Another challenge is to assure that the previous version of the service system continues to operate effectively while the next version is being implemented.

Implications for service management

As with business process engineering and big data, digital transformation is a term that tries to crystallize important ideas but is fundamentally vague and open to different interpretations. The range of interpretations (about society? about new types of commerce or competition? about technology? about digital literacy?) blurs its relationship with service management.

This commentary indicated how a work system/service system lens can help in visualizing the operational meaning of digital transformation and identifying related SM challenges. A longer commentary would present the issues in much more depth. Both within and across enterprises, digital transformation occurs through the implementation of new or improved service systems. Ideas in the WSF and WSLC help in visualizing those transformations regardless of which portrayal of service is used.

Ideas in this commentary imply several research possibilities. One approach superimposes a service system lens on top of the digital transformation literature to see which system-related topics have been considered and which have been underplayed or ignored. Another approach uses the underlying ideas to develop research instruments for describing service management as a service system in its own right and assessing service management in the presence of digital transformation. Yet another approach applies this lens in action research case studies that observe how digital transformation strategies or aspirations unfold in practice. The main point is that a service system lens bypasses hype by focusing on operational and actionable SM topics and challenges related to describing and managing digital transformations.

The language of the revolution

By Albrecht Fritzsche and Irene C. L. Ng

While conceptual and empirical papers contribute to the advancement of scientific research in a given field of study, commentaries give us an opportunity to reflect on its general meaning and express programmatic ideas about its further development. This is particularly important when it comes to a highly dynamic field such as service research. We therefore use the following pages to discuss service research from a wider perspective and explore its role in the digital transformation of economy and society. In particular, we examine the contribution of service-dominant logic to the formation of a new grammar and vocabulary for innovation, which is desperately needed to facilitate radically new solutions designs and application schemes. As an illustration, we use recent advancements in the creation of digital data boxes.

Learning to speak "digital"

In the course of the ongoing digital transformation, new design principles and constructs like cyber-physical systems (Lee 2008) or the internet of things (Atzori et al. 2010) have received increasing attention. They mark a general change of perspective in the treatment of information systems and enable a new type of digital innovation, in which the design of systems architectures takes a much more prominent role (Fichman et al. 2014). So far, digital data processing was considered as a mechanism to support human action and decision making. Cyber-physical systems and the internet of things go one step further by defining a formal-symbolic environment in which action and decision making takes place, and where innovation can be driven by resource integration and operational alignment (Brettel et al. 2014; Lee et al. 2014; Lusch and Nambisan 2015) and the overall generation of new business models (Porter and Heppelmann 2014). The actual development of new physical artefacts plays a secondary role in this context. Yoo et al. (2010; 2012) accordingly describe the digital transformation as a change of mediation which goes way beyond the introduction of new devices to support human action. Quite in the contrary, it redefines the structure of socio-technical systems: the boundaries of existing subsystems disappear, material instantiations of objects and processes lose importance, and new streams of value creation become possible which are expected to revolutionize industry (Kagermann et al. 2013; Rajkumar et al. 2010).

Revolutions require a common language for the revolutionaries to express their goals and align their activities. In the context of information technology, different languages can be found in the respective programming codes and standards for modelling objects and their interaction. Concepts like cyber-physical systems and the internet of things can also be considered as means of articulation of design possibilities on a higher level. This, however, is not enough to grasp the programmatic content of the digital transformation that turns it into a new industrial revolution, because it cannot give an appropriately abstract and conceptual account of how they scaffold into the knowledge of information systems in business and society. The digital transformation is characterized by what Kuhn (1962) and Feyerabend (1962) call incommensurability: It goes along with a new understanding of industry, which cannot be expressed using existing grammars and vocabularies. The digital transformation requires a new language, because it forces us to attribute meaning to industrial operation in radically different ways. Its new "digital language" should allow us to capture future technical designs together with the sociocultural and economic structures in which they unfold effects in their entire disruptive enormity. Service ecosystems research within service-dominant logic is in the comfortable position of having such a language at its disposal. It therefore can play a key role in the upcoming revolution and provide the necessary orientation for all the protagonists of this process to join forces in the development of new ideas and solutions.

