Progress in IS

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Smart Services Summit

Smart Services Supporting the New Normal

Springer

Progress in IS

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Foreword

Winston Churchill is often credited with saying, "Never let a good crisis go to waste." Without a doubt, the 2020 pandemic accelerated the shift to smart service advancements in business and society. Working from home, online classes, online doctor visits, faster home delivery, and higher travel sanitation levels are all around us and all here to stay. Coping with the pandemic required service interaction behavior changes and service innovation investments that were arguably all quite foreseeable. However, previously, progress was slow because of a wide range of technological and organizational barriers. The crisis changed that and crushed those barriers.

This most timely book, edited by West (HSLU), Meierhofer (ZHAW), and Mangla (IBM), advances our understanding of smart service system innovation challenges and opportunities, providing a well-balanced set of perspectives from both industry and academia. The practical industry cases and the theoretical academic frameworks represent a significant contribution to the emerging transdiscipline of service science. The chapters not only advance our understanding of the "what, how, and why" of a wide range of smart service offerings, organizational transformations, and technological innovation investments but also boldly shows a way to an even brighter future.

The contributors to the precursor event and this book have shared knowledge, experiences, and insight that are all well-worth considering, both as lessons learned and foundational elements of exciting discoveries yet to come. Some highlights for me included: Schumann's (IBM) welcome message that hints at exciting times of accelerated scientific discovery to come while reminding us that service science connects to upskilling for future jobs and the digital transformation of business and society that is still very much underway. Sautter (Voith) reminded me of the importance of resilient supply chains, and understanding the distribution and flow of knowledge across the global service ecology, from individuals to businesses and governments. Rösler University of St. Gallen highlighted regulatory friction in the healthcare domain; Piramuthu (University of Florida) considers drones and other IoT technology investments; Bass and Taubert (HTWG) examine startups; Wuhrmann (Kistler) illustrates data to value on collaboration platforms; Flückiger (Energy 360) explores journey mapping; Kern (Aalen University) explores the role of chatbots for greener electricity; Ensinger (Aalen University) looks at forced digitalization; Dobler (Vorarlberg University of Applied Sciences) examines financial sector and circular economy innovation. Boyle (ex-Facebook, ex-TickTock) on augmented reality, smarter homes and industry; Soothill (Sulzer Services) and smart service delivery cases; Schweiger and Galeno (ZHAW) and Holzwarth (RhySearch)—all shed light on the growing importance of digital twins; Mühlberger (Voith) shared insights into co-working; Brenner (Airbus Defense) on military and smart service; Prato as well as Rodel on market segmentation for digitally enabled service; Kalkhofer touched on the importance of service-dominant logic as a much needed enabling mindset; ViscioAaon service design and evidence-based innovations; Melis (SMRT.BIO) on accelerating economic growth with a platform for upskilling; Malakhatka (KTH) on living labs; West (HSLU) on the need to continue to elaborate and build a solid research agenda; Deflorin (FHGE) on servitization.

In all this, we can appreciate responsible entities—individuals, businesses, governments—learning to invest in smart service offerings, technologies, organizational change, and all this while upskilling individuals on the importance of data-driven, science-based approaches to smart service. The community is sharing case studies and evolving frameworks. The event and the book reflect a healthy and growing community with a diversity of perspectives, but all united in advancing smart service to benefit business and society.

Looking ahead even further, do we need more crises to accelerate change? Can we shift from crisis-driven smart service advances to human-potential-maximizing wise service investments? The quality-of-life of future generations depends on this type of shift—a shift that would really be something for humankind to celebrate and a breakthrough for service science.

San Jose, CA, USA Jim Spohrer
November 2021

Introduction

The summit aimed to share openly emerging research and industrial challenges around the general theme of “Smart Services.” This year’s special theme was “COVID-19” and was following on from the prior summit where we were online—this was the first major meeting that many of us had attended since COVID-19 had changed the world so much. The summit was held at the Hotel Belvoir in Rüschlikon (Zürich) and was this year sponsored by IBM and supported by the data innovation alliance. We had 8 industrial presentations from small and large firms and 15 academic papers presented to an active audience of 35. Academic presentations were strictly limited to 10 minutes to allow more time (although never sufficient) for discussions in the main room or over coffee. Part of the purpose of this introduction is to share some of the insights from the summit and to develop further some of the discussions.

Welcome by IBM

Anika Schumann provided a welcome to the service summit and highlighted the importance of service science as a significant field of study that is coupled with key aspects of the digital transformation that we are currently experiencing. We were also reminded how critical this is to jobs of the future. The importance of hybrid clouds, AI, and quantum computing within the frame of service science cannot be understated as the new technologies all provide a service-based platform that provides the basis for new forms of resource integration that can fast track the digital transformation through accelerated discovery.

Part I Accelerated Transformation

The session was opened by Thomas Sautter who spoke about his company (Voith) and how they moved to remote working in part due to COVID-19. He described a traditional German manufacturing company that had embraced remote and hybrid working due in a major part to COVID-19. They were facing challenges due to supply chain shortages, travel restrictions, poor data, and a need to share know-how and know-who. Within an 18-month period, Voith had moved many years forward in one jump in terms of digitalization and services. They had created new ways to collaborate with their customers and suppliers to ensure that they could continue to do business during the worst that COVID-19 could throw at the business. This change had opened up their leadership's mind to new working practices that only 18 months prior would have been unimaginable. Services are now being developed for their customer, for themselves as well as other business partners.

Jonathan Rösler had the first academic presentation "Digital servitization barriers of medical technology firms: an exploratory study", where he confirmed the potentials it offered but due to regulatory issues the journey is rather slow. Digital Services can lead to improvements in diagnostics, patient experience, and prevention, ultimately empowering healthcare providers to use an evidence-based approach to improve clinical decisions. However, current research focuses mostly on patients, organizational and managerial implications for clinics, and service providers are missing. And for this reason, research is rather slow, yet digitalization is needed to reduce costs while improving patient outcomes. Here, the different perspectives of the different actors and their roles have not been fully considered. Organizationally, they need to update processes to create new opportunities, this included a greater focus on service innovation. Service innovations, themselves need a "better" balance between customization and standardization. A culture is needed that promotes learning and two-way communication. Sales were seen as a bottleneck in many of the communications activities, as the old way of selling could not work in the digital world as it had in the "old world". Collaborating with ecosystem actors (partnership management) is key to success yet at the same time it is extremely difficult to define the terms of cooperation, as it is not clear what could give each actor a competitive advantage over the other and vice versa.

Selwyn Piramuthu then introduced "Drone-based Warehouse Inventory Management with IoT for Perishables". This was a presentation of a technology that needs to be married with a new value proposition or business model to help it become applicable to inventory management of perishable goods in warehouses. The work was early-stage research that could clearly be linked to a servitization business model if it was to maximize value co-creation for the actors. And in doing so, it linked with the prior research presentation on ecosystem actors.

Valerie Bass and Julius Taubert then asked what Swiss SMEs could learn from startups in terms of accelerating the digital transition and developing services. Their assumption was that "smart products" were in fact resources that could deliver "smart services" through their application and use. In undertaking their research they found that that startups had younger owners/founders than SMEs, very different decision-making processes, and focused on innovation over incremental process improvements. The hierarchies were flatter and presented different management styles (e.g., inclusivity). The main lesson from the study was that we need to learn more about the differences between startups, SMEs, and larger firms so that we can switch between the different approaches depending on individual situations.

Thomas Wuhrmann closed session one and followed on from the prior presentation by presenting how Kistler (as a larger firm) turns data into value through intensive collaboration. He described their three pillars: i. co-creation platforms; ii. a digital technology incubator; and iii, their digital training center. Their lab was designed to foster the co-creation process within and outside of the firm, this is achieved through connecting the tech with the business and the domain know-how. This has allowed them to transform from being a sensor manufacturer to one that provides value-added digital solutions based on their traditional sensors.

Part II Value Design for Ecosystem Actors

Simon Flückiger opened the session with an industrial presentation that described how his firm uses journey mapping to modify the customer experience in both the sales and in the service delivery phases. He did this by comparing the journeys with his prior manufacturing firm as well as with an energy provider. He showed that the energy provided was needed to deal with a customer journey of 4–5 years with over 40 touchpoints and multiple channels: a very complex environment that was constantly changing and where digital was working hard to keep up with the service demands of the business and households who comprise the customer bases of the firm. He gave three important insights:

(i) The added-value of a service comes into play, by delivering the best customer experience around the core product.
(ii) A seamless and end-to-end customer journey with no gaps is key.
(iii) Digital services are an enabler for more future business.

Daria Kern continued the energy service theme by describing how AI can be used to support aggregation of energy to help better match supply and demand in “green” electricity markets where we have actors who are producers, consumers, and “prosumers”. Using a chatbot, she described how services could be automated and customized on a mass scale and could lead to increased customer satisfaction and cost-saving for all actors. The demand is now for further data collection to train the AI and chatbot and then further testing and evaluation of services.

Andreas Ensinger followed on the energy company topic with a discussion on how they can provide value-added services to their customers within the context of a forced digitalization because of COVID-19. From his interviews, he found that the local power companies were looking for new business models, yet none had actually applied new business systems. In fact, only around a third were even planning to test out the new approaches. The reason for the apparent lag was due to the legacy IT systems that were being operated, so although COVID-19 had forced them to change, fundamental changes to their business models were not yet apparent.

Martin Dobler closed out the session with a presentation on how the financial sector can stimulate innovation in the circular economy by developing smart services. The financial sector valued aspects of the circular economy as a risk for business sustainability and were looking for a way to extend their credit ratings for sustainable solutions. The outline of the risk management process was the automation of the metrics for the circular economy and associated services. This was a very inspirational presentation, as the driver here was the finance sector and the lessons learnt confirmed the importance of trust between partners who collaborate, and that today there is a lack of suitable metrics

An amuse-bouche was given by Chris Boyle, who provided an insight into the tech firms and their interests in the industry. He left us all with three thoughts:

i. there will be an augmented reality application of technologies in services,
ii. smart homes and IOT could be reapplied in industry in immersive initiative layers,
iii. industrial firms will have to find ideas that they can resonate with major tech.

Part III Smart Services for Manufacturing

The keynote by Charles Soothill (head of technology at Sulzer Services) described different industrial cases of smart service delivery. He did this by introducing the new normal with a field service team masked up on a power plant to highlight the difficulties the firm faced with COVID-19 and how it challenged its standard service delivery. He illustrated this with five case studies, explaining how remote assistance allowed them to maintain site-based working to execute their LTSAs during the lockdown, using augmented reality. The integration of additive manufacturing was presented as a proven technology that now allows them to manufacture new parts faster and, in doing so, challenge the traditional supply chains. Additive manufacturing was also described in advanced repair technologies, presenting an example of their use of the technology. The move to conversion, modification, and upgrades was presented within the context of plant optimization and carbon dioxide reductions. A future glimpse of predictive maintenance and equipment optimization was described, confirming that data collection and integration is possible. However, there remain challenges in terms of accuracy and time frames, using mixed models (based on physical and machine learning approaches). He is hopeful of the technology and its integration into smart services with anomaly detection. He closed with a comment on pricing, "it is not possible in normal times to maintain pricing when the customer is only sent a pair of AR goggles in the post".

Lukas Schweiger followed up on the Sulzer presentation by describing the application of near real-time decision support through digital twins. The linking of data from sensors, processes, or people can be translated into information via models, and back again to create a knowledge-driven system that can simulate different scenarios allowing actions and possible actions to be documented.

Gianluca Galeno described an application of digital twins and virtual reality within the machine tool industry. The application closely followed the logic of the prior presentation and built upon the conceptional reference framework of digital twins presented before by ZHAW. In this case, the focus was on end-of-life data use that could improve the application of the circular economy approach by considering recycling and reuse, refurbishment and repair, and combined this with more classic machine data and customer data. This will support both the primary customer (or beneficiary) of the equipment and secondary applications.

Valentin Holzwarth described how virtual reality could be applied to machine tools, continuing with the theme of digital twins and lifecycles. Here, part of the approach was to integrate digital twins with a more useable human interface to support their application in the real world. The innovation here was to integrate the system with a "game engine." The approach should be compared further with other UX approaches to understand better, and further develop the technology and applications.

Marleen Mühlberger explored the different models of co-working between field service and customers. During COVID-19 the amount of co-working has increased with customers. The increasing digitalization, coupled with new working styles, has enabled co-working within firms. The study presented the finding of a survey of 44 participants in Europe. In it, 66% responded that they have experience of co-working, with it being considered very beneficial to field services as it supports joint problem-solving. Almost 60% expect it to increase, and they think it is a valuable way to secure sales, maintain (or improve) customer experience, and maintain margins.

Part IV Smart Service Enabled Innovation Approaches

Michael Brenner from Airbus Defence made the second keynote presentation of the afternoon. The focus of the presentation was on smart services in military aviation, where customer experience and mission success are important metrics for Airbus. COVID-19 created a major headache for Airbus and their military customers as they had to move away from paper- and meeting-based processes to digital working. In 2020, Airbus was able to roll out 60,000 VPN-equipped notebooks, and in 2021, they achieved a point where 120,000 workers become capable of mobile working. Before COVID-19 they were becoming connected, yet the pandemic accelerated the change. They have been able to accommodate four different perspectives for the fleet operation: i. the operator; ii. the manufacturer; iii. the maintenance and overhaul operation; and, iv. the basic materials science and supply chain. Their view of all participants allowed them to concentrate on system optimization rather than individual optimizations. Smart services need to balance security and speed, as waiting for a system update in a conflict situation is impossible.

Luis Prato introduced market segmentation for smart industrial services based on the form of the "data" (e.g., capture, connectivity, transformation, or analytics) and the focus of the performance (e.g., inputs, outputs, or outcomes). Within this matrix, four different segments were described. The segmentation provides an alternative model founded on performance-based relationships and confirms that in some cases, different relationships are needed for value co-creation in digitally enabled systems.

Eugen Rodel provided a second view of the market segmentation for smart services by focusing on the need to identify the "right" segments for digital services. Based on a semi-systemic literature review, ten papers were identified, with one highlighted as highly relevant (Windler et al., 2017) and four others as relevant based on his keyword search. In the discussion, the assessment of customers was segmented based on a 2×2 grid using the quality of the relationship (x-axis) and the potential of a solution (y-axis). Many of the challenges in the industrial world were found to be based on the communication of the value proposition, the perception of value, and the lack of understanding of customer journeys and relevant persons. There exists a need for clear direction (based on a research gap) on how companies can strengthen their competitive position through a digitally enabled PSS architecture based on market segmentation.

Hanno Kalkhofer then presented a study on SMEs and value co-creation; this picked up some of the themes from the previous two presentations, as it focused on the importance of service-dominant logic and the need to incorporate other actors' resources into your solutions to help maximize value co-creation. The work identified a lack of (innovation) methods. With a number of SMEs, the study described a four-layer innovation framework based on: i. innovation processes; ii. actions; iii. intermediary methods to understand what is done; and iv. macro methods to support overall creativity, decision-making, and problem-solving. The framework provides a systematic approach for service innovation and can be integrated with SMEs with no specialized R&D department.

Michele Viscoila closed the session with an industrial presentation on "disclosing value through service design". The presentation reminded the attendees that all too often, the customer is not at the center of the service journey and that today there is an expectation of seamless integration over multiple channels and touchpoints. Today, we need to move to a customer-centric view, moving from products to solutions based on ecosystems of products and services. We need to apply evidence-based innovation processes based on good experiments to build solid innovations in making this transition. The logic was demonstrated through two case studies where his firm had applied advanced innovation processes based on the customer-centric view.

Part V Ecosystems for Value Co-creation

Frank Melis presented the talent platform and made an invitation to join the project. The platform is based on service-dominant logic in terms of resource integration and considers both personal development and economic development within a region from the perspective of the individual and the employer. Through education, it considers how to upgrade the individuals' competencies to support economic growth within the region. Interestingly, the approach considers both current and future states and, therefore, helps accelerate economic growth within a particular region. Three use cases were described: i. green economy in Groningen; ii. digitalization in Durbin; and iii. inclusion in Krakow. The model underlying the cases linked innovation with entrepreneurial approaches.

Elena Malakhatka continued the theme of practical innovation through living labs where value can be co-created with actors' networks. Living labs are, in effect, service providers for innovation and R&D where resources can be combined and re-combined for value constellation identification. The basis for the study was that networks (or ecosystems) are dynamic and continually changing and adapting to different situations. Therefore, there is an underlying need for a value co-creation model that deals with multiple actors and situations. The evidence for the proposed approach came from ten living labs, two workshop cases, and the actor networks presented.

Shaun West presented a paper on building a research agenda for service firms and ecosystems. Most of the studies on servitization focused on manufacturers, but other firms can undergo this transformation, according to the literature. The team found few papers on how independent service providers provide an offering to their customers yet considered that these firms may be well placed to servitize their business, although following a different path to an OEM. The presentation offered four vignettes to shed light on: i. interaction processes; ii. actor insights; iii. business culture; and iv. infrastructure.

Patricia Deflorin's paper on "Methods supporting a shared servitization framework" followed the theme and focused on the potential of value co-creation. The context of servitization in the paper was based on the fact that digital is a core aspect today of any servitization journey. Again, integrating resources (e.g., suppliers, service providers, and customers) is critical to the journey. As with change management, the approach needs to be irritative as the teams (and individuals) learn as they participate.

Lessons from Papers

Across the papers and presentations, it became apparent that digital service innovation has substantially changed and accelerated since the start of the pandemic. Customer needs and service processes have undergone dramatic disruption, which is still ongoing. Against this background, new approaches for smart service design and innovation are needed.

A common thread throughout all the papers was the concept of ecosystem thinking, which was discussed from a wide field of perspectives and in a comprehensive way. Taking the ecosystem perspective has the potential to yield a holistic optimization of the system, instead of a local one focused on individual actors. In line with the concept of Service-Dominant Logic, the needs of the different actors in the ecosystem must be identified and integrated into the design of the services and the integration of the various resources in the ecosystem. The ecosystem perspective not only integrates the different human actor, but also technological and digital resources. Thus, through the integration of technology and humans, these domains are married for seamless value creation.

When turning data and technology into value, co-creation and interlinking the various domains in the ecosystem are a crucial prerequisite. Innovation through intensive collaboration allows participants to switch different perspectives and innovation approaches. This results in seamless value propositions and solutions for the beneficiary actors, which is a necessary prerequisite for economic value creation. Well-designed service experiences based on a consequentially customer-centric view and approach are thus the basis of value creation. This can lead to gamification approaches, which provide value even in industrial environments, and also applies to non-manufacturing firms.

This transition to digital service innovation in ecosystems requires more than fundamental changes to the technological platforms. In particular, collaboration across actors, organizations, and industry requires a new level of trust, culture, skills, marketing approaches and innovation frameworks. This needs to take into account that the accelerated adoption of digital solution results in dynamically changing ecosystems with human resources that require permanent up- and re-skilling. Incorporating this broad range of impacts, smart service innovation provides economic benefits to firms, individuals, and society, also including ecological benefits, thus contributing to the triple bottom line.

Closing

The three key themes that clearly stood out are rapid digital acceleration, creation of platform-based business models, and evolution of ecosystems across industries. The importance of smarter services has never been more critical. COVID-19 has spurred a manyfold acceleration of the digital transformation. As businesses pivot, they are also looking for ways to use this as a step change to modernize and evolve into the platform-based ecosystem economy. Rapid technological shifts, the impact of 5G, changes in buying behavior, virtual adaptation, and sustainability are some of the key drivers causing this change. Leveraging the full set of resources in the ecosystem is paramount for productivity and realizing the full potential, and this is where the focus on service science becomes essential. The jobs of the future require a knowledge of service science and it becomes the nucleus for multiple branches of education. It needs to be incorporated in multiple streams and at multiple levels. To make this happen, requires proactively working with academia, government, and businesses to train the workforce, or else we will not be able to realize the full benefits of the massive shifts that are happening. As Jim Sphorer said, do we need a crisis to accelerate change? We need to grab this moment in time and leapfrog the power of smart services to make a multi-generational change that future generations can take advantage of and celebrate.

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About the Editors

Shaun West gained a Ph.D. from Imperial College in London, then worked for over 25 years in several businesses related to industrial services. He started his industrial career with AEA Technology before moving to National Power, where he developed and sold services to external businesses. After studying at HEC (Paris) for an MBA, he moved to GE Energy Services, modeling and negotiating long-term service agreements. At Sulzer, he drafted the strategy that led to the service division tripling in size over 10 years and executed part of the strategy by acquiring a 220M CHF service business. Now at the Lucerne University of Applied Sciences and Arts, he is the Professor of Product-Service System Innovation. He focuses his research on supporting industrial firms to develop and deliver new services and service-friendly business models. He is a member of the advisory board for the ASAP Service Management Forum and a member of the Swiss Alliance of Data-Intensive Services. He lives close to Zurich with his wife and two children. He climbs, skis, and runs.

Jürg Meierhofer has been a lecturer, researcher, and project manager in service science and service engineering at the Zurich University of Applied Sciences (ZHAW) since 2014. Previously, he worked as a manager for service innovation and optimization in the telecommunications and insurance industry for more than ten years. He is the coordinator of the “ZHAW Platform Industry 4.0” and academic expert group lead in the “data innovation alliance”. He has a Ph.D. from the Swiss Federal Institute of Technology in Zurich (ETHZ) as well as an executive MBA degree from the International Institute of Management in Technology (IIMT).

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Prior to moving to Zurich, she worked as a Research Strategist at IBM's TJ Watson Research Center, New York, USA, where she evaluated, recommended, and shaped topics and recommendations that define IBM's strategic directions. Initially, she joined IBM as a Researcher in Dublin, Ireland, where she led the Cognitive Buildings work.

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Accelerated Transformation

Digital Servitization Barriers of Medical Technology Firms: An Exploratory Study

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Abstract Digital transformation creates tremendous innovation opportunities for medical technology firms. By offering digital services, medical technology firms can support healthcare providers to improve the efficiency and outcomes of care delivery. The shift towards digital-enabled services business models is referred to as digital servitization. However, digital servitization in healthcare is still in its infancy and many medical technology firms struggle to successfully develop and commercialize digital services. As existing research on the topic is scarce, this study investigates the prevailing barriers to digital servitization for medical technology firms. Interviews were conducted with 11 executives of medical technology firms. As a result, 5 key dimensions of digital servitization barriers were identified. This study contributes to current research in digital servitization literature by investigating digital servitization barriers in healthcare. The findings of this paper suggest that medical technology firms need to develop distinct organizational capabilities to overcome these healthcare ecosystem-specific barriers, taking the varied interests of all stakeholders involved into account.

Keywords Servitization · Digitalization · Digital services · Healthcare · Barriers

1 Introduction

In recent years, the healthcare ecosystem has seen the emergence of major issues concerning healthcare spending, regulatory requirements, price transparency, and many more (Elton & O'Riordan, 2016; OECD, 2021). Additionally, the unprecedented health crisis caused by the new coronavirus (SARS-CoV-2) has abruptly reconfirmed these existing issues and paved the way for the emergence of new challenges for the healthcare industry (Cobianchi et al., 2020). At the same time, the urgent management of this health crisis has illustrated further potential uses of digital technologies in the healthcare ecosystem (Secundo et al., 2021).

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Digital transformation refers to "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies" (Vial, 2019). Digital transformation is the basis of digitalization, which is defined as the use of digital technologies to create new value and generate new opportunities for revenue (Gartner, 2017). In the healthcare industry, digital transformation has been ongoing for more than a decade (Secundo et al., 2021) and has enabled captivating innovation opportunities (Cohen et al., 2017; Nambisan, 2017; Ramaswamy & Ozcan, 2018).

Concurrently, servitization, which is defined as the shift from product-centric business models to service-oriented offerings, has started to gain traction among manufacturers of industrial equipment (Baines & Lightfoot, 2013). Research has demonstrated that there is a strong interconnection between digitalization and servitization (Kamalaldin et al., 2020). Further, digitalization works both as a driver and an enabler of servitization (Kohtamäki et al., 2019). Therefore, the sub-stream of servitization that is enabled by digital technologies is known as digital servitization. Digital servitization among medical technology firms is primarily enabled by sensors, connectivity, and cloud computing (Stantchev et al., 2015).

The provision of digital services offers new possibilities for medical technology firms to innovate and create value with customers and intermediaries and is increasingly changing the interaction logic within the ecosystem from transactional to co-creational and relational (Reim et al., 2018). But although digital service adoption in healthcare is on the rise, it is still considered to be in its infancy compared to other industries (Neely, 2013). Many medical technology firms struggle to develop and commercialize digital services successfully, and the reasons for this are not yet fully understood in current research. What is known, however, is that there are certain characteristics and antecedents of the healthcare ecosystem that act as barriers to digital servitization (Stantchev et al., 2015; Porter & Heppelmann, 2014).

Addressing the call for more research on digital servitization in healthcare, this paper investigates digital servitization barriers faced by medical technology firms. Thus, the following research question is raised:

RQ: What barriers hinder medical technology firms to progress with digital servitization?

To answer these questions, an exploratory case study approach was chosen, drawing on data from interviews held with 11 mid-level to senior-level managers in 11 European-based medical technology firms.

Based on this analysis, 5 key dimensions of digital servitization barriers were identified. The findings suggest that medical technology firms assuming a new role as service providers need to build up distinct organizational capabilities to overcome the various barriers.

The remainder of the article is organized as follows. Section 2 reviews the literature on digital servitization in the context of the healthcare industry. Section 3 describes the research method upon which this investigation is based, and Sect. 4 presents the study findings and discusses the results with the existing research. Section 5 concludes the paper, providing implications for theory and practice as well as identifying the study's limitations and avenues for further research.

2 Literature Review

Servitization can be characterized as the complex process by which a firm shifts or expands from selling products or basic services to delivering customized solutions (Kohtamäki et al., 2019). Thus, according to Adrodegari and Saccani (2017), digital transformation and digitalization enable medical technology firms to shift from product-centric models to digital service-oriented offerings. This shift, which is known as servitization is defined as "the transformation in processes, capabilities, and offerings within industrial firms and their associated ecosystems to progressively create, deliver, and capture increased service value" (Kamalaldin et al., 2020). Further, organizations can capitalize on products, services, and software using digital technologies to gain additional value from digital servitization (Coreynen et al., 2020). The basis that digital servitization is predominantly based on is enabled by digitization, which is defined as the evolution of "smart, connected products", that are "a combination of hardware, software, sensors, data storage, and connectivity" (Kamalaldin et al., 2020). Possible service branches for manufacturing firms consist of remote monitoring and the evaluation of available data to preemptively repair or replace machines (Allmendinger & Lombreglia, 2005). Similarly, medical technology firms have adjusted their offerings to incorporate digital services as a means to remotely maintain and diagnose the physical and mental well-being of patients (Stantchev et al., 2015). Some examples of digital service offerings in healthcare are electronic health records, condition monitoring of medical devices, e-prescription services (Haggerty, 2017), and intelligent diagnostics based on AI (Hermes et al., 2020).

Despite the presence of countless digital service and servitization opportunities, medical technology firms, intermediaries and their customers must overcome substantial barriers to exploit them. Thus, to take full advantage of digitalization and servitization, firms must find an efficient digital service adoption strategy. Such a strategy necessitates collaboration between firms and their ecosystem partners since the development of digital services often goes beyond firm boundaries (Kohtamäki et al., 2019).

Many firms have difficulties in this endeavor. They struggle to transform the nature of their stakeholder relationships from transactional to co-creational, as it requires new and innovative approaches (Iansiti & Lakhani, 2014). The barriers for intermediaries are often similar to those experienced by the servive providing firms, namely the introduction of a new business model and the establishment of closer relationships with ecosystem partners (Story et al., 2020). According to Klein et al. (2018), digital service providers often fail to adjust the value proposition to the needs of their customers, as they lack customer knowledge (Gustafsson et al., 2005) and have an insufficient development process for the value proposition (Foote et al., 2001).

The difficulties in pinning down the value of digital services act as a further barrier to digital service adoption (Grubic & Peppard, 2016). Integral to the provision of digital services is also the exchange of data. The invisible and continuous exchange of data also creates several barriers for medical technology providers and their customers, as strict regulations governing data privacy and security must be navigated (Wünderlich et al., 2015). Once the data have been transferred, problems stem from the unclear legal status of the data (Porter & Heppelmann, 2014). Further, medical technology firms face internal barriers, which mainly consist of difficulties arising from the lack of service culture and service strategy (Allmendinger & Lombreglia, 2005). Both the ability to commercialize and flexibility to adapt the offered services to changing circumstances can hinder service adoption (Nambisan, 2017; Porter & Heppelmann, 2014).

3 Methodology

This study employs an exploratory approach to investigate the barriers of digital service adoption in the healthcare industry from the perspective of medical technology firms. As is the case with digital transformation, digital servitization and digital service adoption in the context of the medical technology firms are novel and insufficiently studied phenomena in scientific research. Hence, a qualitative research methodology was deemed suitable (Miles & Huberman, 1994). A qualitative approach is appropriate in instances where there is a lack of understanding of a phenomenon, and an associated need for exploratory research to improve the existing understanding of underlying causes (Miles & Huberman, 1994). To reliably select firms to take part in the study, a stratified purposive sampling approach (Bryman, 2016) was used to identify barriers confronting a range of medical technology firms (Miles & Huberman, 1994).

The barriers surrounding digital service adoption were the point of focus for the interviews. Thus, while we may have explored the ecosystem relations between multiple actors who collaboratively deal with certain barriers, the focus of this study is rather on the provider's perspective. 11 mid to senior-level executives from various departments (or similar) of service providers were approached. Conditions for interviewee selection included a minimum of 3 years working with the firm on digital services, to ensure high-quality in-depth responses, and a maximum of 10 years working at the firm, to minimize bias that may arise from long-term tenure.

The audio-recorded interviews were transcribed verbatim and cleaned afterward. The data analysis of the transcripts was then conducted by applying an informed inductive coding procedure based on Mayring (2014), carried out using Atlas.ti.

4 Results and Discussion

In line with prior research, this study reveals a range of barriers to digital servitization confronting medical technology firms. Our data accords with previous literature but extends the perspective towards healthcare and underlines the need to look beyond the development of the service towards the implementation of the services, as the specific nature of digital services often requires resource-intensive individualization. The identified barriers are presented in 5 key dimensions. Table 1 provides an overview of the identified barriers.

First, as our data show, the question of how to set up and align the organization internally with digital service development and provision is a key question that is discussed in medical technology firms. Our findings are in line with prior research where various organizational-related issues, such as conflicts between different sectors and different hierarchies in organizations, or blockages in terms of processes and reward structure have been identified. Most interviewed organizations decided to set up a centralized, dedicated organizational unit responsible for the digital service business.

Table 1 Identified digital servitization barriers of medical technology firms

Dimension	Identified barriers
Organization	• Missing organizational anchoring • Unsuitable processes • Missing formalization of "digital service topics" • Missing organizational incentives to engage on "digital service"-related topics
Culture	• Reactive service culture • Risk aversion • Organizational inagility • Missing or unclear communication
Innovation	• Heterogeneity of customer needs and requirements • Product-driven research & development orientation • Long-term research & development orientation • Lack of software developers, data analysts, etc • Lack of industry standards • Missing customer pull • Lack of customer intimacy • Missing access to customer data • Legal barriers
Commercialization	• Missing or unclear strategy • Unsuitable or too complex offer structure • Unsuitable customer segmentation • Complex and not a value-based revenue model • Unclear value proposition • Ineffective sales approach • Lack of qualified sales personnel • Unsuitable compensation systems
Collaboration	• Lack of trust • Resource slack • The missing connection between partnerships and "real business" • Unsuitable compliance policies • Missing business-orientation

Second, moving towards digital services often entails various cultural barriers. Our data reveals four main culture-related barriers to digital service innovation in medical technology firms: A reactive service culture, risk aversion, organizational inagility, and missing or unclear communication.

Third, developing digital service and related business models comes with manifold challenges for medical technology firms and requires them, as firms in other industries, to develop digital service-specific innovation capabilities. Previous literature frequently emphasizes the need to balance product and service innovation and consider heterogenous customer demands through service innovation co-creation and co-innovation. In line with existing research, our findings show that strongly technology-oriented and product-centric development methods and processes often hinder digital service innovation. But also a lack of resources, particularly software developers and data analysts, lacking industry standards, data privacy-related legal barriers, and a missing customer pull hinder progress with digital services for medical technology companies. Last but not least, many medical technology firms struggle to access customer data and as a consequence, find it difficult to understand customers' processes in detail.

Fourth, significant barriers to adopting digital services lie in designing a suitable commercial model for the digital service and to market and sell it to the customers, i.e., the hospitals. Contributing to the scarce domain of existing research at the interplay between digital services and their commercialization, our findings highlight the need to build up specific capabilities in pricing and selling digital services, particularly, by adopting value-based approaches, and redefining established compensation systems for sales-related roles.

Fifth and finally, although value creation in networks and ecosystems is currently emphasized in digital servitization-related literature, observation in practice is quite limited. Building strong partnerships is far from easy and requires relational capabilities to manage coordination and cooperation with different actors successfully. As our data reveals, collaborating with external partners and utilizing their knowledge and expertise to build better digital services is a strategy that almost all interviewed medical technology firms facilitated. Also, facilitating innovation closely together with customers and creating value for both partners is a key activity of medical technology firms during digital service innovation. This rather advanced collaboration for digitals service innovations seems to originate from the fact that historically, the healthcare sector collaboration between the ecosystem actors has been established as a common practice. These interactions between network partners, however, can entail conflicts, leading to the identification of the following barriers to digital service adoption.

5 Conclusions

This study investigates digital servitization barriers for medical technology firms. In doing so, the study complements existing academic efforts and makes two key contributions.

First, the calls for studies on digital service adoption in healthcare and research investigating the influence of digital servitization in specific industries were addressed. Thus, the study supports the validity of barriers retrieved from the extant literature in this context and adds further healthcare-specific findings. For example, this research highlights the importance of barriers relating to co-creating digital services with customers, legal barriers that strongly affect servitizing companies in healthcare as well as the clear tendency to separate and centralize digital service business in medical technology firms.

Second, by uncovering digital service adoption barriers, guidance for practitioners is created. As the data suggest, medical technology firms are well-advised to pay attention to the varying barriers and perceptions of digital services within the healthcare ecosystem and design their digital services and go-to-market activities accordingly. Firms must be able to individualize their digital service offering to the prevailing customer and market characteristics and the regulatory frameworks. They must also build up competencies in identifying, quantifying, and communicating the value that their digital service is creating for the customer. And they need to invest significantly in building up new digital capabilities through building up infrastructure, connectable products, and hire highly trained human resources.

As with all research, this study has its inevitable limitations which offer promising directions for future research. Further studies could extend the sample by focusing on other medical technology firms, while also including the intermediaries and customers' perspectives in the analysis. Also, the analysis could be extended to pharmaceutical companies, which are increasingly competing with established medical technology firms in the digital service and platform business. Next to this, one could make a comparison with other industries. In addition, the area of interconnectivity and how proprietary aspects of technology as well as regulatory and liability barriers hinder innovation offer great potential for further studies. Moreover, as the study is characterized by limited representativeness and generalization due to the methodology of exploratory research, it could be used as the basis of quantitative research in a future investigation.

Finally, as this study focused on the identification of digital servitization barriers, research exploring how the identified barriers can be overcome is highly encouraged because interviewees already volunteered information on how to mitigate such barriers. As the data suggest, medical technology firms need to develop distinct organizational capabilities to overcome these barriers. While the data indicates these capabilities must be interconnected and aligned with the entire ecosystem, further analysis is required to understand their exact nature.

References

Adrodegari, F., & Saccani, N. (2017). Business models for the service transformation of industrial firms. *The Service Industries Journal, 37*(1), 57–83.

Allmendinger, G., & Lombreglia, R. (2005). Four strategies for the age of smart services. *Harvard Business Review, 83*(10), 131.

Baines, T., & Lightfoot, H. (2013). *Made to serve: How manufacturers can compete through servitization and product-service systems.* Wiley.

Bryman, A. (2016). *Social research methods.* Oxford University Press.

Cobianchi, L., Pugliese, L., Peloso, A., Dal Mas, F., & Angelos, P. (2020). To a new normal: Surgery and COVID-19 during the transition phase. *Annals of Surgery, 272*(2), 49.

Cohen, B., Amorós J. E., & Lundy, L. (2017). The generative potential of emerging technology to support startups and new ecosystems *60*(6), 741–745.

Coreynen, W., Matthyssens, P., Vanderstraeten, J., & Van Witteloostuijn, A. (2020). Unravelling the internal and external drivers of digital servitization: A dynamic capabilities and contingency perspective on firm strategy. *Industrial Marketing Management, 89*, 265–277.

Cusumano, M. A., Kahl, S. J., & Suarez, F. F. (2015). Services, industry evolution, and the competitive strategies of product firms. *Strategic Management Journal, 36*(4), 559–575.

Elton, J., & O'Riordan, A. (2016). *Healthcare disrupted: Next generationn business models and strategies.* John Wiley & Sons.

Foote, N. W., Galbraith, J.; Hope, Q., & Miller, D. (2001). "Making solutions the answer," The McKinsey Quarterly, 3. 84. Retrieved from Gartner (2017). IT glossary—Digitalization.

Grubic, T., & Peppard, J. (2016). Servitized manufacturing firms competing through remote monitoring technology. *Journal of Manufacturing Technology Management, 27*(2), 154–184.

Gustafsson, A., Edvardsson, B., & Brax, S. (2005). A manufacturer becoming service provider–challenges and a paradox. *Managing Service Quality: An International Journal, 15*(2), 142–155.

Haggerty, E. (2017). Healthcare and digital transformation. *Network Security, 8*, 7–11.

Hermes, S., Riasanow, T., Clemons, E. K., Böhm, M., & Krcmar, H. (2020). The digital transformation of the healthcare industry: Exploring the rise of emerging platform ecosystems and their influence on the role of patients. *Business Research, 13*(3), 1033–1069.

Iansiti, M., & Lakhani, K. R. (2014). Digital ubiquity: How connections, sensors, and data are revolutionizing business. *Harvard Business Review, 92*(1), 19.

Kamalaldin, A., Linde, L., Sjödin, D., & Parida, V. (2020). Transforming provider-customer relationships in digital servitization: A relational view on digitalization. *Industrial Marketing Management, 89*, 306–325.

Klein, M. M., Biehl, S. S., & Friedli, T. (2018). Barriers to smart services for manufacturing firms–an exploratory study in the capital goods industry. *Journal of Business & Industrial Marketing, 33*(6), 846–856.

Kohtamäki, M., Parida, V., Oghazi, P., Gebauer, H., & Baines, T. (2019). Digital servitization business models in ecosystems: A theory of the firm. *Journal of Business Research, 104*, 380–392.

Mayring, P. (2014). *Qualitative content analysis: Theoretical foundation, basic procedures and software solution.*

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook.* Sage Publicatios.

Nambisan, S. (2017). Digital entrepreneurship: Toward a digital technology perspective of entrepreneurship. *Entrepreneurship Theory and Practice, 41*(6), 1029–1055.

Neely, A. (2013). Servitization in Germany: An international comparison. *Cambridge Service Alliance, 1*(10).

OECD (2021). *Health spending* (indicator).

Porter, M. E., & Heppelmann, J. E. (2014). How smart, connected products are transforming competition. *Harvard Business Review, 92*(11), 64–88.

Ramaswamy, V., & Ozcan, K. (2018). What is co-creation? An interactional creation framework and its implications for value creation. *Journal of Business Research, 84*, 196–205.