Based on the seminal works by Vargo and Lusch (2004; 2008), Service-dominant logic (S-D logic) has turned to a broader definition of service as a general synonym for the application of a competency. It has evolved a wider understanding of value, phenomenologically created in experience or use, depending on the given context where co-creation happens. Service-dominant logic makes it possible to address any contributing entity to value creation as a competency that becomes a resource in context, no matter if it is an artificially constructed device, a human actor or a part of nature. The notion of service ecosystems allows the discussion of the dynamics between the contributors to value creation and the distinction of different substructures, institutions which control and regulate their interaction, and markets as mechanisms of exchange. Vargo and Lusch (2016) advanced the argument for a systems approach by considering system entities as 'actors' and because actors become stakeholders in the system's viability and progress, they therefore reinforce the structures within the system to drive further co-creation and service exchanges, creating network effects. The connectivity between actors in the service system goes beyond formal connectivity but also includes social norms, beliefs and other "human devised rules" (Vargo and Lusch 2016). It is such institutional arrangements, and often rearrangements, that make a service system resilient, adaptive and self-adjusting, therefore evolving the conceptualization of service system to *service ecosystem*.

Orientation for engineering

What makes the language of service ecosystems in S-D logic so important in the context of the digital transformation is its focus on value creation and the conditions under which it proceeds. Value-in-context is differentiated from value-in-exchange (Vargo and Lusch 2004; 2008) as being the super set of mutual value creation, and systemic architectures are considered as key to the viability of a system as a whole, as well as its management and control (Maglio et al. 2009; Spohrer et al. 2007). Similar to the classic Marxist theory on use value, exchange value and the role of machinery (Marx 1887), this perspective turns the attention to the further implications of value creation beyond industry boundaries. Service ecosystems work is therefore able to inform the design and operations of systems whose boundaries may not be function, firm, or even industry based; and the broadening of the perspective (see Vargo and Lusch 2016) can inform directions in which future developments should proceed and assess the progress, especially when bringing in the amorphous nature of data and digital (see also Ng and Wakenshaw 2017; Smith et al. 2014).

Where other fields of research in business or engineering evoke the images of physical objects and existing organization structure in their vocabulary, service ecosystems work avoids references to entities which could change or disappear. Instead, it turns the attention towards the constructs that might determine future industry: Smart things, artificial intelligence entities and other organised and organising bundles that would allow decision makers to arrange competencies (and in turn, resources) and operations for the benefit of more and better business activity.

As Normann (2001) pointed out, digital transformation goes along with a liquification, a separation of information from physical carriers, such that it can be easily moved about and re-manifested in many different ways (Michel et al. 2008). Existing constraints on the bundling of resources that enable specific operations consequently lose importance. Digital transformation makes it possible to mobilize resources very specifically for certain purposes and to focus exclusively on only the operations which necessarily have to be performed and nothing else, thus increasing the density of the resource bundles to a maximum in terms of cost-value structures (Michel et al. 2008). The language of service ecosystems in S-D logic supports this process perfectly because there are no predefined notions of existing bundles of resources inscribed in its vocabulary. It does not need to include any reference to specific devices, roles and institutions of current industry. As an 'actor' in a system, it is a bundle of competencies of which become resources in context for value creation and it can have a form, and then change its form dynamically to suit a context. This makes the understanding of an 'actor', competency and resource appear very abstract and hard to grasp on one hand, but on the other, ideal to support a revolution of the views on objects (particular digital/software objects) and even for the business in the course of the digital transformation.

An application case: databoxes and micro-servers

Considering the almost endless possibilities for further socio-economic development through the digital transformation, one of the most important tasks for researchers is to provide transparency about the different paths on which these possibilities can be realised and their implications for the emergence of new institutional structures in the coming years. This applies in particular to the understanding of data access and control for the design of future value networks and their attractiveness for the participants in the value generation processes (Ng et al. 2017). At the moment, we can see that personal data are mainly collected by organisations in the digital economy because of their technological competency, often called organization-controlled personal data (OPD), while the overwhelming majority of individuals who generate the data have no such competency to control over their further usage, and are in many cases not even aware of the fact that their data matter and that they are collected. While this might be necessary to drive the digital transformation ahead in their early phases, a socially sustainable setting for the digital economy will require a different design. During the past years, different concepts of databoxes have been developed to address this issue (Perera et al. 2017). We briefly describe the underlying idea on the example of the Hub of All Things (HAT) (Ng et al. 2013).