Reim, W., Sjödin, D., & Parida, V. (2018). Mitigating adverse customer behaviour for product-service system provision: An agency theory perspective. *Industrial Marketing Management, 74*, 150–161.
Secundo, G., Riad Shams, S. M., & Nucci, F. (2021). Digital technologies and collective intelligence for healthcare ecosystem: Optimizing Internet of Things adoption for pandemic management. *Journal of Business Research, 131*, 563–572.
Stantchev, V., Barnawi, A., Ghulam, S., Johannes, S., & Tamm, G. (2015). *Smart items, fog and cloud computing as enablers of servitization in healthcare.* IEEE Computer Society.
Story, V., Zolkiewski, J., Verleye, K., Nazifi, A., Hannibal, C., Grimes, A., & Abboud, L. (2020). Stepping out of the shadows: Supporting actors' strategies for managing end-user experiences in service ecosystems. *Journal of Business Review, 116*, 401–411.
Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *The Journal of Strategic Information Systems, 28*(2), 118–144.
Wünderlich, N. V., et al. (2015). Futurizing smart service: Implications for service researchers and managers. *Journal of Services Marketing, 29*(6/7), 442–447.

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Drone-Based Warehouse Inventory Management with IoT for Perishables

Selwyn Piramuthu

Abstract Perishables are very sensitive to their ambient conditions that essentially determine their remaining shelf-lives. Since a large number of perishables spend a significant amount of time in transit or in warehouse storage, it is of paramount importance to appropriately manage warehouse inventory to reduce wastage due to premature spoilage. We consider the use of drones and object-level RFID tags to automate inventory management in warehouses that handle perishables and compare this with the case where all processes are manually done by humans. These scenarios exemplify digital twins with the use of IoT and drones in a warehouse environment and associated value creation for the customer and service provider. Our results indicate that automation through RFID tags and drones help the operators of automated warehouses as well as the customers of such warehouses.

Keywords Digital twin · Drones · IoT · Warehouse inventory management.

1 Introduction

Expiry dates on perishables (e.g., milk) are very conservative and are based on typical shelf-lives of such items. The actual shelf life of a perishable item can be markedly different from its expiry date. A major cause of this variation is the set of ambient conditions that the item experiences. The remaining shelf-lives of perishables can vary across items that are even on the same pallet and depend on their ambient condition history since "harvest." Given this dynamic, the significance of perishable inventory management to reduce wastage/spoilage cannot be overstated. Recent developments in sensor-based RFID/IoT technology allow for ease of ambient condition (e.g., temperature) measurement. With such ambient condition information, it is relatively easy to accurately determine the remaining shelf-life of a perishable item vs. relying on a conservatively determined "expiry date" on that item Grunow and Piramuthu (2013).

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We consider and model two types of warehouse environment that exemplify digital-twins Meierhofer and Heitz (2021) in the sense that everything is manually done in one scenario whereas the same is digitally accomplished in the other (automated warehouse scenario). Warehouses play a major role in supply chains that involve perishables as the ambient storage conditions as well as the amount of time spent at these locations determine the quality degradation rate of the perishables and ultimately their remaining shelf-lives. As warehouses tend to be large in scale, pick and place operations in such environments tend to be cumbersome and prone to errors. This is especially salient when pick and place and other warehouse operations are manually performed by humans. There is therefore a trend toward warehouse automation through varied means and facets that include automated pick and place through automated guided vehicles, barcodes placed on the shelves and the location of these barcodes recorded in databases that are then used to help humans locate and identify a given item with database-generated information provided through hand-helds, RFID-tagging items so they are easy to accurately locate even from a reasonably far distance within a warehouse, among others.

We consider drone-assisted warehouse inventory management of perishables. Drones have several advantages vs. on-floor systems since they face fewer environmental constraints on their movement, drones can fly around objects to identify them even if these objects are not visible from floor-level due to their small form factor, drones can also be designed to carry an on-board RFID or barcode reader to read RFID tags or barcodes on objects, and drones can be safely used in environments where humans may not necessarily be able to operate with ease. With sensor-based RFID tags for ambient condition measurement and item identification, the next item to pick or place is based on available items' remaining shelf-life values. With such accuracy in inventory management of perishables, it is possible to reduce wastage of such perishables due to spoilage, for example, because the item was not visible for pick-up or it was passed on for other items due to accessibility reasons.

The idea of service science and its relationship with digital twins for value creation Dominguez-Péry et al. (2021) is exemplified in this study. As discussed in West et al. West et al. (2020), digital twins facilitate the design of novel value propositions in digitally enabled servitization. This is significant since automated warehouses as digital twins of manual warehouses provide the opportunity to identify and deliver heretofore nonexistent services to customers while gaining a deeper understanding of the detailed operation and performance of automated warehouses. Such an approach also allows for *mutual* Meierhofer and et al. (2021) value creation through smart connected products through RFID/IoT and drones for both provider (here, warehouse operator) and customer (here, firm that uses service provided by the warehouse to store and retrieve perishable objects).

In Sect. 2, we consider related literature on the use of drones for warehouse inventory management. In Sect. 3, we develop a model to compare warehouse inventory management through drones and IoT/RFID and the manual case where humans are involved in the entire process. We conclude the paper with a brief discussion in Sect. 4.

2 Related Literature

The simultaneous consideration of an automated warehouse environment and a manual warehouse environment evokes the general concept of digital twins Meierhofer and Heitz (2021) where one side of the coin (here, manual warehouse environment) is where everything is manually done and the other side is its digital twin where the processes are automated (here, automated warehouse). The value creation West et al. (2020) process in automated warehouses allow for novel insights into how these warehouses operate from a detailed perspective. In addition to its effects on performance improvement in automated warehouses, the study of digital twins could facilitate insights into how the manual warehouses could be improved in terms of efficiency and overall performance.

The automated warehouse scenario we considered is operated by an entity that provides this warehouse service to third parties. This is similar in vein to the convergence of manufacturing and services as presented in Toivonen and Valminen (2012) where they consider the case of Finnish forklift manufacturers who offer warehouse logistics optimization service to clients through use of their forklift fleet. Here, the service includes the forklifts as well as human resource issues such as work safety, forklift driver skill levels, among others. While a typical forklift manufacturer is seen as proving just the forklifts, the provision of these additional human resource services is seen as servitization in the manufacturing context.

A majority of extant literature on drone use in a warehouse environment consider the last mile problem where delivery is facilitated through drones from a nearby warehouse to the item's final destination. However, there are studies that consider scenarios that are solely inside warehouse environments. These studies consider various facets of warehouse inventory management with the help of drones. For example, Sorbelli et al. (2019) study an automated picking system in a warehouse. Specifically, they develop algorithms to determine the placement location of the cart associated with a drone by minimizing the sum of the distance the drone travels to pick up all items that belong in that cart. They consider both Euclidean and Manhattan distance measures and also compare the efficiency of this setup with that of a manual picking system.

To supplement simulation as the most commonly used method to study drone use in warehouses, Ridolfi et al. (2019) create a testbed for warehouse automation experiments with mobile AGVs (automated guided vehicles) and drones to study various aspects of this environment such as indoor localization solutions, sensor fusion algorithms, video recognition, assets scanning, autonomous flight, path planning, drone charging, drone construction and materials.

Rahmadya et al. (2020) propose a framework to determine a secure distance between a drone and metallic objects affixed with RFID tags. They theoretically and experimentally evaluated their framework for RFID tag and reader radiation patterns and multipath propagation effects. The secure distane allows a drone operator to securely operate the drone without any accidents through identification of RFID tags attached to objects in its path in inventory management systems. Ong et al. (2007)

discuss high-level design considerations and implementation challenges associated with an RFID reader-equipped drone for automated inventory management in a warehouse. They use simulation to develop navigation algorithms and to visualize the feasibility of the proposed system.

Wawrla et al. (2019) study the state-of-the-art of drone deployment in warehouses and observe that inventory management as the most discussed use case with several deployments already in place. Cho et al. (2018) consider drone-assisted inventory management and propose a detection framework that localizes 2D barcodes. They use a weighted sum-based score fusion method to improve detection accuracy. They use 2D barcode images in real-life warehouse conditions to experimental illustration.

Bae et al. (2016) consider an open storage yard environment where manual inventory checking is difficult, and propose the use of drone and RFID to reduce incentory checking cost and mismatches in inventory management.

Fernández-Caramés et al. (2019) develop a block chain based framework for drone use in supply chains from a security-based perspective.

While drone applications in warehouses generally use indoor drones, there are variations on this theme as well. For example, Shen et al. (2021) study a multi-warehouse drone delivery system in which multiple warehouses share several drones through warehouse assignment heuristics (e.g., closest drone to a warehouse, random assignment). We consider drone use for inventory management in a warehouse environment.

3 Model and Analysis

We consider two scenarios in a warehouse environment used for storage and retrieval of perishables: an automated scenario where pallets or perhaps even individual items are sensor-based RFID-tagged and drones are used to read these RFID tags and a manual scenario with no automation where human labor is extensively used throughout the warehouse. To facilitate comparison of these two scenarios, we use the unit selling price (i.e., the price per unit item or pallet or object at any other level of granularity) a *customer* of such a warehouse is willing to pay as a proxy since it provides a good approximation for any given object (e.g., item, case, pallet) under equilibrium conditions. We consider the scenario where customers pay to store and retrieve perishable objects in a warehouse. This scenario is not uncommon in supply chains where the warehouses are owned by independent operators.

We use a fairly common Hotelling line of unit length to operationalize this study. The Hotelling location model Hotelling (1929) illustrates the relationship between location and pricing behavior of firms with a fixed length line. This model assumes that identical customers are uniformly distributed on the unit line between two considered scenarios that compete based on price and not on product variations or any other distinguishing factor. Here, price is used as proxy for quick and accurate retrieval of items from warehouses. We assume that sensor-based RFID tags are used on objects that need to be identified at the required level of granularity (e.g., item, case, pallet).

We do not place any restrictions on the type of RFID tags (e.g., passive, semi-passive, active) that are used as long as these tags have embedded sensors. Embedded sensors exist even in low-cost passive RFID tags (e.g., WISP tags Sample et al. (2008)), therefore cost is really not a constraint with sensor-based RFID tags. The notation used in the rest of the paper follows.

A, M	automated and manual warehouses respectively
c_A, c_M	unit cost per object incurred by A, M
p_A, p_M	unit selling price per object in A, M
l_A, l_M	unit travel cost for objects in A, M
v_A, v_M	speed at which objects are stored/retrieved in A, M
t_A, t_M	wait time for objects to be stored/retrieved in A, M
T	(remaining) shelf-life of product
$\theta(t)$	fresh degree function $\theta(t) = 1 - \frac{t}{T}$
π_A, π_M	profit functions for A, M
α	customer perceived benefit from A (e.g., error-free order)

We derive the results based on equilibrium conditions, when the customer at an automated or manual warehouse is indifferent between the two types of warehouses that are modeled at the two ends of a unit line segment. We assume that $c_A > c_M$ since a warehouse that implements drones and object-level (here, an object represents an item, case, or pallet as required by the modeled scenario) incurs fixed costs related to these devices and associated systems as well as variable costs of related maintenance and other expenses whereas the manual warehouse incurs no such costs but incurs human labor-related expenses. By the same token, we also assume that $l_M > l_A$. The customer is indifferent between the automated and manual warehouses when

$$\theta\left(1 - \frac{t_A}{T}\right) - l_A v_A t_A - p_A + \alpha = \theta\left(1 - \frac{t_M}{T}\right) - l_M v_M t_M - p_M \tag{1}$$

Since we have a unit length line, $v_A t_A + v_M t_M = 1$. We assume $v_A > v_M$, where v_A represents the drone-based speed of the process and v_M the represents the speed of a the same process that is manually done, since drone-based setup is generally faster than human-based manual pick and place.

The profit function corresponding to the above for the drone-based automated warehouse setup that is to be optimized is given by:

$$\pi_A = (p_A - c_A) v_A t_A^* = (p_A - c_A) \frac{v_A \theta + v_A v_M T (p_M - p_A + l_M + \alpha)}{\theta(v_A + v_M) + (l_A + l_M) v_A v_M T} \tag{2}$$

To determine the optimum selling price per object by the automated warehouse, we take the partial derivative of the above with respect to p_A.

$$\frac{\partial \pi_A}{\partial p_A} = \frac{v_A \theta + v_A v_M T (p_M - 2p_A + l_M + c_A + \alpha)}{\theta(v_A + v_M) + (l_A + l_M) v_A v_M T} \tag{3}$$

The second derivative $\frac{\partial^2 \pi_A}{\partial^2 p_A}$ is negative, indicating that π_A is concave. When the above expression is set to zero, we get the optimum (here, maximum) p_A value that is represented as p_A^*.

$$p_A^* = \frac{\theta(2v_A + v_M) + v_A v_M T(l_A + 2l_M + 2c_A + c_M + \alpha)}{3v_A v_M T} \tag{4}$$

Similarly, the profit function corresponding to the above for the human-based manual setup that is to be optimized is given by:

$$\pi_M = (p_M - c_M)v_M t_M^* = (p_M - c_M)\frac{v_M\theta + v_A v_M T(p_A - p_M + l_A - \alpha)}{\theta(v_A + v_M) + (l_A + l_M)v_A v_M T} \tag{5}$$

Again, we take the partial derivative of the above-expression with respect to p_M to determine the optimum selling price per object for the manual warehouse.

$$\frac{\partial \pi_M}{\partial p_M} = \frac{v_M\theta + v_A v_M T(p_A - 2p_M + l_A + c_M - \alpha)}{\theta(v_A + v_M) + (l_A + l_M)v_A v_M T} \tag{6}$$

The second derivative $\frac{\partial^2 \pi_M}{\partial^2 p_M}$ is negative, indicating that π_M is concave. When the above expression is set to zero, we get the optimum (here, maximum) p_M value that is represented as p_M^*

$$p_M^* = \frac{\theta(v_A + 2v_M) + v_A v_M T(2l_A + l_M + c_A + 2c_M - \alpha)}{3v_A v_M T} \tag{7}$$

We can now derive some results based on the analysis above. We are specifically interested in the comparison of the two systems—the drone- and IoT-based automated warehouse and the manual warehouse—with respect to their advantages and disadvantages in concrete terms. We first look at the optimal price differences between the manual and automated warehouse scenarios.

Proposition 1 *The warehouse operator can charge more for storage in an automated warehouse as compared to the manual warehouse.*

Proof We show this by considering p_A^* and p_M^*, the optimal (i.e., maximum) unit selling price per object respectively in the automated and manual warehouses. From equations (4) and (7), we get

$$p_A^* - p_M^* = \frac{\theta(v_A - v_M) + v_A v_M T(l_m - l_A + c_A - c_M + 2\alpha)}{3v_A v_M T} \tag{8}$$

Since $v_A > v_M$, $l_m > l_A$, and $c_A > c_M$, the above expression is positive (i.e., $p_A^* - p_M^* > 0$ □

Proposition 1 states that the warehouse operator can charge the customer more to store the same object in an automated warehouse when compared to that in a manual warehouse. The benefits associated with automated warehouses include the speed at which objects can be picked from storage and placed in storage, and the very low possibility for human-induced errors since automated warehouses have minimal human input in the process loop.

Proposition 2 *A customer's high perceived benefit for automated warehouse setting allows for the warehouse operator to charge more for storage in an automated warehouse and less in a manual warehouse.*

Proof We show this by considering p_A^* and p_M^*, the optimal (i.e., maximum) unit selling price per object respectively in the automated and manual warehouses. From Eqs. (4) and (7), we see that α is positively related to P_A^* and negatively related to P_M^* since as P_A^* increases with α as is seen in (4) and P_M^* decreases with α as is seen in (7). □

Proposition 2, a variant of Proposition 1, states that due to the customers' high perceived value for the service offered by automated warehouse in terms of fast service with minimal error possibility when compared against those offered by a comparable manual warehouse, the automated warehouse operator can set a higher price than the manual warehouse operator.

Proposition 3 *The overall profit associated with automated warehouse setting is more than that for the manual warehouse setup.*

Proof We show this by considering (2) and (5), the profit functions respectively for the automated and manual warehouse systems. From these expressions, we have

$$(p_A - c_A)\Big(v_a\theta + v_A v_M T(p_M - p_A + l_M + \alpha)\Big) \tag{9}$$

$$\lesseqgtr (p_M - c_M)\Big(v_M\theta + v_A v_M T(p_A - p_M + l_A - \alpha)\Big) \tag{10}$$

We know that $v_A > v_M$, $l_M > l_A$, $c_A > c_M$, and $p_A > p_M$. We first assume that $(p_A - c_A) = (p_M - c_M)$ and get

$$\theta(v_A - v_M) + v_A v_M T\Big(2(p_M - p_A) + l_M - l_A + 2\alpha\Big) \lesseqgtr 0$$

In the above, the first term $\theta(v_A - v_M)$ is positive since θ is positive and $(v_A - v_M)$ is also positive. In the second term, $(l_M - l_A)$ is positive as $l_M > l_A$. We now show $(|p_M - p_A|) < \alpha$ to show that the latter dominates the former. We do this by considering expression (8). We know that the left hand side is positive and in the right hand side, we have a set of positive terms and then $\frac{2\alpha}{3}$, which points to the likelihood that the left hand side is less than α. Therefore, in the expression above, the left hand side is > 0. □

Proposition 3 shows that the automated warehouse setting is associated with increased profit versus that in the manual warehouse setting. From the three propositions, it is clear that the automated warehouse environment provides benefits both in monetary terms to the warehouse operator as well as in terms of efficiency and quickness of the processes in the automated warehouse environment while the manual warehouse environment suffers lower benefits in monetary terms and is clearly not efficient nor quick due to the slowness of the operations as well as (human) error-proneness of the entire process.

4 Discussion

Digital twins help with understanding both the automated part and the non-automated part of a system to learn from both sides. We considered a warehouse environment that is automated through the use of object-level RFID tags and drone-based readers to read those tags. We also considered its manual counterpart where the processes are manually done. We analytically showed a few advantages of the automated warehouse environment with specific emphasis on estimated profit and the automated warehouse operator's possibility to charge more for the service to customers who want to avail of the storage and retrieval services offered versus that at the manual warehouse. In doing this, we showed the mutual value creation for both the customers as well as the automated warehouse service provider. This study provides yet another evidence for the beneficial aspects of digital twins in the creation of value. We intend to conduct detailed experimental analysis of the proposed framework in a subsequent study.

References

Bae, S. M., Han, K. H., Cha, C. N., & Lee, H. Y. (2016). Development of inventory checking system based on UAV and RFID in open storage yard. In *Proceedings of the International Conference on Information Science and Security (ICISS)* (pp. 1–2) (2016). https://doi.org/10.1109/ICISSEC.2016.7885849.

Cho, H., Kim, D., Park, J., Roh, K., & Hwang, W. (2018). 2D barcode detection using images for drone-assisted inventory management. In *Proceedings of the 15th International Conference on Ubiquitous Robots (UR)* (pp. 461–465) (2018).

Dominguez-Péry, C., Ageron, B., & Neubert, G. (2021). A service science framework to enhance value creation in service innovation projects. An RFID case study. *International Journal of Production Economics*, *141*(2), 440–451 (2021).

Fernández-Caramés, T. M., Blanco-Novoa, O., Froiz-Míguez, I., & Fraga-Lamas, P. (2019). Towards an autonomous industry 4.0 warehouse: A UAV and blockchain-based system for inventory and traceability applications in big data-driven supply chain management. *Sensors*, *19*, 2394 (2019). https://doi.org/10.3390/s19102394

Grunow, M., & Piramuthu, S. (2013). RFID in highly perishable food supply chains—Remaining shelf life to supplant expiry date? *International Journal of Production Economics, 146*(2), 717–727.

Hotelling, H. (1929). Stability in competition. *Economic Journal, 9*(153), 41–57.

Meierhofer, J., & Heitz, C. (2021). Service customization: optimizing value creation and capture by designing the customer journey. In *Proceedings of the 8th Swiss Conference on Data Science (SDS)* (pp. 32–38).

Meierhofer, J., Heitz, C., & Hannich, F. (2021). Optimizing service value creation with smart, connected products. In *Proceedings of the Naples Forum on Service, a Service Lens on Changing Business and Society* (2021).

Ong, J. H., Sanchez, A., & Williams, J. (2007). Multi-UAV system for inventory automation. In *Proceedings of the 1st Annual RFID Eurasia* (pp. 1–6). https://doi.org/10.1109/RFIDEURASIA.2007.4368142.

Rahmadya, B., Sun, R., Takeda, S., Kagoshima, K., & Umehira, M. (2020). A framework to determine secure distances for either drones or robots based inventory management systems. *IEEE Access, 8*, 170153–170161.

Ridolfi, M., Macoir, N., Gerwen, J. V., Rossey, J., Hoebeke, J., & de Poorter, E. (2019). Testbed for warehouse automation experiments using mobile AGVs and drones. In *Proceedings of the IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS)* (pp. 919–920) (2019).

Sample, A. P., Yeager, D. J., Powledge, P. S., Mamishev, A. V., & Smith, J. R. (2008). Design of an RFID-based battery-free programmable sensing platform. *IEEE Transactions on Instrumentation and Measurement, 57*(11), 2608–2615.

Shen, Y., Xu, X., Zou, B., & Wang, H. (2021). Operating policies in multi-warehouse drone delivery systems. *International Journal of Production Research, 59*(7), 2140–2156.

Sorbelli, F. B., Corò, F., Pinotti, C.M., & Shende, A. (2019). Automated picking system employing a drone. In *Proceedings of the 15th International Conference on Distributed Computing in Sensor Systems (DCOSS)* (pp. 633–640).

Toivonen, M., & Valminen, K.: Optimization of the clients' warehouse logistics: a KIBS-type service in the manufacturing context. In L. Macaulay, I. Miles, J. Wilby, Y. Tan, L. Zhao, B. Theodoulidis (Eds.), *Case studies in service innovation. Service science: Research and innovations in the service economy* (pp. 37–41) (2012). New York, NY: Springer.

Wawrla, L., Maghazei, O., & Netland, T. (2019). Applications of drones in warehouse operations. Whitepaper. ETH Zurich, D-MTEC, Chair of Production and Operations Management. Downloaded from www.pom.ethz.ch.

West, S., Meierhofer, J., Stoll, O., & Schweiger, L. (2020). Value propositions enabled by digital twins in the context of servitization. In *Proceedings of the Spring Servitization Conference : Advanced Services for Sustainability and Growth* (pp. 152–160) (2020).

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Capability of Service Innovation—What SMEs Can Learn from Start-Ups

Valerie Bass and Julius Taubert

Abstract A key objective of this research is to take a more detailed look at a central aspect of resilience in small and medium-sized enterprises (SMEs). A literature review and expert interviews were used to investigate which factors have an impact on the innovative capacity of start-ups and whether these can also be adapted by SMEs. First of all, it must be stated that there are considerable structural and process-related differences between start-ups and SMEs. These can considerably inhibit cooperation between the two forms of enterprise. However, in the same context, success factors and issues in the start-up sector could also be identified that can improve cooperation with SMEs. These and other findings are then discussed in both an economic and an academic context. This article was written as part of the research activities of the Smart Services Competence Centre (proper name: Kompetenzzentrum Smart Services), a central contact point for all questions in the area of smart service digitalization in Baden-Wuerttemberg. Here, companies can obtain information about various digital technologies and take advantage of various measures for the development of new ideas and innovative services (Kompetenzzentrum Smart Services BW: Über das Kompetenzzentrum, 2021).

Keywords Start-ups · Service innovation · Innovative capability · New work

1 Introduction

Not least the impact of the Covid-19 pandemic has shown that companies with a high degree of service innovation have proven to be more resilient and crisis-resistant than more conservative companies. According to a study of the Berner Fachhochschule, companies that were open to creative solutions and short-term changes were less affected by the Corona Crisis (Gurtner & Hietschold, 2021). This shows that agility and a strong innovative capability of companies can help them to raise their resilience.

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However, there seem to be differences depending on the company size and history that affect their innovative capability. Especially start-ups have proven their innovative culture by introducing creative ideas and new business models and hence increased the potential for digital solutions in the last years (Demary & Rusche, 2021). However, this striving for new potential has not affected the broad economy yet (Engels & Röhl, 2019). A variety of studies imply that especially SMEs are still lacking in implementing digital solutions and services (Gaycken & Hughes, 2021; Institut der deutschen Wirtschaft and IW-Consult, 2016; BMWi—Bundesministerium für Wirtschaft und Energie, 2018; IGM, 2021).

This leads to the assumption of a cultural gap between start-ups and especially SMEs when it comes to innovative capability and service innovation. Therefore, the following research questions need to be analyzed: What are typical characteristics of start-ups and SMEs and how do the two differ when it comes to innovative capability? Can start-ups be a rolemodel for SMEs in terms of service innovation and if so what are specific takeaways for SMEs?

This study in the scope of the Kompetenzzentrum Smart Services provides an approach for this identification and guidelines for SMEs about how to raise their innovative capability by comparing relevant and contemporary literature and results of a recently conducted survey of start-ups.

2 Literature Review

This research aims to give a broad understanding about the cultural dimension of service innovation and especially compare the organizational culture of both, start-ups and SMEs.

2.1 Service Innovation

Services in particular play an overriding role, as they offer companies the opportunity to develop a pure product business into an additive service business and thus innovate a scalable and often profitable business model (Freiling & Harima, 2019). According to Janssen and den Hertog, Service innovation means the "successful introduction of a (replicable) solution with a particular degree of novelty" (Janssen and den Hertog, 2016, p. 99). In this regard, they include the process of the creation of new services as well as the final solution—an innovative service—into their definition.

Analyzing contemporary literature of different strands, they found out that one of the least explored fields refers to the innovative capabilities of organizations that are crucial for developing innovative services and business models.

Den Hertog et al. claim that service innovation has to be examined in a multi-dimensional way with six components (Hertog et al., 2010). One of the six dimensions as mentioned by Hertog is the *Organisational delivery system* referring to the human part of innovation and including the required organizational routines, know-how and cultural aspects that are needed in order to compete in service innovation.

When it comes to innovative, organizational culture, Janssen and den Hertog claim that it requires "a widely distributed preparedness or capability within the firm to think out of the box, question current practices and processes and be eager to test prototypes or run experiments" (Janssen and den Hertog, 2016, p. 110). In this sense, they also mention the relevance of an environment and organizational structures that enable and encourage new ideas about innovative solutions and delivery forms.

Lauer argues that the organizational culture should shift to a service-oriented culture rather than a culture of error prevention and safety (Lauer, 2021).

2.2 Innovative Culture—Cultural Differences Between Start-Ups and SMEs

This section provides an overview of suggestions of prior research in terms of typical features of start-ups and SMEs as the fundament for the following assumptions.

First, there is an obvious difference considering the age structure of the founders of the company comparing start-ups and SMEs. In Switzerland, owners of SMEs have an average age of 50 years (Organisator: KMU-Studie, 2017) whereas founders of start-ups have an average age of 41 years (Institut & für Jungunternehmen: Neues Allzeithoch bei Firmengründungen, 2018). This age gap might be one of the reasons for the cultural differences between the two company types, as age and the experience gained with it shape the actions of a founder.

Another difference is that SMEs focus on a high continuity of their processes and structures and tend to operate with a certain prudence which has been crucial for their survival in the past (Röhl, 2021). They are more likely to develop and improve consisting products and services than implement something completely new (IW Consult & Santiago, 2021). Start-ups however, tend to focus on fast decision making, fast processes and often disruptive ideas and business models (Leitner et al., 2021).

Furthermore, there are significant differences when it comes to hierarchy levels and management styles. Start-up owners often work in the same office space as their employees and tend to have frequent communication with every company member, especially as most start-ups have a manageable employee base (Bogott et al., 2017). This leads to the assumption that start-ups in most cases have very low hierarchy levels and open communication between management and employees. SMEs on the other side, are often family owned and led by the owner. Dieckhoff claims that owner-managed companies are often less innovative which is due to the fact that they often rely on traditions based on the company history (Dieckhoff et al., 2021).

Based on these findings, the authors raise the assumption that SMEs still have potential to raise their innovative capability on a cultural dimension and approach an innovative culture like e.g. the typical culture of start-ups.

3 Methodology

Standardized interviews were conducted for this research project. The text-analytical questions are derived from the overarching question of the research object. At the end of such an evaluation, these questions should be answered, which distinguishes qualitative content analysis from completely open and explorative procedures, such as grounded theory methodology (Mayring, 2019). For this article, a total of six different expert interviews were conducted with start-ups from different phases of the founding process.

The procedure is derived from the usual procedure for partially standardized or completely standardized interviews. Such surveys are usually conducted with a comparatively small number of cases (small-N), i.e. few respondents (von dem Berge, 2021). In this case, following the data collection, the interviews were transcribed in each case and computer-coded for the evaluation of the individual aspects. In this research project, this codebook consists of around 145 codes and is divided into three different levels and reflects the different questions of the standardized interviews. It contains the category names and the short definitions, but without resorting to the precision of the coding guide used in qualitative content analysis for similar purposes (Mayring, 2019).

Subsequently, it was analyzed how often individual aspects of a code were mentioned by the interviewees. Based on these figures, priorities or rankings were formed in order to filter out subjective opinions that could falsify the results.

4 Results

Figure 1 summarizes the most significant highlights of the interviews. The results of

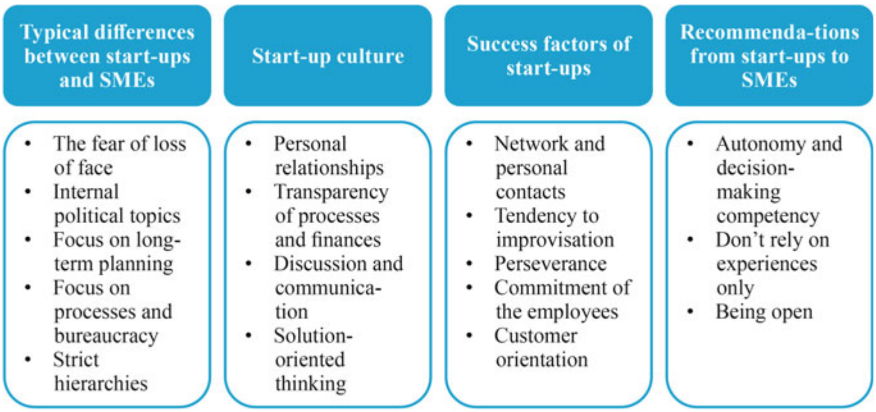

Fig. 1 Results of the interviews (own illustration, based on codebook)

the research including further information are presented in the following chapters.

4.1 Typical Differences Between Start-Ups and SMEs

Given the results of the previous literature review, this paper already pointed out a variety of differences between start-ups and SMEs when it comes to the culture of each company type. In the subsequent survey, start-up representatives answered the question what characteristics of SMEs differ from their own. The answers confirm many of the characteristics from Chap. 2.

The most common answer of the interviewed start-up representatives when it comes to differing cultural characteristics of SMEs is *the fear of loss of face* – meaning the fear of damages in reputation and career due to poor decisions that have been made in the past. According to the start-up representatives, this prudence prevents SMEs from being agile and focusing on service innovation. Another common argument from the interviews is *internal political topics* within SMEs that supposedly holds SMEs back to from making choices that support service innovation.

Other common answers are: *focus on long-term planning*, *focus on processes and bureaucracy, strict hierarchies*, *lack of focus on the overarching goal of the company*.

4.2 Start-Up Culture

In addition, the survey collects cultural characteristics of start-ups which are perceived as significant by the interviewees. The literature analysis already determined that start-ups often operate on a very personal level. The start-up survey confirms this finding giving the fact that *personal relationships* is the most common answer regarding cultural traits. Equally common is the answer *transparency of processes and finances*. *Discussion and communication* and *solution-oriented thinking* are also two important cultural aspects that seem to be typical for start-ups.

4.3 Success Factors of Start-Ups

Another interview question is the main success factors of the respective start-up according to the start-up representatives. The most popular answer is *network and personal contacts* which is not a surprise given the fact that many start-ups are reliant on their personal contacts due to the initial lack of customers and other business partners. More interesting is the second most common answer *tendency to improvisation* which refers to the capability to find alternative solutions and new sources of income. The environment of most start-ups is utterly dynamic e.g. because they have to build up a new customer base and often depend on a small amount of important launch customers. Therefore, they have to adapt to changing circumstances quickly in order for the company to survive. In this sense, another important success factor as pointed out in the interviews is *perseverance.* Also, *the commitment of the employees* seems to be a strength and promising characteristic for start-ups.

Other commonly used answers are: *customer orientation*, *skills and specific know-how*, *taking different perspectives* and *believe in the business idea.*

4.4 Recommendations from Start-Ups to SMEs

This section will give an overview of the recommendations that start-ups have for established companies in order to stay innovative. The recommendation that occurs the most is *autonomy and decision-making competency.* One difficulty in SMEs as perceived by the start-up representatives is the often slow decision making process that might involve a high amount of hierarchy levels within the company. This condition slows down the whole innovation process. Therefore, start-ups recommend to transfer more decision-making power to employees from lower or medium hierarchy levels to enable fast decisions and agility. Another recommendation that occurs in the interviews is *don't rely on experiences only* which advises SMEs to pretend forgetting everything they know to create space for new ideas and avoid being stuck in the past. The last recommendation is *being open* e.g. to learn continuously, to new solutions, to different perspectives and a changing environment.

5 Discussion

5.1 Implications for Economy

The findings presented in this text have considerable economic significance. It can be seen that the cultures of the two types of companies differ significantly from each other.

As a measure, it can be stated that the aforementioned ability to act quickly can also be achieved by integrating lower hierarchical levels into decision-making processes. In addition, SMEs could anchor the innovative activities often successfully practiced by Start-ups in their corporate culture through their own measures. Targeted innovation management could be helpful here, creating appropriate space where employees can get involved and develop their own ideas. This enables everyone to make their own individual contribution to innovation. It is also advisable to make this team as diverse as possible, which can also prevent the organization as a whole from deriving decisions too much from past experience, which is seen as critical by the Start-ups interviewed.

Additionally, SMEs could also benefit from being open and further agile ways of working of start-ups and thus make the organization more agile as an economic subject. This can also sustainably strengthen the culture of innovation in the company described above.

Conversely, however, it can be observed that interdependencies exist with regard to innovation and resilience. Since this connection means that the degree of resilience can now also be improved by increasing innovation, and start-ups have been proven to have a high degree of innovation, it is advisable for SMEs to transfer the innovation culture of start-ups as described in this paper to their own companies. This can sustainably increase the degree of innovation and strengthen the resilience of the company.

5.2 Implications for Science

This paper contributes to the differentiation of SMEs and start-ups on a cultural level and provides assumptions about the development of the capability for service innovation within companies. However, the findings are limited to a small number of representative start-ups. Therefore, future research should focus on deepen the present research questions on a broad level e.g. using quantitative methods. Furthermore, future research should take the opposite perspective into account by analyzing the results of similar questions for SMEs instead of start-ups. Such results would enable a double-sided overview and contribute even more to the understanding of specific differences of both company types.

6 Conclusions and Recommendations

Since, due to the research question, only start-ups were surveyed, the recommendations from the previous chapter should rather refer to SMEs. This paper pointed out how start-ups and SMEs differ especially on a cultural level and gave a broad understanding why start-ups tend to be more agile and innovative. Those differences include e.g. the gap of the average age of the company owners of start-ups and SMEs, focus on structure and continuity on the SME-side and focus on disruption and innovation on the start-up-side.

Furthermore, this paper summarized the recommendations of the interviewed start-up representatives for SMEs regarding innovative capability such as improving *autonomy and decision-making competency* on lower hierarchy levels and a general open mind for new solutions and business models. This openness can also be reflected, among other things, in the corporate cooperation officer already mentioned.

In summary, this paper provides important guidelines and recommendations for SMEs to increase their innovation capabilities. A general open-mindedness towards the start-up culture can help SMEs to become more agile and resilient and to focus on service innovations.

References

BMWi—Bundesministerium für Wirtschaft und Energie. (2018). *Monitoring-Report Wirtschaft DIGITAL 2018: Kurzfassung*. Retrieved August 20, 2021, from https://ftp.zew.de/pub/zew-docs/gutachten/ZEW_MonitoringWirtschaftDigital2018.pdf.

Bogott, N., Rippler, S., & Woischwill, B. (2017). *Im Start-up die Welt gestalten: Wie Jobs in der Gründerszene funktionieren* (1st ed). Springer Gabler: Wiesbaden.

Demary, V., Rusche, C. (2021). *The Economics of Platforms: IW-Analysen.* Retrieved September 28, 2021, from https://www.iwkoeln.de/studien/vera-demary-christian-rusche-the-economics-of-platforms.html.

den Hertog, P., van der Aa, W., & de Jong, M. (2010). Capability for managing service innovation: Towards a conceptual framework. *Journal of Service Management, 21*, 490–514.

Dieckhoff, K., Hoffmann, T., Schreurs, M., Schröter, W. (2021). *Arbeitsinnovationen in kleinen und mittelständischen Unternehmen: Ergebnisse einer Repräsentativbefragung von mittelständischen Unternehmen des Verarbeitenden Gewerbes.* Retrieved August 23, 2021, from www.innovative-arbeitswelten.de.

Engels, B., Röhl, K.-H. (2019). *IW-Analysen 134: Start-ups und Mittelstand: Potenziale und Herausforderungen von Kooperationen.* Köln: Institut der deutschen Wirtschaft Köln Medien GmbH.

Freiling, J., & Harima, J. (2019). *Entrepreneurship: Gründung und Skalierung von Start-ups.* Springer Gabler Wiesbaden.

Gaycken, S., Hughes, R. (2021). *Cyberreadiness in kleinen und mittleren Unternehmen.* Retrieved September 28, 2021, from https://www.ihk-nuernberg.de/de/media/repository/attachments/cyberreadiness-in-kmus.pdf.

Gurtner, S., Hietschold, N. (2021). *Schweizer KMU und Start-ups in der Corona-Krise.* Retrieved September 17, 2021, from https://www.bfh.ch/de/forschung/referenzprojekte/kmu-corona-krise/.

IGM—Industriegewerkschaft Metall. (2021). *Transformationsaltas: Wesentliche Ergebnisse.* Pressekonferenz der IG Metall. Retrieved September 27, 2021, from https://www.igmetall.de/download/20190605_20190605_Transformationsatlas_Pressekonferenz_f2c85bcec886a59301dbebab85f136f36061cced.pdf.

IFJ Institut für Jungunternehmen: *Neues Allzeithoch bei Firmengründungen: 1. Halbjahr 2018.* Retrieved September 18, 2021, from https://www.ifj.ch/Neues-Allzeithoch-bei-Firmengruendungen-1-Halbjahr-2018.

Institut der deutschen Wirtschaft/IW-Consult. (2016). *Wohlstand in der digitalen Welt: Erster IW-Strukturbericht*. Cologne

IW Consult and Santiago. (2021). *Innovationen den Weg ebnen: Eine Studie von IW Consult und Santiago für den Verband der Chemischen Industrie.* Retrieved September 12, 2021, from https://www.iwconsult.de/aktuelles/projekte/innovationen-den-weg-ebnen.

Janssen, M. J., & den Hertog, P. (2016). Developing service-based business models: which innovation capability for which innovation dimension? In M. Toivonen (Ed.), *Service Innovation: Novel Ways of Creating Value in Actor Systems* (6th ed., pp. 97–128). Japan: Springer.

Kompetenzzentrum Smart Services BW. (2021). *Über das Kompetenzzentrum.* Retrieved October 5, 2021, from https://smart-service-bw.de/kompetenzzentrum/.

Lauer, T. (2021). *Change management: Fundamentals and success factors.* Springer.