The Hub of All Things (HAT) ecosystem[3] is one that has been created to explore how a wider distribution of data

[3] http://hubofallthings.com

storage, control and rights by those who generate the data can spur further economic development with newly emerging businesses in the field of data processing and integration. The HAT is a piece of technology designed to help individuals exchange and trade personal data across the Internet through a personal 'micro-server' to claim, control, use and exchange data much like organisations are able to (HPRT 2016). HATs Micro-server data accounts are fully owned by individuals and they have full control, access and rights over the data within it. This gives the individual the freedom and the power to own and exchange as much (or as little) of their own information as they want with the companies and the websites that they like. It also implies that the HAT owners participate in the same market for data, originally supplied only by large organisations, with a new supply of personal data – person-controlled personal data (PPD)[4]. With the potential to generate and collect rich sets of personal information, while preserving personal privacy, the HAT has the potential to disrupt the current Internet economy by creating an alternative supply to the market in parallel with organisation-controlled personal data (OPD). In addition, a HAT Micro-server is a powerful piece of technology able to generate new data through machine learning algorithms and analytics, by transforming the data coming into the HAT, in the private domain of the individual. As an alternative supplier of data, PPD can therefore also supply insights such as contexts, persona, interests, priorities and intentions dynamically[5]. As a new 'actor' on the Internet, one that is the digital data-driven avatar of the person, the HAT can create value in multiple contexts by shifting and changing the types of data that may be competent for different personalised contexts such as ads, new and products, fulfilling the real potential of the Internet for firms, organisations, and individuals alike.

Conclusion

The HAT Micro-server raises issues about the nature of the artefact. While it is only controlled by the person and the data inside processed through code instructed by the person, it behaves similarly to how the PC came about in the 1970s and the smartphone in the 1990s. Originally just a box with few applications, the HAT Micro-server, like both PC and smartphones, will also slowly grow with more private applications within it. However, within the wider Internet, it is neither an organization nor a physical person behind a mouse or a screen. It is a bundle of competencies under the control of a person that potentially unlocks much innovation on the Internet. The language to describe that, which we argue is provided by service ecosystems work in S-D logic, is the language of the revolution.

Research directions: Living Labs and other spaces for innovation and co-creation

By Julia M. Jonas, Veronica Martinez, Kathrin M. Möslein and Andy Neely

With digital product-service systems and the need to speed up innovation cycles, living labs have become a platform for interactive co-creation and innovation which allow for direct exchange with the public, customers, users and other stakeholders (Dell'Era and Landoni 2014; Greve et al. 2016; Roth et al. 2014). These spaces for interactive value creation "create conditions to generate customer-driven information" (Edvardsson et al. 2012, p. 424) and innovation. Nyström et al. (2014, p. 483) put forward that living labs invite users to collaborate, "to create, prototype, validate, and test new technologies, services, products, and systems in real-life contexts". To create more knowledge about the co-creation in living labs, its effects and its transferability to other settings and industries, we propose directions for research integrating a stronger system perspective and a broader range of digital, physical and blended reality research methods.

First, on a micro level, the focus of research needs to shift from highlighting the process of co-creation and its mere facilitation (see e.g. Greve et al. 2016; Leminen et al. 2012; Nyström et al. 2014) to questions such as "how can we design living lab spaces for specific requirements of digitized organizations?", "how can the co-creation process and tools in living labs be designed to optimally derive knowledge from co-creation in digital and physical spaces, with the public?" and "how should we design co-creation projects and the role of innovating firms so that the gained outputs can be taken up in digital innovation development?". To create more and better interactions between involved organizational entities of an innovation project and the living lab platform and/or co-creators, the embeddedness of co-creation activities in the organization, including the utilization of digital service, are promising paths for useful future research.

Research has already highlighted that living labs are embedded in and highly dependent on the network actors supporting the co-creation process with equipment, knowledge and other resources (Leminen et al. 2012). The multi-dimensional nature of relationships and sub-service systems within the ecosystem of a living lab have not been fully acknowledged, as in other fields of open innovation (see e.g. Bogers et al. 2017). The integration of firm actors and their organizational service system may impact their established practices and arrangements and their roles or

4 https://medium.com/hub-of-all-things/personal-data-as-an-asset-class-2e713deedd10

5 https://medium.com/hub-of-all-things/me-myself-and-ai-b6f92fbc6052

role perceptions. This may be taken into account for future research as well as the aspect that the multiple interfaces of actors organizing for co-creation in living labs and the inter-relatedness of stakeholders of the living lab are affected by the practices and activities in living labs. The service system view on co-creation with multiple stakeholders in a space for innovation shows strong potential for insights in the micro-processes of co-creation and organizing for sustainable innovation.