Leitner, L., Leitterstorf, M., & Kammerlander, N. (2021). *Start-ups und Familienunternehmen: Ein Leitfaden für Unternehmerfamilien und Start-up-Gründer.* Retrieved September 20, 2021, from https://www.researchgate.net/profile/Nadine-Kammerlander/publication/334151303_Start-ups_

und_Familienunternehmen_-_ein_Leitfaden_fur_Unternehmerfamilien_und_Start-up-Grunder/links/5d23541f92851cf44070e452/Start-ups-und-Familienunternehmen-ein-Leitfaden-fuer-Unternehmerfamilien-und-Start-up-Gruender.pdf.
Mayring, P. (2019). Qualitative Inhaltsanalyse—Abgrenzungen, Spielarten, Weiterentwicklungen. *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research, 20*(3) (2019).
Organisator: *KMU-Studie 2017*. Retrieved August 20, 2021, from https://www.organisator.ch/kmu-studie-2017/.
Pfäfflin H. (2008). *Stärken und Schwächen des Innovationsverhaltens von KMU: Exemplarische Analyse und mögliche Handlungsoptionen.* Nürnberg.
Röhl, K.-H. (2019). Entrepreneurship: a competitive study of the interplay of culture and personality from a regional perspective. *Journal of Small Business & Entrepreneurship, 31*(2), 119–139
Röhl, K.-H. (2021). *Die Zukunft der Familienunternehmen in Deutschland: Potenziale und Risiken in der globalen Wirtschaft*. IW-Analysen. Retrieved September 12, 2021, from https://www.iwkoeln.de/fileadmin/user_upload/Studien/IW-Analysen/PDF/Bd_38_Familienunternehmen.pdf.
von dem Berge, B. (2021). Teilstandardisierte Experteninterviews. In M. Tausendpfund (Ed), *Fortgeschrittene Analyseverfahren in den Sozialwissenschaften: Ein Überblick* (pp. 275–300). Wiesbaden: Springer Fachmedien Wiesbaden.

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Value Design for Ecosystem Actors

Application Possibilities of Artificial Intelligence in a Renewable Energy Platform

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Abstract Digitization and the trend to work from home are significantly accelerated by the COVID-19 pandemic. The relocation of the workplace to the home office is accompanied by increased electricity consumption in private households. Furthermore, with the threat of climate change, the transition to renewable energies is becoming increasingly important. This includes the need for new and innovative business models in the energy sector. Artificial intelligence is one of the key technologies for innovation. We investigate how and where artificial intelligence can be incorporated into the business model of a German research project. The business model aims to market renewable energy through a platform where private electricity consumers and producers are part of the user base. With the help of AI, future supply and demand can be forecasted more accurately, which is ecologically and

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economically beneficial. Chatbot assistance and further applications are presented as well. The resulting added value can benefit both the platform operator as well as the platform users.

Keywords Artificial intelligence · Business model development · Renewable energy · Platform innovation · Smart services

1 Introduction

Due to the challenges caused by the COVID-19 pandemic, many companies are struggling to survive. Digitization is being driven ever further by the pandemic, and innovative business models can be a way out of the crisis (Shahzad & Imran, 2021). Artificial intelligence (AI) is commonly regarded as one of the key technologies of the future, as it can determine the success and competitiveness of a company. It has high innovative potential and could ensure the survival of struggling companies. Hence, many companies want to participate in the promising trend. But often, the question arises as to how and where AI could be applied in a useful way. Another highly relevant issue on a global scale is climate change. Action is already being taken, for instance, by switching to renewable energy sources. However, consumers are also becoming increasingly environmentally aware. It is in their interest to protect the environment and to responsibly consume electricity. All the more so as the pandemic has caused more people to move their workplaces to their homes. Thus, the electricity consumer as an environmentally conscious prosumer is a growing customer segment.

At the beginning of 2021, the 20-year subsidy period for renewable energy plants came to an end in Germany. This means that the guaranteed feed-in tariff is no longer available to German cooperatives. The business model of many citizen energy cooperatives starts to collapse. Therefore, a need for new and innovative business models arises in the German energy sector (Ensinger et al., 2021). This work examines the application possibilities of AI. A German renewable energy platform appears to be a pertinent example to explore the potential added value of AI. Hence, the question of where and how AI can be applied is examined using the example of the German research project 'BuergerEnergieWende' (BEW) (www.hs-aalen.de/buergerenergiewende) The project aims to develop a platform for renewable energy. In connection with the business model (Bozem & Nagl, 2022), the possible applications of AI are studied, and potentially resulting advantages and benefits are discussed. The results can be transferred to other business models and can thus be of interest to them. The issue is viewed holistically from the business side and partly from the technical side. However, the focus will be on service value creation. Especially effects on the customer experience and customer satisfaction are studied.

2 Literature Review

The COVID-19 pandemic has led to a change in load patterns as people spend more time in their homes, and production sites have partly come to a halt. The electricity demand in the industry has decreased, while it has risen in the private sector. Energy demand peaks now occur during different times of the week and day. It might be possible that the recent pandemic has altered people's lifestyle for good, empathizing a need for flexible energy sources (Zhong et al., 2020). Electricity demand is also increasing due to electromobility. A growing number of people are driving electric cars. The electricity used to fuel these cars is best provided by a renewable resource in order to tackle climate change (Ensinger et al., 2021). Renewable sources are not flexible per se, but increased flexibility can be reached through the use of AI. In the energy sector, AI is already being used in practice. Zheng et al. (2020) introduce a platform (PIDS) that helps companies optimize electric energy consumption. As a result, the power outage was reduced from 16 to 0.56%. Based on an AI for short-term load forecasting, consumption adjustments are made. Participating companies commit to a demand response in exchange for a better electricity price. Intelligent orderly power utilization (a forced but fair shutdown) is a second measure to bridge the gap between supply and demand. Witell (2021) notes that identifying customers or equipment that can benefit from AI is a desired ability. AI potentially facilitates sales and cost savings. Thus, it enhances value capture. Xu et al. (2019) propose the concept of a holistic, AI-enabled energy platform for value capture. In doing so, they examine the potential impact of AI on the evolving energy sector. It is argued that the market shifts towards decentralized and distributed energy and that the sharing economy will also find its way into the energy sector. The platform approach is certainly advocated. Nevertheless, there exist challenges in the use of AI in the green energy sector. Climate change makes the weather volatile and difficult to predict. Weather data is subject to fluctuations and can only be used for AI to a limited extent. Other challenging aspects are Big Data and Data Mining, which refer to the constantly increasing amount as well as the processing speed of the data. Big Data and its methods are described in Elgendy and Elragal (2014).

3 Methodology

3.1 Platform

The German BEW project aims to build a platform for regional and green energy (Bozem & Nagl, 2022; Ensinger, 2021; Ensinger et al., 2021; www.hs-aalen.de/buergerenergiewende). Part of the idea is to allow private households to market surplus electricity through the platform. Mere producers and moreover prosumers (consumer + producer) may want to market their electricity produced by solar panels, installed on their roof. A prosumer generates energy for self-supply. However, they

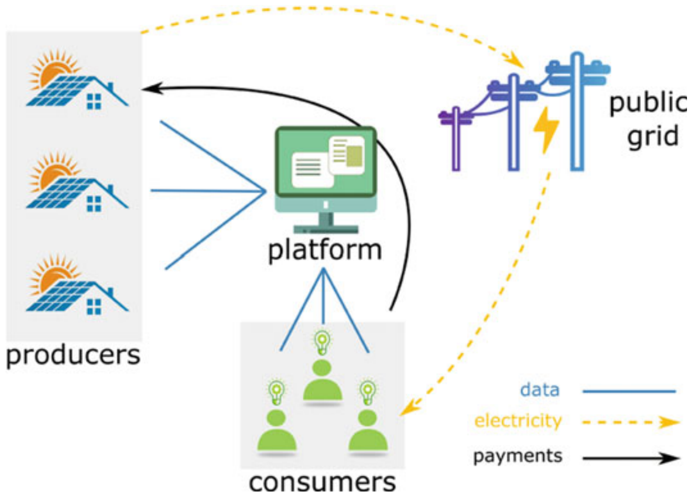

Fig. 1 Households with installed solar panels (producers) and environmentally aware electricity consumers form part of the customer base of the platform. The physical electricity is accumulated in the public grid as usual and likewise distributed via it. The payment processing for the green electricity is carried out via the platform

may not consume all the energy they generate. This surplus energy can then be sold and redistributed to other households in the region via the platform. In return, customers that want to purchase regionally generated, green electricity will be able to do so via the platform. The electricity price is to be based on supply and demand, as on the stock exchange. Figure 1 illustrates the simplified concept. It is worth mentioning that numerous other business models can be coupled to the basic business model. For instance, excess electricity could be temporarily stored in electric cars (see Ensinger et al. (2021)).

3.2 Data

Smart meters were installed in households participating in the BEW pilot project. The meters measure the amount of electricity fed into the public grid (supply) and the amount drawn by each household (demand). The data is recorded at 15-min intervals and is being collected anonymously in a database that is available to the project. Meteorological data is also collected in the database. Similar to the electricity data, this data is recorded every 15 min and can therefore be assigned to the corresponding time frame. A geographical assignment is also possible. This is due to the location of the weather station and the location of the household. All data originates from southern Germany, the place for which the business model was designed. In addition, data on installed performance, tilt angle, and cardinal direction are available for each photovoltaic system.

4 Results

4.1 Supply and Demand Forecast

The first scenario of an AI application within the platform is forecasting the amount of electricity that is supplied to the grid. The AI learns from historical weather data in combination with past smart meter data and data about the installed solar panels (see Fig. 2). This process is called training and takes place before the AI can be applied. When applied, the AI uses the (most recent) input data to predict the amount of electricity that will be fed into the grid. The demand forecast forms the counterpart to the supply forecast and predicts the electricity that will be taken from the grid.

The forecast results are visualized in an interactive dashboard which can be filtered and adjusted by the platform customer. By subtracting the predicted supply and demand, expected excess and shortfall quantities can be calculated. Intelligent forecasting enables surpluses and shortfalls to be detected at an early stage. As a result, the necessary measures for the management of excess and shortfall quantities can be initiated, enabling a reliable supply of green electricity to the customer. In addition, the customer receives an overview of all forecast values, which can be dynamically adapted to the customer's needs and provides transparency.

The prediction of future events, like the supply and demand of electricity for the next day, falls under time series forecasting. AI for time series forecasting can be divided into different forecasting horizons. Very short-term, short-term, medium-term, long-term, intra-hour, intra-day, and day-ahead. The most suitable horizon depends on the further application of the results (Ahmed et al., 2020). The time series forecasting techniques, range from statistical models like ARIMA (Box & Pierce,

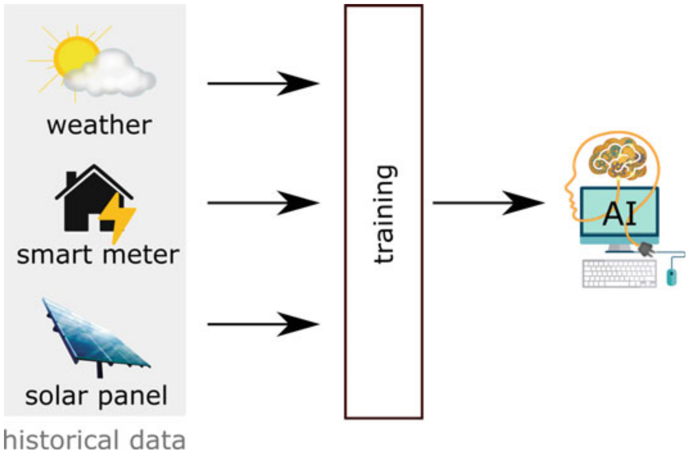

Fig. 2 Historical data provide the training basis for the forecast-AI

1970) to deep learning using artificial neural networks like LSTMs (Long short-term memory) (Hochreiter & Schmidhuber, 1997), CNNs (Convolutional Neural Network) (LeCun et al., 1999) and Transformer (Vaswani et al., 2017).

4.2 Chatbot Assistance

Another possible AI application on the platform is a chatbot. The AI analyzes and categorizes the request from the customer before comparing it with a database that contains different scenarios. In case there is a match, the chatbot provides the requested information. If the AI is unable to answer the query, the customer is forwarded to the personal customer service. The chatbot is visualized as an icon that is positioned in the bottom right corner of the platform. Clicking on the icon opens a chat window where the customer can start a conversation. While the AI is processing requests in the background, the customer sees an animation of three dots which gives him the feeling of communicating with a human being. Possible topics covered by the chatbot are questions regarding electricity generation and consumption or information regarding the tariff, such as the monthly invoicing. One advantage of using a chatbot is that customer inquiries are answered automatically and quickly, even if the volume of requests increases. Additionally, a lower commitment of personnel capacities in customer services is needed, which leads to cost efficiency. The customer benefits from the 24/7 service of the chatbot and is independent of customer service availability. Additionally, they do not have to search for answers on the platform. Since the response time of the chatbot is relatively short, it results in time savings for the customer.

4.3 Further Applications

Another possibility of AI on the platform is in the area of energy data management. The data from the energy management system is evaluated and analyzed to derive patterns and consumption profiles. This allows deviations and malfunctions to be detected at an early stage, for instance, by initiating an alarm. Anomalies, such as energy-theft, can also be detected by recognizing patterns and identifying deviations (Guido et al., 2019). In addition, individual recommendations for action to optimize the customer's electricity consumption can be created as part of an energy consultation. Based on the forecasted energy surpluses or shortages, an AI could give concrete suggestions to the customer for action on how the upcoming hours could be used in an energy-optimal way. For instance, it is conceivable that the AI will recommend starting the washing machine and the dryer for periods when more electricity is generated than consumed. If the customer owns an electric car, the AI could give the recommendation to charge it during that time. In addition, the AI could also take action, i.e., start the charging process of an electric car. Situations occur during which the prosumer is unable to power themselves. During such a power shortage, the AI could shut down unnecessary electric devices. In doing so, more flexibility is introduced to renewable energies.

5 Discussion

5.1 Industrial Implications

AI is on the rise. This also applies to the energy sector. Since a large amount of data is necessary for the successful implementation of AI applications, the term Big Data is becoming increasingly important. A suitable infrastructure including servers and databases for collecting and processing the data as well as corresponding specialized personnel, such as data managers or programmers, go hand in hand with this. Collecting and storing large amounts of data also increases vulnerability for cyber-attacks, making the strengthening of competencies in the area of IT security and qualified professionals indispensable. But also new technologies pose potential security risks. It is undeniable that technologies such as AI and the smart grid come with immense benefits, but the security aspect must be kept in mind and data security must be ensured at all times. Continuing education and innovation are of particular importance as the energy sector is undergoing change. As digitization advances, an ever-increasing number of people and thus customers are becoming digitally literate. This paves the way for the use of new technologies. Assistance systems, such as chatbots, will no longer be a special feature in the future, but will even be expected by customers.

5.2 Academic Implications

Interdisciplinary training of research staff in the energy sector will become increasingly important in the future. Skills in the area of computer science or business model development are already a great advantage in today's world. They will become even more so with the advance of AI. Unfortunately, it is often the case that AI only takes place in research, and no real-world applications are produced. The potential is there, but it is not sufficiently exploited. Applicable AI that can be transferred to the industry beyond research should be the primary focus. Therefore, interdisciplinary exchange and projects need to be encouraged.

6 Conclusions and Recommendation

Possible applications of AI in a renewable energy platform were shown. The changing consumption patterns, which have arisen as a consequence of the COVID-19 pandemic, could be detected by AI. Thus, making them easier to deal with. It was also shown how AI can increase the much-needed flexibility of renewable energy. AI-controlled services can enable households to optimize their electricity consumption. The consumed electricity is ideally produced by regional and renewable sources like solar energy. Moreover, applications such as chatbots can improve the customer experience and lead to cost savings. However, the success of an AI depends heavily on the underlying data. Among the most important things to keep in mind is that the right data in sufficient quantity is essential for the development of a successful AI. The energy sector is in a state of transformation, and new technologies and digitalization are creating further change. As a consequence, the rethinking of new business models that can replace old ones is key.

References

Ahmed, R., Sreeram, V., Mishra, Y., & Arif, M. (2020). A review and evaluation of the state-of-the-art in pv solar power forecasting: Techniques and optimization. *Renewable and Sustainable Energy Reviews,124*, 109792.

Box, G. E. P., & Pierce, D. A. (1970). Distribution of residual autocorrelations in autoregressive-integrated moving average time series models. *Journal of the American Statistical Association, 65*(332), 1509–1526.

Bozem, K., & Nagl, A. (2022). *Successfully realizing digital business models* (in German). Springer Fachmedien Wiesbaden GmbH, Ch. 2.

Buergerenergiewende: Innovative business models for citizen energy cooperatives (in German) (2021) [Online]. www.hs-aalen.de/buergerenergiewende

Elgendy, N., & Elragal, A. (2014). *Big data analytics: A literature review paper* (pp. 1–14).

Ensinger, A., Kern, D., Nagl, A., Bozem, K., Weber, H.-P., Hoh, A., Harrison, D. K., & Wood, B. M. (2021). Citizens' energy cooperatives: Key drivers of the energy transition in baden-wuerttemberg. *Renewable Energy Grid Integration Week.*

Ensinger, A., Salzer, M.-R., Bozem, K., Nagl, A., Rath, V., Harrison, D. K., & Wood, B. M. (2021). The energy company as a smart electricity supplier and service provider. In: *Spring Servitization Conference Proceedings*

Guido, Z., Wolf, S., Korzynietz, R., Gaaß, M., Kraus, T., Seifert, I., Bürger, M., & Zinke, G. (2019, May). Application of artificial intelligence in the energy sector (in german). Begleitforschung Smart Service Welt II Institut Innovation u. Technik VDI/VDE Innovation + Technik GmbH (Hrsg.).

Hochreiter, S., & Schmidhuber, J. (1997, 11). Long short-term memory. *Neural Computation, 9*(8), 1735–1780 [Online]. https://doi.org/10.1162/neco.1997.9.8.1735

LeCun, Y., Haffner, P., Bottou, L., & Bengio, Y. (1999). Object recognition with gradient-based learning. In D. Forsyth (Ed.), *Feature grouping*. Springer.

Shahzad, K., & Imran, F. (2021). Surviving the covid-19 pandemic: The role of digital innovation and transformation. In J. Kalra, N. J. Lightner, & R. Taiar (Eds.), *Advances in human factors and ergonomics in healthcare and medical devices* (pp. 708–715). Springer International Publishing.

Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., Kaiser, L., & Polosukhin, I. (2017). Attention is all you need. In *Proceedings of the 31st International Conference on Neural Information Processing Systems*, ser. NIPS'17 (pp. 6000–6010). Curran Associates Inc., Red Hook, NY, USA.

Witell, L. (2021). *Business models for digital service infusion using AI and big data* (pp. 103–115). Springer International Publishing.

Xu, Y., Ahokangas, P., Louis, J.-N., & Pongrácz, E. (2019). Electricity market empowered by artificial intelligence: A platform approach. *Energies, 12*(21).

Zheng, Y., Yu, H., Shi, Y., Zhang, K., Zhen, S., Cui, L., Leung, C., & Miao, C. (2020, April). Pids: An intelligent electric power management platform. In *Proceedings AAAI Conference on Artificial Intelligence* (Vol. 34, No. 08, pp. 13 220–13 227).

Zhong, H., Tan, Z., He, Y., Xie, L., & Kang, C. (2020). Implications of covid-19 for the electricity industry: A comprehensive review. *CSEE Journal of Power and Energy Systems, 6*(3), 489–495.

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The Change from Small and Medium-Sized Energy Com-Panies to an Energy Service Provider of Smart Value-Added Services

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Abstract During the Covid 19 pandemic, it became apparent how little digital developments such as digital customer communication or the trend towards working from home are used in the energy industry. Particularly small and medium-sized energy companies did not have the digital options to implement digital trends at the beginning of the COVID 19 pandemic. For them, this externally imposed change resulted in an acceleration of digitization. Due to this development, there is now an increasing possibility of introducing innovative business models intended to offer customers added value. For this purpose, in addition to an extensive literature search, a hypothesis-based survey of all small and medium-sized energy companies (full survey) in Germany was carried out in 2021. The aim of this empirical survey was to show the current situation and options for action of the energy companies for the introduction of innovative business models and thus to clarify the question: What necessary prerequisites still have to be created in order to introduce innovative business models?