When it comes to co-creation in virtual, physical or AR/VR spaces, more in-depth knowledge is needed from longitudinal studies: The value co-creation, and so the co-creation of innovation, can be seen as "a longitudinal, dynamic, interactive set of experiences and activities performed by the provider and the customer, within a context, using tools and practices that are partly overt and deliberate, and partly based on routine and unconscious behavior" (Payne et al. 2007, p. 85). In the context of living labs, the repeated activities and routinization of co-creating behavior, stable or changing tool-sets as well as the context and changes should be taken into account, when analyzing co-creation processes and outcomes (Kaulio 2010). As we still lack insight into the long-term effects of co-creation for innovation on e.g. learning and motivation of co-creating actors (Frow et al. 2015; Hoyer et al. 2010), employee behavior, and the network relationships resulting, these issues are promising pathways for future research.

In the context of co-creation for innovation, with subjective and inter-subjective behavior and plural perceived realities, the notion of time and space as well as the physical and digitally enabled environments – also referred to as servicescapes (Bitner 1992; Nilsson and Ballantyne 2014) or context (Edvardsson et al. 2012) – have a strong impact on the experience of co-creating as well as in context of the actual purchasing process (Helkkula 2011; Kotler 1973; Payne et al. 2007; Prahalad and Ramaswamy 2004). Yet, the atmosphere, surrounding and inter-personal behavior, including the embeddedness of co-creation in (several potentially overlapping) innovation ecosystems – in living labs and in general – are still underrepresented in current research. More research on the suitability of different types of spaces for the different types of co-creation in digital and physical spaces, or blended experiences in spaces for innovation can improve the practical and theoretical understanding of co-creation for innovation.

Moreover, living labs offer the opportunity for the application of a variety of research methods, including observations and mixed methods (Edvardsson et al. 2012; Russo-Spena and Mele 2012; Pera et al. 2016). To shed light on the behavioral and experiential aspects of co-creation for innovation as well as the inter-relatedness of actors in this context, in situ research, experimental and phenomenological research are needed. Such approaches, combined with the possibilities of digital technologies such as e.g. emotion recognition, sociometric badges (Dietzel et al. 2018) or voice analyses, to research interactive co-creation in living labs will allow to capture behavior, meaning of resources and actions in context as well as real-time perceptions, beyond what can be expressed in words, clicks or imagined situations (Echeverri 2017).

Further, more research is needed on how co-creation for innovation, and especially the living lab approach, works in different spacial arrangements (e.g. virtual realities, physical spaces in different locactions), in different cultures, including economic and society related aspects; living labs are not only embedded in innovation – firm and co-creator – ecosystems, but even connected and intertwined with the local public, politics and education systems, (Dell'Era and Landoni 2014; Guzman et al. 2013; Nyström et al. 2014; Siltaloppi et al. 2016) as evidenced e.g. in smart city and citizen participation projects (Hilgers and Ihl 2010; Komninos et al. 2013; Letaifa 2015). Future research may take these aspects into account and create more in-depth insight on co-creation of innovations in locally embedded open and living laboratories.

Living labs are a rapidly growing phenomenon (Dell'Era and Landoni 2014): Temporal or event-based, company-, community-, public actor or intermediary driven (Leminen et al. 2012; Roth et al. 2014), in physical or virtual spaces, living labs are offering the opportunity to test, develop and prototype products, services and digital product-service systems. To apply interactive tools for co-creation in order to understand user needs, to get access to wishes and ideas about their offerings, innovating firms may not need to go to a designated living lab space, but could potentially bring the living lab approach and the connected interactive and digitally enabled methods to their natural environment; this may be suitable especially for large and complex gears, for difficult to transport and niche user solutions. This is why we put forward the question how living lab mechanisms and methods can be transferred to more traditional settings (like e.g. trade fairs and retail), for more interactive and conversational discourses about products and services in place of multilayered interconnected interactions in the digital age.

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