Keywords Small and medium-sized energy companies · Survey · Innovative business models · Digitization

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1 Introduction

The basis for digital innovations in the energy industry is primarily data that can be obtained from intelligent measuring systems. The lack of widespread use of intelligent measuring systems and the added value that has so far hardly existed for customers are hindering the introduction of digital innovations. The Federal Office for Information Security (BSI) issued the market declaration in accordance with §30 Messstellenbetriebsgesetz (Hellmuth & Jakobs, 2020) at the beginning of 2020, thereby giving the go-ahead for the mandatory rollout of intelligent metering systems. This means that more and more intelligent metering systems will have to be rolled out in the future, but most of the rollout has not yet taken place. Most small and medium-sized energy companies saw the introduction of intelligent metering systems as a necessary evil for a long time and ignored the added value these metering systems can offer. On the one hand, the possibilities that these systems offer with regard to innovative business models were misunderstood (Zeller, 2015), on the other hand, the existing IT infrastructure often did not allow innovative business models at all.

The decision for far-reaching restrictions on public life by the government due to the COVID 19 pandemic in mid-March 2020 has led to massive changes in the way small and medium-sized energy companies work. Numerous processes had to be "forcibly digitized" in a short time and customer centers were closed to the public. This meant that communication and data exchange with customers had to be almost exclusively electronic with no possibility of communicating with customers. At this time, many energy companies relocated their jobs to the "home office" for the first time. Meetings were held digitally via online services, and the IT infrastructure was expanded accordingly. Another special feature of the small and medium-sized energy companies fell victim to the COVID 19 pandemic at the end of 2020: the annual consumption readings, which for historical reasons were carried out entirely or partially by readers at many small and medium-sized energy companies, had to be digitized.

The extent to which progress in digitization has changed the digital understanding of small and medium-sized energy companies and has led to a rethinking of the introduction of innovative modern business models and the innovation of existing ones was determined in an empirical survey of small and regional energy companies, which was carried out from 10th August 2021 to 25th August 2021 queried. The main questions of this survey concerned the ownership structure of the energy companies and the extent to which they influence the willingness and strength to innovate, the existing business models, the openness and interest in innovative business models as well as the IT-technical possibilities.

2 State of the Art

Trends such as digitization, big data, AI but also the increasing number of interesting business models such as digital electricity trading platforms or tariffs from innovative providers are becoming more and more important for energy companies (Doleski, 2019). However, despite this development, the majority of small and medium-sized energy companies are not in a digital spirit of optimism. Price pressure is increasing through energy discounters, while innovative providers such as the start-up Tibber Germany or Octopus Strom are stepping up the pressure through their innovative business models (Bozem & Nagl, 2021). The business model of Tibber Germany exists in the form of a variable electricity tariff in conjunction with an intelligent metering system. Tibber's variable electricity tariff is based on market prices that reflect the relationship between electricity supply and demand at a specific point in time. In times of electricity scarcity, the electricity price can be multiple times higher than the average price, while in times of low load the customer benefits from low prices. The customer only pays the purchase price of the electrical energy plus a monthly basic amount. However, if a customer wants to use the advantages of this tariff model, they are dependent on a controllable, flexible consumption infrastructure. Tibber offers value-added services around the topic of electricity in order to cover operating costs and generate profits (Bozem & Nagl, 2021). In this way, a significantly higher customer loyalty can be achieved than would be possible with the pure power supply.

Innovative platform-based business models are becoming increasingly important in the energy industry. Here, too, some companies such as Kisters, Lumenaza or Talmarkt offer their first platform solutions. This development threatens the existing business model, especially of small and medium-sized energy companies. The absolute majority of the added value is still generated by the commodity product electricity, but in an increasingly tough market environment. Currently, the network area of many small and medium-sized energy companies is in a phase of digital change, which is also promoted by legal requirements such as the mandatory rollout of digital intelligent measuring systems (Zeller, 2015) or the measures of Redispach 2.0. As a result of the COVID 19 pandemic, the advantages of digital communication and those of smart meters, which were previously unattractive due to the costs, became apparent. When it comes to sales innovations, however, there is still too little courage and the costs of smart meters keep people from developing and implementing innovative business models.

The Bundesverband der Energie- und Wasserwirtschaft e. V. (BDEW) and the consulting firm Ernst & Young write in their public utility study "Habitual Paths Leaving" "*Public utilities have fundamentally recognized that innovations are necessary and that solutions to increase the ability to innovate must be found. Due to the diverse challenges in day-to-day business and the return requirements of the shareholders, however, there is a lack of time, money, human resources and, in some cases, the willingness to take risks to break new ground*" (BDEW & Ernst Young, 2015). As an example for further literature research, the book "Successfully Realizing Digital

Business Models" by Bozem & Nagl should be mentioned. They describe the problematic situation of small and medium-sized energy companies as well as the necessary need for innovation in business models, which is not least caused by the growing competition from startups or platform providers (Bozem & Nagl, 2021). In order to analyze the current situation and to identify options for action for energy companies to introduce innovative business models, the author of this paper carried out a hypothesis-based empirical survey as part of the research project "Citizen Energy Turnaround". The aim of falsifying the following hypotheses is to draw conclusions about the willingness to change and the possibilities of small and medium-sized energy companies (Grunwald & Hempelmann, 2012; Bortz & Schuster, 2011).

Hypothesis I:

Most of the small and medium-sized energy companies are in municipal hands. (Bauer et al., 2019; Bruckner, 2017).

Hypothesis II:

The additional municipal tasks inhibit the willingness of small and medium-sized energy companies to innovate. (Bruckner, 2017).

Hypothesis III:

Existing business models of small and medium-sized energy companies have not yet been innovated. (Löbbe & Hackbarth, 2017).

Hypothesis IV:

Small and medium-sized energy companies are aware of the lack of innovative business models, but measures to introduce such are only hesitantly implemented. (BDEW & Ernst Young, 2015).

Hypothesis V:

The small and medium-sized energy companies are aware of the fact that business models are changing and that the business model of pure electricity delivery as a commodity product is currently in a phase of change. (Krickel, 2015).

Hypothesis Vl:

The degree of digitization in small and medium-sized companies is low. (Roth, 2018).

3 Methodologie

3.1 Empirical Research

To test these hypotheses (Bortz & Schuster, 2011), a questionnaire with 31 questions was developed. In order to increase the willingness to answer the questions, easy-to-answer structural data was chosen as the first question. Questions regarding the digitization of small and medium-sized energy companies were asked at the end of the questionnaire (Grunwald & Hempelmann, 2012). The scope of the survey was chosen in such a way that answering the questionnaire in 15–20 min would be realistic. In addition, the questions were chosen in such a way that they could be answered without extensive research. In many cases, a significantly higher expenditure of time for the respondents leads to the termination of the survey (Batinic et al., 1999). Before the survey was sent, a pretest with ten randomly selected companies was carried out. Seven of them gave critical feedback, which was incorporated into the final version of the questionnaire (Beywl & Schepp-Winter, 2000). The survey was carried out online.

3.2 Selection of the Sample

The aim of the empirical survey are small and medium-sized energy companies in Germany, which are in a "simplified regulatory procedure". According to the Anreizregulierungsverordnung (ARegV) §24 Sect. 2, the “simplified regulatory procedure” is only available to energy companies with fewer than 30,000 subscribers.

In August 2021, 897 energy companies in Germany operated an electricity supply network. Of these, 749 were in the simplified procedure to which this survey relates. Against this background, a full survey within the scope of this research project was recommended (Grunwald & Hempelmann, 2012).

4 Results

Of the 749 small and medium-sized energy companies contacted, 87 took part in the survey, which corresponds to a response rate of 11.6%. The evaluation of the survey shows that 78% of the small and medium-sized energy companies surveyed are wholly or partly in municipal hands. This result supports Hypothesis I, which is interesting insofar as municipal energy companies usually have to cover activities of public services of general interest. These additional tasks mean that fewer resources (in terms of personnel and money) are available for developing innovative business models. This assumption of Hypothesis II is supported by the result of the question “What other fields of activity does your energy company serve besides the area of ‘electricity’?” 40% of the energy companies look after public swimming pools, 67% public charging infrastructure. While the charging infrastructure is part of the business model for 62% of the energy companies, other business models not directly related to the energy supply, distribution and generation are hardly used. This result underpins the statement from Hypothesis III.

The following questions dealt with the core statement of Hypotheses IV and V. Especially for small and medium-sized energy companies, the introduction of new innovative business models or the innovation of existing ones will only be possible with the involvement of other market participants, this assessment was also shared by the vast majority of participating energy companies. In response to the question “Which market participants, cooperation and services do you think must be included in a sustainable business model?”, almost all market participants gave a high level of agreement. A surprising result was the question of the need for change in the existing business models, which is shown in the following Fig. 1 necessary adjustments to the business model.

Knowing need for change is an essential prerequisite for the innovation of the business models. As a result, a high need for digitization and the need for new products and services were indicated, a cooperation with citizens’ energy cooperatives was being considered for the existing business models was not expected in these highs. 64% of the responding energy companies agreed at least in part. The acceptance of the stakeholders in relation to digital value-added services is assessed as very positive or positive by 65%, especially for new products and services. Apart from the consideration of the merger with other energy companies, which was seen as negative by 67%, there seem to be no taboos here. However, with regard to the necessary innovation of the business models or the introduction of new business models, a higher level of approval could have been expected. The extent to which

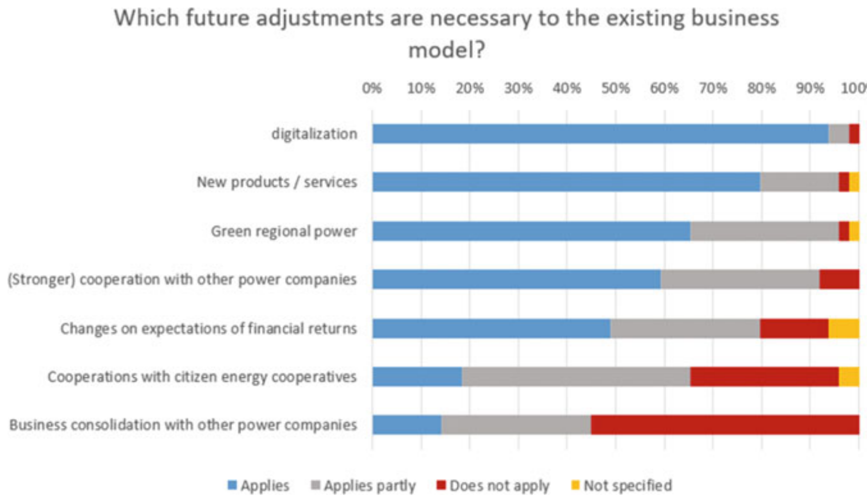

Fig. 1 Necessary adjustments to the business model

small and medium-sized energy companies deal with the necessary digitization of the company, which Hypothesis VI describes, was examined in the following questions. The evaluation of the question "Are innovative products/services such as platform-based business models planned?" showed that only 37% of small and medium-sized energy companies are planning to introduce new innovative products and services such as the platform-based business model. When asked "Does the company already have solutions for innovative, e.g. platform-based business models?", it turned out that almost none of the respondents had these business models, particularly with regard to innovative digital business models such as platform-based business models, load-variable tariffs, smart home, etc. Only already established business models such as Power to Heat or § 14a EnWG applications are used sporadically. More than half of the energy companies surveyed, i.e. 56%, see the current business model of pure electricity supply in jeopardy, whereas 52% also deal with competition from innovative providers/start-ups. The greatest danger, however is seen in digital offers/solutions, in classic bonus systems and consumer portals, but also in innovative providers and legal requirements.

In the following block, the question of whether the energy company is aware of the need to expand the IT area was asked. Only 62% of the responding companies have their own IT staff in-house, with 50% of the responding companies requiring the support of external IT staff. 47% of the responding companies expect investment increases of up to 20% in IT within the next five years, while 24% are planning an increase of 20–30% and 20% by more than 30%.

5 Discussion

This survey dealt with the perspective of small and medium-sized energy companies with regard to the introduction of digital innovations. The needs of other stakeholders that must be taken into account as part of the business model innovation, e.g., those of the citizens' energy cooperatives, were not considered. The initial question was to what extent the digitization of energy companies, accelerated by the COVID 19 pandemic, has led to an awareness of the need for innovative business models or the innovation of existing ones. To this end, hypotheses were formed falsified through the empirical survey.

Hypotheses I and II, which deal with the ownership structure and the fields of activity of small and medium-sized energy companies, have been confirmed. The majority is in municipal hands and entrusted with public services, which ties up resources and inhibits innovation. The literature research also revealed that municipal energy companies have to cross-finance deficit tasks of public services with the revenues from energy supply, which reduces the ability to invest in new, innovative business models. Hypothesis III describes the currently prevailing business model. Here, the survey showed that the majority of small and medium-sized energy companies serve the classic business areas of network operation and energy supply. Due to the increasing competitive pressure from energy discounters and innovative competitors, the number of customers is falling continuously. This development, which is mentioned in Hypothesis IV, and the associated threat are also perceived by the majority of small and medium-sized energy companies. Hypothesis V describes the status-quo of the business models, which have essentially been used without modification for several decades. Although the trend towards innovative business models is well known, only very few small and medium-sized energy companies offer innovative business models. The greatest need for change is seen in the need for digitization. The acceptance of stakeholders is assessed as positive. 65% rate them as high for new products and services. Hypothesis VI describes a tendency towards a lower degree of digitization in small and medium-sized energy companies. This is a statement that is confirmed by the results of the survey, which is why 44% of small and medium-sized energy companies are planning an investment increase of >20% in the IT sector within the next 5 years.

6 Conclusion

The COVID 19 pandemic has forced small and medium-sized energy companies to introduce a digitization strategy for business operations. Existing processes, e.g., in the area of customer communication, consumption readings but also the general organization had to be adapted to the new situation and digitized. Furthermore developments that have been postponed for a long time now seem possible, the existing business models can now be innovated or replaced by new business models. For 78% of small and medium-sized energy companies with a municipal background, the challenge lies not only in introducing new business models, but also in making resources available for the activities of municipal services of general interest. The small and medium-sized energy companies are well aware that the key to innovative business models lies in digitization and that cooperation with other market participants will be necessary for this. The survey also showed that progress has been made in the area of IT infrastructure as a result of the COVID 19 pandemic, but there is still an urgent need for action here. Clear recommendations that canbe made to small and medium-sized energy companies are the structure of the IT infrastructure and innovative business. If this is not possible due to the size or the main focus of local activities, cooperation can be a possible solution, whereas sticking to the previous business model as the sole means of safeguarding livelihoods would be fatal.

References

Batinic, B., Werner, A., Gräf, L., & Bandilla, W. (1999). Online research: Methoden, Anwendungen und Ergebnisse. Goettingen: Hogrefe.

Bauer, W., Stowasser, S., Mütze-Niewöhner, S., Zanker, C., & Brandl, K. H. (2019). Arbeit in der digitalisierten Welt. Stand der Forschung und Anwendung im BMBF-Förderschwerpunkt. Stuttgart: Fraunhofer IAO.

BDEW, Ernst & Young. (2015). Gewohnte Wege verlassen, Innovation in der Energiewirtschaft, Stadtwerkestudie Juni 2015. Retreived November 13, 2021, form, https://www.bdew.de/internet.nsf/id/20150819-pi-neue-stadtwerkestudie-von-ey-und-bdew-de/file/stadtwerkestudie_2015.pdf.

Beywl, W., & Schepp-Winter, E. (2000). Zielgeführte Evaluation von Programmen: ein Leitfaden. Materialien zur Qualitätssicherung in der Kinder- und Jugendhilfe. Bundesministerium für Familie, Senioren, Frauen und Jugend. Heft Qs 29/9, 56.

Bortz, J., & Schuster, C. (2011). Statistik für Human- und Sozialwissenschaftler. Wiesbaden: Springer.

Bozem, K., & Nagl, A. (2021). Digitale Geschäftsmodelle erfolgreich realisieren. Wiesbaden: Springer.

Bruckner, T. (2017). Kommunale Energieversorger: Gewinner oder Verlierer der Energiewende? Friedrich-Ebert-Stiftung.

Doleski, O. D.: Realisierung Utility 4.0 Band 1: Praxis der digitalen Energiewirtschaft von den Grundlagen bis zur Verteilung im Smart Grid. Springer, Wiesbaden (2019).

Grunwald, G., & Hempelmann, B. (2012). Angewandte Marktforschung: eine praxisorientierte Einführung. München: Oldenbourg Wissenschaftsverlag.

Hellmuth, N., & Jakobs, E. M. (2020). Informiertheit und Datenschutz beim Smart Metering. *Zeitschrift Für Energiewirtsch, 44*, 15–29.

Krickel, F. (2015). Digitalisierung in der Energiewirtschaft. In Zukunftsorientierte Unternehmenssteuerung in der Energiewirtschaft. Wiesbaden: Springer.

Löbbe, S., & Hackbarth, A. (2017). Geschäftsmodelle in der Energiewirtschaft: Ein Kompendium von der Methodik bis zur Anwendung. Reutlinger Diskussionsbeiträge zu Marketing & Management.

Porst, R. (2014). *Fragebogen.* Springer.

Roth, I. (2018). Digitalisierung in der Energiewirtschaft: Technologische Trends und ihre Auswirkungen auf Arbeit und Qualifizierung. In Working Paper Forschungsförderung.

Zeller, M. (2015). Analyse und Simulation von Geschäftsmodellen für Elektrizitätsvertriebsunternehmen: Untersuchungen für die Implementierung von Smart Metern. Berlin: Universitätsverlag TU Berlin.

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Smart Circular Economy Value Drivers: The Role of the Financial Sector in Stimulating Smart Regional Innovation-Driven Growth

Bojana Suzic, Sabrina Urban, Michael Hellwig, and Martin Dobler

Abstract Smart services disrupt business models and have the potential to stimulate the circular economy transition of regions, enabling an environmentally friendly atmosphere for sustainable and innovation-driven growth of regions. Although smart services are powerful means for deploying circular economy goals in industrial practices, there is little systematic guidance on how the adoption of smart services could improve resource efficiency and stimulate smart regional innovation-driven growth, enabled through circular design. Implemented in the scope of Vorarlberg's smart specialization strategy, this paper contributes to the literature on the circular economy and regional innovation-driven growth by assessing critical factors of the value creation and value capture implemented within the scope of the quadruple helix system. By identifying the main challenges and opportunities of collaborative value creation and value capture in setting-up smart circular economy strategies and by assessing the role of innovation actors within the quadruple helix innovation system, the study provides recommendations and set of guidelines for managers and public authorities in managing circular transition. Finally, based on the analysis of the role of actors in creating shared value and scaling-up smart circular economy practices in the quadruple helix innovation systems, the paper investigates the role of banks as enablers of circular economy innovation-driven regional growth and smart value creation.

Keywords Smart systems · Circular economy · Value co-creation · Collaborative models · Quadruple helix · Business model innovation · Dynamic systems

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1 Introduction

The circular economy is a source of innovative and advanced forms of value creation, allowing more efficient industrial transformation by creating new business and cost-saving opportunities. Simultaneously, circular economy enables organizations to address environmental, social, and governance (ESG) concerns and stimulate regional innovation-driven growth, leveraging smart service models that highlight collaborative synergic actions among regional actors (Halstenberg et al., 2019). The ESG dimensions developed to assess corporate sustainability factors, and circular transition can be enabled by IT and smart services. Vargo and Lusch identify a smart service system as a set of actors who interact, collaborate, and depend on each other in the process of value co-creation (Vargo & Lusch, 2008). In the context of system dynamics, these actors can reshape the ecosystem by creating shared value. This process can increase and redefine not only productivity within the value chain in individual actor-scheme, but also strengthens local clusters, and at the same time creates a community impact and promotes ecosystem innovation. Implemented within the scope of the quadruple helix model of innovation, this study examines collaborative value drivers in smart circular economy strategies in Vorarlberg (Austria). The paper analyses interaction models among regional actors and highlights the role of banks in stimulating smart regional innovation-driven growth based on circular economy and ecosystem services. Outlining challenges and opportunities associated with ecosystems services and smart circular economy transition, we propose the system dynamics model for smart circular transition contributing to the literature by providing a set of recommendations and guidelines for industry, academia, and governments in managing collaborative innovation models aimed at smart circular transition.

2 Theoretical Background

2.1 System Dynamics and Circular Economy Transition

Economic prosperity and environmental quality are defined as the main goals of circular economy in the literature, but its link to sustainable development is barely mentioned (Kirchherr et al., 2017b). A circular economy contributes to the sustainable development by emphasizing high value and high-quality material cycles, and by setting in motion the sharing economy which—adding up to the production-consumption culture (Korhonen et al., 2018). Designing shared value in such systems refers to strategies that lead to improvement of a company's competitiveness and concurrent facilitation of the welfare of the society (Porter & Kramer, 2011). By tackling social problems that incur additional costs and negatively impact productivity, companies can reach unserved market opportunities and innovate busines models more efficiently, designed on the base of innovative forms of value co-creation (Pfitzer et al., 2013).

Through dematerialization, an extension of product lifetime, and increase in efficiency by means of digitization, smart services can efficiently stimulate and enable the circular economy transition. However, the transition towards the smart circular economy means managing diverse barriers—financial, structural, operational, technological, and attitudinal (Kirchherr et al., 2017a). Also, the role of actors participating in value co-creation in such complex, open, and dynamic systems is particularly challenging, and it is needed to increase understanding of the principles and intricacies of the system (Cibat et al., 2017).

2.2 Role of Actors in Smart Circular Economy Transition

Quadruple Helix Innovation models

The quadruple helix concept of innovation systems requires mutual agreement and consensus space among industry, academia, governments, and citizens with the goal to bring together their competencies and co-create value based on a common goal and shared value, to achieve enhanced economic and social development on the systemic scale (Carayannis & Campbell, 2012). Knowledge production and communication among regional stakeholders continuously reshape innovation systems, clustering around strengths of individual regions, mirrored in smart specialization strategies (RIS3) (Foray, 2016). When enabling smart circular-oriented innovation, it is required to reconcile different aspects of CE emphasized by each group of regional actors (Petteri et al., 2015).

The potential impact each regional actor group leaves in the shared value creation process can be measured against the motives and mutual trust (Ranga & Etzkowitz, 2013). While academia may exhibit adaptability to the context of value co-creation, industry members are more heterogenous with the potential to access the process from divergent entry points and can be very selective in what is further extended in the policy-making process. Contrarily, governments usually frame the context in line with the general societal welfare, sometimes easily merging with the academic setting. However, managing societal welfare is majorly determined by how efficiently industry players permeate policy-making processes (Persson & Tabellini, 2002; Rosanvallon, 2011).

Role of the financial sector in smart circular economy transition

Financial companies are investing more money in companies committed to protecting the environment and implementing green innovation projects. Majorly, regulators encourage banks to provide green credit services for corporate financing through the securities market (Yaoteng & Xin, 2021). In Austria, the Green Finance Agenda was initiated in 2019, with the aim to support green financing and aid the Austrian financial market contributing to achieve climate targets by 2030. To reach this goal, at least 17 billion euros in green investments must be made annually, requiring that not only public but also private funds must be used. That is why the Austrian financial sector is an important lever for climate protection (Green Finance). In Austria, financial institutions offer various sustainable products such as green funds, green shares, green loans, green leasing, green crowdfunding, green savings, and checking products—exhibiting a significant financial sector's potential to enable the circular transition.

In 2013, a collaboration of ten companies and banks in Vorarlberg (Austria) founded the Climate Neutrality Alliance 2025 intending to contribute to all 17 Sustainable Development Goals defined by the United Nations with self-implemented climate protection projects (Klima Neutralitaets Buendnis, 2025). Until today the alliance grew to a network of 195 participants, of which around 100 are residents in Vorarlberg, committing to achieve climate neutrality by 2025 and thus support the state of Vorarlberg on its way to energy autonomy. Indented actions involve five main steps: Measurement, Reduction, Compensation, Certification and Communication. In assessing CE and ESG criteria, a challenge arises regarding lending decisions. Innovative companies are often very risk-intensive because many of the ideas and innovations fail due to high spending on salaries and the uncertainties regarding the investment outcomes. Banks must therefore also revise their risk analyses to obtain all relevant information from companies to minimize the risk of loan default (Korhonen et al., 2018).

3 Research Methodology

The paper deploys a qualitative research method—focus group and discourse analysis methodology. By affiliating already existing studies, authors identify circular economy in the context of the financial sector, and within the scope of quadruple helix innovation system. Focus group analysis served as a method for the data collection and discussion on the major thematic fields, constituting the broad range of actors from industrial setting, reginal authorities, academia, and citizens—quadruple helix innovation model. With this in line, authors present current smart circular economy practices implemented in Vorarlberg and its association to the sustainable financing. We propose a quadruple helix framework for smart circular oriented innovation, making the case that the regional-innovation driven growth is a system dynamics issue and further propose recommendations to guide governments, academia, industry, citizens and inform broader discussions on how to integrate smart circular economy strategy into decision-making processes and business models (Fig. 1).

In addition, by studying the role of financial sector banking as an enabler of smart circular economy models, we identify the main barriers to smart circular economy transition in the quadruple helix innovation system. Further, we identify a consensus space in the context of shared value potential and provide a set of recommendations and guidelines to industry, financial, and government representatives in managing

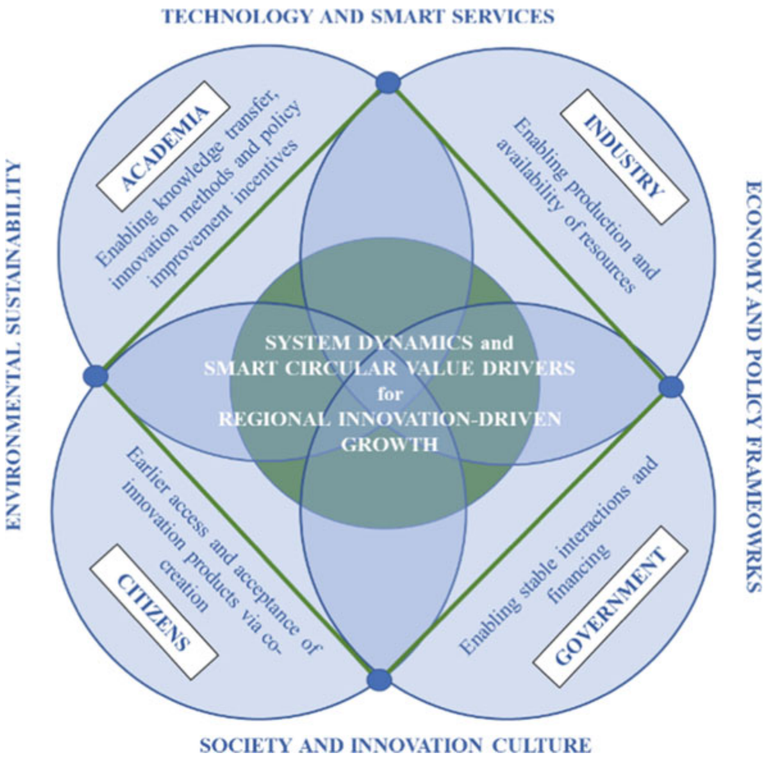

Fig. 1 Quadruple helix model of circular oriented innovation (authors' elaboration)

smart circular economy transition—in the scope of the quadruple helix collaborative value creation.

4 Discussion and Recommendations

This research examines smart circular economy value drivers and regional actors' collaborative value co-creation contribution to the transition towards a circular economy. Following the service-dominant logic perspective and highlighting the role of the financial sector in managing the transition, the study suggests that banks may take an important role in stimulating circular growth by facilitating shared value creation among regional stakeholders and increasing trust among them. Also, creation of a more efficient knowledge transfer in collaborative value creation by managing barriers, motives, and interest of regional actors to deploy circular thinking is another task to perform. Within the figure below, we provide an overview of the smart circular quadruple helix innovation model, outlining the main barriers in collaborative value co-creation driving the smart circular economy transition in Vorarlberg (Fig. 2).

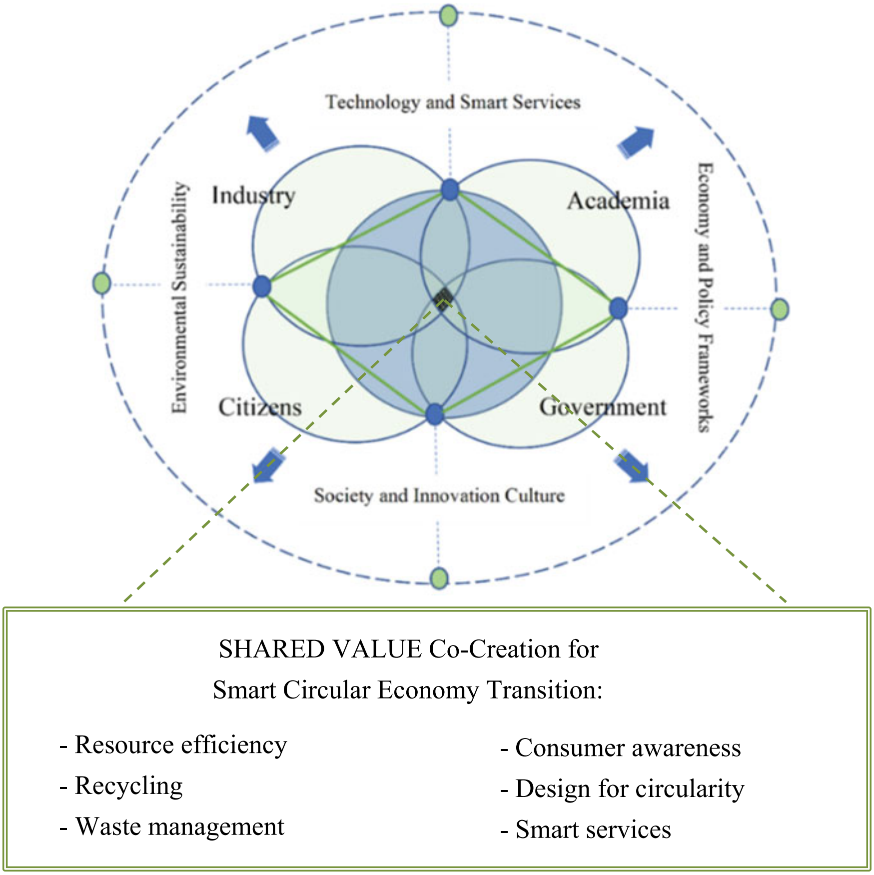

Fig. 2 System dynamics and smart circular quadruple helix innovation model

The quadruple helix model of innovation implemented within the scope of the framework represented by Fig. 2 indicates that Vorarlberg's main circular collaborative value drivers are resource efficiency, recycling, waste management, consumer awareness, and circular design. The financial sector may boost more efficient use of resources by the industrial sector and minimize carbon emission, waste disposals and carbon emissions through the internal changes and transformation towards more circular oriented lending decisions. Although the industrial sector in Vorarlberg lacks the availability of circularity metrics, which could decrease risks the banking sector carries in financing circular projects, managing knowledge transfer and developing stronger relationship among players through circular quadruple helix innovation networks could aid in bridging circularity gaps. Such networks could promote more efficient cross-sectoral collaboration and increase trust among actors in the long term. With this in line, the internal organizational culture is a leading barrier in bridging the circularity gap by the financial sector in Vorarlberg—still favoring linear models. In addition, the awareness on collaborative modeling and wilingness of banks to collaborate in the value chain is another governing challenge. Similar is observed within other dominant industrial sectors, still lacking defined circularity metrics that blocks the transition process on both sides. Sectoral collaboration can also play a dominant role in the transition towards the smart circular economy and regional innovation-driven growth. However, facilitating the process depends on who takes the role of the process facilitator—financial sector, industrial players from other dominant sectors, governments, or academia.

Applied framework in the context of the Vorarlberg region, represented by Fig. 2, outlines the dominant role of the governmental sector in circular transition. However, governmental regulations promote circular economy only indirectly—mainly through climate and energy policy frameworks. Based on the study results, we provide a set of barriers identified in the scope of quadruple helix innovation modeling for circular economy and each group of regional innovation ecosystem actors:

– Industry: Know-how and incentives for repair and reuse; technology gaps and digitization infrastructure; lack of enablers of cross-cycle and cross-sector performance; skills and investment of circular design.
– Financial sector: Non-standardized CE metrics; non-standardized ESG evaluation; lack of cross-sectoral frameworks for monitoring circular best practices; internal organizational culture which is mainly linear.
– Academia: Availability of the data; closed business models and the reluctance of industrial players to share data; time, space, and funding constraints in implementing circular projects, as well as open science and citizen science projects.
– Government: Circular economy infrastructure; synergies in updating circular policies; market coupling; citizen awareness and incentivizing wasteful behavior.
– Citizens: Low levels of innovation exposure; knowledge absorption; circular economy more aligned with regulator's perspectives than with social perceptions of the circular economy; regional issues (instead of local) in focus of circular initiatives.

Implications for industry and academia

Industry representatives and scholar can be informed through this study on the role of the financial sector in managing the smart circular economy transition. Our results suggest that quadruple helix innovation models applied in the context of smart circular economy transition could aid regional actors in more efficient knowledge sharing and value co-creation practices and decrease barriers towards financing circular business models when financial sector is an active participant in the circular transition. The study suggests that although different regional actors perceive the circular economy concept from different perspectives, a mutual consensus space can be identified and lead future circular business models relative to quadruple helix value-creation modeling. Shared value, in this case, may lead to a more efficient implementation of circular business models and consequently to a greater regional innovation-driven growth. In addition, suggested by Fig. 2, the financial sector may play a pivotal role in accelerating the growth rate and the transition to the circular economy when mutual consensus space builds on the intersection of collaborative value creation, which highlights financial variables of business modeling. To leverage on quadruple helix innovation models, it is needed to stimulate the financial sector to participate more actively in a shared value creation towards circular transition. Thus, we identify major barriers and recommendations to manage smart circular value co-creation models.

5 Conclusion

Regulatory and technological advancements are insufficient to enable the transition towards the smart circular economy transition while managing the shift towards collaborative business models, and understanding stakeholder interaction models is required to understand system dynamics and its effects on regional innovation-driven growth. This study examines smart circular economy value drivers and regional actors' collaborative value co-creation contribution to the transition towards the circular economy, using the quadruple helix model of innovation. The study defines main barriers and recommendations that can assist financial institutions, industrial players, academia, and policy planners in identify in circular capacity to create shared value and promote the transition towards smart circular economy. Further studies should consider collaborative performance measurement models and feedback loops analysis, which could aid in understanding the relationship between the collaborative output and service ecosystem dynamics.

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References

Carayannis, E. G., & Campbell, D. F. J. (2012). *Mode 3 knowledge production in quadruple helix innovation systems* (pp. 1–63). Springer.

Cibat, J., Süße, T., & Wilkens, U. (2017). An ecosystem approach as a design principle for a PSS-specific business simulation. *Procedia CIRP, 64*, 223–228.

Foray, D. (2016). On the policy space of smart specialization strategies. *European Planning Studies, 24*(8), 1428–1437.

Green Finance. Bundesministerium - Klimaschutz, Umwelt, Energie, Mobilitaet, Innovation und Technologie. Retrieved September 22, 2021, from https://www.bmk.gv.at/themen/klima_umwelt/klimaschutz/green_finance.html

Halstenberg, F., Lindow, K., & Stark, R. (2019). Leveraging circular economy through a methodology for smart service systems engineering. *Sustainability, 11*(13), 3517.

Kirchherr, J., Hekkert, M., Bour, R., Huibrechtse-Truijens, A., Kostense-Smit, E., & Muller, J. (2017a). Breaking the barriers to the circular economy. *Deloitte,* 1–13.

Kirchherr, J., Reike, D., & Hekkert, M. (2017b). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling, 127*, 221–232.

Klima Neutralitaets Buendnis. (2025). Retrieved September 22, 2021, from https://www.klimaneutralitaetsbuendnis2025.com/ueber-uns/

Korhonen, J., Honkasalo, A., & Seppälä, J. (2018). Circular economy: The concept and its limitations. *Ecological Economics, 143*, 37–46.

Persson, T., & Tabellini, G. (2002). *Political economics: Explaining economic policy*. MIT Press.

Petteri, R. J., et al. (2015). *An evolving European policy application of circular economy. CASI in the wider policy context: Sustainable innovation and climate action, environment, resource efficiency and raw materials* (pp. 50–58).

Pfitzer, M., Bockstette, V., & Stamp, M. (2013). Innovating for shared value. *Harvard Business Review, 91*(9), 100–107.

Porter, M. E., & Kramer, M. R. (2011). Creating shared value: How to reinvent capitalism—And unleash a wave of innovation and growth. *Harvard Business Review, 1*, 2–17.

Ranga, M., & Etzkowitz, H. (2013). Triple Helix systems: An analytical framework for innovation policy and practice in the knowledge society. *Industry and Higher Education, 27*(4), 237–262.

Rosanvallon, P. (2011). The metamorphoses of democratic legitimacy: Impartiality, reflexivity, proximity. *Constellations, 18*(2), 114–123.

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

Yaoteng, Z., & Xin, L. (2021). Research on green innovation countermeasures of supporting the circular economy to green finance under big data. *Journal of Enterprise Information Management*.

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Smart Services for Manufacturing

End-to-End Digital Twin Approach for Near-Real-Time Decision Support Services

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Abstract An end-to-end approach for near-real-time decision support services constructed of different elements from the fields of digital twins, decision support systems, data analytics, symbiotic simulations, and product-service systems is proposed based on a literature review. Parts of the concept have been validated based on two practical cases in an earlier research project. The model presented combines elements of those existing approaches from the literature into a single end-to-end model. The resulting end-to-end model will be tested in an industrial context to support service decision-makers.

Keywords Product service system · Digital twin · Symbiotic simulation · Near-real-time decision making

1 Introduction

The service sector is continuously growing and makes up a substantial part of employment and the gross domestic product (Kindström and Kowalkowski, 2014). The transition from products to services follows a change from the concept of "Goods-Dominant Logic" (G-D Logic) to "Service-Dominant Logic" (S-D Logic). By this transition, both manufacturers and service firms become more service-centric. In S-D Logic, service is considered the fundamental purpose of economic exchange (Vargo et al., 2008). As a result, the concept of manufacturing companies as service providers has emerged (Lay, 2014). Although the provision of service spans the entire equipment lifecycle, after-sales service plays a significant role in value creation (Durugbo, 2020) and is in the focus of this paper. For the efficient creation of service value, managing the variability inherent in services is crucial for the provider, among which the

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variability of demand and capacity plays a central role (Frei, 2006). These variability factors were amplified by the effects of the COVID-19 pandemic (Rapaccini et al., 2020). Travel restrictions for service technicians and supply difficulties for spare parts during the pandemic have influenced operations of manufacturing companies up until today. These restrictions show again how important flexible service planning is, especially during these difficult times. However, for manufacturing companies, with established service processes for their installed base, this may pose a significant challenge. The changing circumstances regarding the availability of spare parts and travel restrictions for service technicians require a flexible planning tool that supports decision-makers in industrial companies regardless of the COVID-19 pandemic.

2 Background

Machine Learning (ML) is widely used in smart maintenance cases to detect errors in machines before their occurrence (Çnar et al., 2020). The models used to detect errors ahead of time vary from basic ML methods to complex neural networks. Those data-based models are now often supported or supplemented with digital twins of the physical system (Jaensch et al., 2018). Those digital twins represent existing physical systems or products and can produce data independently, which can improve error detection in combination with machine learning as described by (Jaensch et al., 2020). The concept of digital twins is used in multiple industrial fields, such as farming (Verdouw et al., 2021), or healthcare (Croatti et al., 2022). The majority of those digital twins represent physical objects. Those digital twins will be referred to as equipment twins in this paper. However, there are also digital twins of business processes that represent real-world processes (Ivanov et al., 2019 and consume and produce data similar to physical entity's (Meierhofer et al., 2021). Those types of digital twins will be referred to as process twins in this paper. Such process twins, sometimes also referred to as symbiotic simulations (Tjahjono & Jiang, 2015), are integrating data from enterprise-resource-planning (ERP) and customer-relationship-management (CRM) systems in a near real-time environment (Onggo et al., 2021). Equipment twins, and process twins, are often integrated into a decision support system or process (Leonardo et al., 2019) to support the data, information, knowledge, and wisdom (DIKW) hierarchy (Rowley, 2007). Such an implementation aims to provide insights as they help to understand and reflect upon certain situations in a complex system. However, most of the approaches introduced do stay relatively contained in their domain. In many cases, the system boundary of the approaches, both equipment- and process-wise, is the monitored machine or process itself, not considering the possible interplay on each other. Therefore, this paper proposes a mixed-method approach for an end-to-end decision support system for industrial use cases in the context of installed base services. The proposed approach focuses on the proactive prevention of errors and how the service team can respond to them concerning resources, cost, or quality of service.

3 Methodology

The literature in the field was reviewed to support the hypothesis that there is a possibility to support decision-making by a systematic combination of equipment twins and process twins. The following four keywords were chosen to represent the fields of interest: 1. Digital Twins (for equipment twins), 2. Symbiotic Simulations (for process twins), 3. Decision Support (for decision support systems), 4. Machine Learning (for data analytics in twins). A paper was labeled relevant if their content included models or approaches that contain solutions in their field of expertise on maintenance or service in general. A relevance analysis was then performed on the collected papers. The papers that were found to be relevant are listed in Table 1. Then, by comparing the resulting methods and approaches, similar solutions were grouped and further developed by applying a system design methodology into a single end-to-en workflow. This new approach aims to support decisions in an end-to-end service and maintenance case based on data from the different sources that contribute to the process of decision support. Additionally, the new approach conceptualized in this paper is preliminary and was validated in parts using two practical cases from a field study. In all these cases, digital models were developed for either equipment or processes or a combination of these. These cases allowed to check whether the new approach covers the relevant elements of a smart service concept.

4 Results

The proposed approach consists of methods from machine learning, equipment twins, and process twins. In combination, they can support value creation in socio-technical smart service systems (Meierhofer et al., 2021). The approach starts with the analysis of the data from a physical system. Then, with the help of machine learning and in combination with an equipment twin, the relevant health information of an object is evaluated. Based on the results, a process twin is triggered that simulates possible response scenarios. Based on the process simulation results by the twin, the decision-makers can make more informed decisions on how to respond to the situation that triggered the process simulation. However, it can also be used for reactive use cases, i.e., the service process twin can also be triggered by error messages or in the planning of periodical maintenance visits. As a ground layer, the DIKW model of (Rowley, 2007) is used to structure the model into four parts: *Data*, where the handling of machine data, equipment twins and the physical entity is located. *Information*, by using different approaches of data analytics based on the data from the first part additional value is generated. *Knowledge*, the information generated in the preceding part is now transformed into knowledge, with the help of a process twin and the additional data from ERP and CRM systems. *Wisdom*, finally the knowledge is used in combination with the companies experienced human decision makers to deliver the best possible service actions. With each step the value of the data initially produced is increasing (Fig. 1).

Table 1 Table of relevant papers for model building

	Equipment twins	Process twins	Decision support system	Data analytics
Digital twins	Griva (2019), Boschert et al. (2018), Verdouw et al. (2021), Jaensch et al. (2018), Redelinghuys et al. (2019), Longo et al. (2019)	Zhang et al. (2019), Longo et al. (2019), Kunath and Winkler (2018), Ivanov et al. (2019)	Verdouw et al. (2021), Jans-Singh et al. (2020), Meierhofer et al. (2020), Longo et al. (2019), Kunath and Winkler (2018)	Booyse et al. (2020), Jaensch et al. (2018), Zhang et al. (2019)
Symbiotic simulation	Leonardo et al. (2019)	Tjahjono and Jiang (2015), Leonardo et al. (2019), Onggo et al. (2021)	Tjahjono and Jiang (2015), Leonardo et al. (2019), Onggo et al. (2021), Onggo (2019)	x
Decision support	Meierhofer et al. (2020, 2021), Belkadi et al. (2020), Kunath and Winkler (2018), Bertoni et al. (2021)	Dong et al. (2013), Meierhofer et al. (2020, 2021), Kunath and Winkler (2018), Bertoni et al. (2021), Zhou et al. (2016), Oleghe and Salonitis (2019), Camargo et al. (2020)	Dong et al. (2013), Meierhofer et al. (2020, 2021), Belkadi et al. (2020), Kunath and Winkler (2018), Turker et al. (2019), Bertoni et al. (2021), Zhou et al. (2016), Oleghe and Salonitis (2019)	x
Machine learning	Jaensch et al. (2018)	x	Dalzochio (2020)	Çnar et al. (2020), Dalzochio et al. (2020), Lehmann et al. (2020)

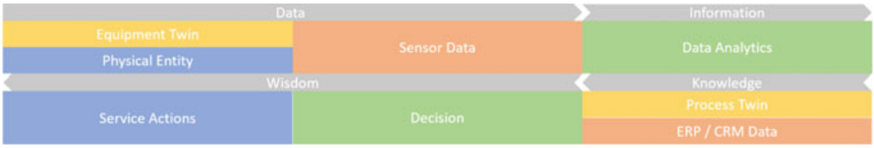

Fig. 1 Proposed approach for an end-to-end near-real-time decision support service model

4.1 *Data*

The first part of the model revolves around the data generated by the physical entity and, therefore, also around data storage and data accessibility. **Physical Entity**: The physical entity as in Meierhofer et al. (2020, 2021)—often also called real system as in Griva (2019), Boschert et al. (2018), Jaensch et al. (2018)—resembles the physical or real part of a system or product. From this physical entity, data is gathered (Jaensch et al., 2018) via sensors. The service data which is gathered through the lifetime of a physical entity (Boschert et al., 2018) is not included in this part of the model. Those data sources are discussed in the ERP/CRM Data part in Sect. 4.3. The physical entity can be seen as the start and the endpoint of the model, as without it, there would not be a need for an end-to-end approach for a decision support service. **Equipment Twin**: Connected and built upon the physical entity is the equipment twin (Meierhofer et al., 2020)—in the majority of papers dealing with twins of physical entity's they are called digital twins as in Griva, (2019), Boschert et al. (2018), Verdouw et al. (2021), Jaensch et al. (2018), Redelinghuys et al. (2019), Longo et al. (2019). In order to be more precise in describing the use of the digital twins in this approach there is the differentiation between equipment twins and process twins.**Sensor Data**: The sensor data part of the model contains several aspects of data collected from physical entities and the equipment twins. It contains the first two steps of the nine-factor framework of Lim et al. (2018). The data has to be collected and made available for external systems to be analyzed (Schroeder et al., 2016). As there are multiple technical approaches to handling and storing data in an enterprise, this model does not focus on this topic. Some approaches can be found in Lehmann et al. (2020), Dalzochio et al. (2020), Schroeder et al. (2016). The main point made here is that the data needs to be accessible for further steps.

4.2 *Information*

Following the data acquisition, there is the need to make sense of the data collected from the preceding elements. The model focuses on the different possibilities to make sense of the data, as no solution works with all possible cases. **Data Analytics**: This part of the model analyzes the data from the physical entity and the equipment twin. Depending on the problem, the solution has to be adapted for a good fit. Methods such as knowledge-driven system analysis as in Zhang et al. (2019), data-driven machine learning models for error and failure prediction as in Jaensch et al. (2018), Çnar et al. (2020), Dalzochio et al. (2020), or even complex deep digital twins as in Booyse et al. (2020).

4.3 Knowledge

Based on the information generated in the data analytics part of the approach, the process twin and the ERP and CRM Data part add another layer to generate knowledge. Therefore, the knowledge generation is based on the results of the process simulations in the process twin. Which, in return, are directly connected to the data from the ERP and CRM tools. Process twins are also referred to as symbiotic simulations in the literature (Onggo et al., 2021). **Process Twin**: This part of the model is pivotal as it gets triggered by its predecessor's results. There are several possible triggers. However, this model uses the approach of Tjahjono and Jiang (2015). The three triggers for the process twins are: 1. *Operator Triggers*: where an operator in the system starts the process twins simulation. This triggering could be due to a machine malfunction or any other unplanned event that needs to be handled by the service department. 2. *Period Triggers*: recurring triggers which need to be planed. For example, yearly maintenance visits. 3. *Anomaly Triggers*: due to machine data and digital twins detected possible machine failures. This trigger opens the possibility to plan a suitable reaction. Each of those triggers starts a simulation of different possible scenarios of reaction. The data used in these simulations are mainly based on the ERP and CRM data of the company. **ERP/CRM Data**: ERP and CRM data lay the ground truth for the process twin simulations (Onggo et al., 2021). Different types of process twins simulate possible futures based on the near real-time information from those enterprise data storage systems. The data gets synchronized each time the simulation gets triggered.

4.4 Wisdom

In this last part of the model, the results of the previous parts are used to decide the optimal response to the triggering event. **Decision**: Utilizing the Knowledge generated over the last three parts of the model, decision-makers can support their choices with simulation, and machine learning results (Oleghe and Salonitis, 2019). In Meierhofer et al. (2020) the decision making is summarized into three steps: 1. describe the set of possible actions, 2. evaluate these actions, 3. select the preferred action. **Service Actions**: The selected actions are then set to action with the service resources available to the enterprise. The central point of this step is to document the actions taken so that in a future case, the data generated by this one can be used as a further basis for decision making, generating further wisdom.

5 Discussion

By linking machine learning methods, digital twins—physical and process twins—and decision making, a new possible solution for handling uncertainty in service processes is proposed. **Industrial Implications**: By implementing the presented approach, companies may gain a competitive advantage in leveraging their installed base. However, the challenges include the continuous integration of data and the confidence in their evaluation and the simulation of possible solutions. **Academic Implications**: Combining the discussed approaches and methods from different research fields holds great opportunities and some stumbling blocks to industrial firms. The challenge in implementing such a model is to synchronize the different research areas, often using different terms for the same or similar approaches. Therefore, it is essential to create clarity in order to achieve the common goal. **Practical Validation**: The verification with the two practical cases revealed that the new approach solves an existing problem in the industry, but some parts need to be tested further to find optimal implementation strategies. In addition, the question of whether implementation is financially worthwhile is of great interest to many SMEs and needs to be investigated in more detail.

6 Conclusions and Recommendation

Toward implementing the proposed process, special attention must be paid to the interconnection of the individual elements. Therefore, the focus will be on triggering the process twin and integrating the ERP and CRM data.

References

Belkadi, F., Dhuieb, M. A., Aguado, J. V., Laroche, F., Bernard, A., & Chinesta, F. (2020, 2). Intelligent assistant system as a context-aware decision-making support for the workers of the future. *Computers and Industrial Engineering, 139*. https://doi.org/10.1016/j.cie.2019.02.046

Booyse, W., Wilke, D. N., & Heyns, S. (2020). Deep digital twins for detection, diagnostics and prognostics. https://doi.org/10.1016/j.ymssp.2019.106612

Boschert, S., Heinrich, C., & Rosen, R. (2018, 5). NEXT generation digital twin. In *Proceedings of TMCE 2018*, Las Palmas de Gran Canaria, Spain

Camargo, M., Dumas, M., & González-Rojas, O. (2020). Automated discovery of business process simulation models from event logs. *Decision Support Systems, 134*. https://doi.org/10.1016/j.dss.2020.113284

Çnar, Z. M., Abdussalam Nuhu, A., Zeeshan, Q., Korhan, O., Asmael, M., & Safaei, B. (2020, 10). Machine learning in predictive maintenance towards sustainable smart manufacturing in industry 4.0. *Sustainability, 12*(19), 8211. https://doi.org/10.3390/su12198211, https://www.mdpi.com/2071-1050/12/19/8211

Croatti, A., Gabellini, M., Montagna, S., & Ricci, A. (2022). On the integration of agents and digital twins in healthcare.

Dalzochio, J., Kunst, R., Pignaton, E., Binotto, A., Sanyal, S., Favilla, J., & Barbosa, J. (2020). Machine learning and reasoning for predictive maintenance in Industry 4.0: Current status and challenges. *Computers in Industry, 123*, 103298. https://doi.org/10.1016/j.compind.2020.103298

Dong, C. S. J., & Srinivasan, A. (2013, 4). Agent-enabled service-oriented decision support systems. *Decision Support Systems, 55*(1), 364–373. https://doi.org/10.1016/j.dss.2012.05.047

Durugbo, C. M. (2020, 3). After-sales services and aftermarket support: A systematic review, theory and future research directions. *International Journal of Production Research, 58*(6), 1857–1892. https://doi.org/10.1080/00207543.2019.1693655

Frei, F. X. (2006, 11). Breaking the trade-off between efficiency and service. *Harvard Business Review*. https://hbr.org/2006/11/breaking-the-trade-off-between-efficiency-and-service

Griva, M. (2019, 2). Digital *twin. Mondo Digitale, 18*(80). https://doi.org/10.1007/978-3-642-35950-7_16870-1

Ivanov, D., Dolgui, A., Das, A., & Sokolov, B. (2019). Digital supply chain twins: managing the ripple effect, resilience, and disruption risks by data-driven optimization, simulation, and visibility. In *International series in operations research and management science* (Vol. 276, pp. 309–332). Springer New York LLC. https://doi.org/10.1007/978-3-030-14302-2_15

Jaensch, F., Csiszar, A., Scheifele, C., & Verl, A. (2018). Digital twins of manufacturing systems as a base for machine learning. In *25th International Conference on Mechatronics and Machine Vision in Practice (M2VIP)*

Jans-Singh, M., Leeming, K., Choudhary, R., & Girolami, M. (2020, 12). Digital twin of an urban-integrated hydroponic farm. *Data-Centric Engineering*. https://doi.org/10.1017/dce.2020.21, https://www.cambridge.org/core

Kindström, D., & Kowalkowski, C. (2014, 1). Service innovation in product-centric firms: A multidimensional business model perspective. *Journal of Business & Industrial Marketing, 29* (2), 96–111. https://doi.org/10.1108/JBIM-08-2013-0165

Kunath, M., & Winkler, H. (2018). Integrating the digital twin of the manufacturing system into a decision support system for improving the order management process. In *Procedia CIRP* (Vol. 72, pp. 225–231). Elsevier B.V. https://doi.org/10.1016/j.procir.2018.03.192

Lay, G. (2014). Introduction. In *Servitization in industry*. Springer International Publishing, Cham. https://doi.org/10.1007/978-3-319-06935-7_1

Lehmann, C., Goren Huber, L., Horisberger, T., Scheiba, G., Sima, A. C., & Stockinger, K. (2020, 12). Big data architecture for intelligent maintenance: A focus on query processing and machine learning algorithms. *Journal of Big Data, 7*(1). https://doi.org/10.1186/s40537-020-00340-7

Leonardo, E., Teixeira, S., Tjahjono, B., Crisóstomo, S., Alfaro, A., & Wilding, R. (2019). Extending the decision-making capabilities in remanufacturing service contracts by using symbiotic simulation

Lim, C., Kim, K. H., Kim, M. J., Heo, J. Y., Kim, K. J., & Maglio, P. P. (2018, 4). From data to value: a nine-factor framework for data-based value creation in information-intensive services. *International Journal of Information Management, 39*, 121–135. https://doi.org/10.1016/j.ijinfomgt.2017.12.007

Longo, F., Nicoletti, L., & Padovano, A. (2019, 1). Ubiquitous knowledge empowers the smart factory: the impacts of a service-oriented digital twin on enterprises' performance. *Annual Reviews in Control, 47*, 221–236. https://doi.org/10.1016/j.arcontrol.2019.01.001

Meierhofer, J., Züst, S., Jinzhi, L., Schweiger, L., & Kiritsis, D. (2021). Enabling decision support services in industrial ecosystems by digital twins. In *Proceedings of the Spring Servitization Conference* (pp. 138–146)

Meierhofer, J., & West, S. (2020, 6). Data-driven decision support by digital twins in manufacturing. In *2020 7th Swiss Conference on Data Science (SDS)*. IEEE. https://doi.org/10.1109/SDS49233.2020.00019

Oleghe, O., & Salonitis, K. (2019). The application of a hybrid simulation modelling framework as a decision-making tool for TPM improvement. *Journal of Quality in Maintenance Engineering*

Onggo, B. S., Corlu, C. G., Juan, A. A., Monks, T., & de la Torre, R. (2021). Combining symbiotic simulation systems with enterprise data storage systems for real-time decision-making. *Enterprise Information Systems, 15*(2), 230–247. https://doi.org/10.1080/17517575.2020.1777587

Onggo, B. S. (2019). Symbiotic simulation system (S3) for industry 4.0. In *Simulation for Industry 4.0* (pp. 153–165). Springer. https://doi.org/10.1007/978-3-030-04137-3_10

Rapaccini, M., Saccani, N., Kowalkowski, C., Paiola, M., & Adrodegari, F. (2020, 7). Navigating disruptive crises through service-led growth: The impact of COVID-19 on Italian manufacturing firms. *Industrial Marketing Management, 88*, 225–237. https://doi.org/10.1016/j.indmarman.2020.05.017

Redelinghuys, A. J., Kruger, K., & Basson, A. (2019). A six-layer architecture for digital twins with aggregation. In *Studies in computational intelligence* (Vol. 853, pp. 171–182). Springer Verlag. https://doi.org/10.1007/978-3-030-27477-1_13

Rowley, J. (2007, 4). The wisdom hierarchy: Representations of the DIKW hierarchy. *Journal of Information Science, 33*(2), 163–180. https://doi.org/10.1177/0165551506070706

Sala, R., Bertoni, M., Pirola, F., & Pezzotta, G. (2021). Data-based decision-making in maintenance service delivery: The D3M framework. *Journal of Manufacturing Technology Management, 32*(9), 122–141. https://doi.org/10.1108/JMTM-08-2020-0301

Schroeder, G. N., Steinmetz, C., Pereira, C. E., & Espindola, D. B. (2016). Digital twin data modeling with AutomationML and a communication methodology for data exchange. *IFAC-PapersOnLine*. https://doi.org/10.1016/j.ifacol.2016.11.115

Tjahjono, B., & Jiang, X. (2015, 2). Linking symbiotic simulation to enterprise systems: Framework and applications. In *Proceedings—Winter Simulation Conference* (Vol. 2016-February, pp. 823–834). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/WSC.2015.7408219

Turker, A. K., Aktepe, A., Inal, A. F., Ersoz, O. O., Das, G. S., & Birgoren, B. (2019). A decision support system for dynamic job-shop scheduling using real-time data with simulation. *Mathematics, 7*(3). https://doi.org/10.3390/math7030278

Vargo, S. L., & Lusch, R. F. (2008, 5). From goods to service(s): Divergences and convergences of logics. *Industrial Marketing Management, 37*(3), 254–259. https://doi.org/10.1016/j.indmarman.2007.07.004, http://www.sciencedirect.com/science/article/pii/S0019850107001514

Verdouw, C., Tekinerdogan, B., Beulens, A., & Wolfert, S. (2021, 4). Digital twins in smart farming. *Agricultural Systems, 189*, 103046. https://doi.org/10.1016/j.agsy.2020.103046

Zhang, C., Zhou, G., He, J., Li, Z., & Cheng, W. (2019). A data-and knowledge-driven framework for digital twin manufacturing cell. In *Procedia CIRP* (Vol. 83, pp. 345–350). Elsevier B.V. https://doi.org/10.1016/j.procir.2019.04.084

Zhou, R., Hu, Y., Xiao, S., & Wen, J. (2016). A multi-agent based decision-making approach for field service delivery of IPS2. In *Procedia CIRP*. https://doi.org/10.1016/j.procir.2016.03.070

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Virtual Reality Extension for Digital Twins of Machine Tools

Valentin Holzwarth, Christian Hirt, Joy Gisler, and Andreas Kunz

Abstract Digital twins (DTs) provide numerous opportunities for value creation in manufacturing. Services enabled by DTs include remote monitoring of assets' conditions and predictive maintenance. In this paper, we introduce novel, previously unexplored services based on a fully virtualized machine tool, which are targeted at increasing machine operators' productivity. This allows conducting procedures, such as operator training at a virtual machine tool, which results in the real machine tool being available for value adding activities. Beyond operator training, we envision further potential applications of the virtual machine tool including the run-in of new processes and collision detection.

Keywords Digital twin · Manufacturing · Machine tools

1 Introduction

The manufacturing industry is changing fundamentally due to the influence of the fourth industrial revolution, also referred to as "Industry 4.0". Its main drivers are digitization and networking of processes, systems and machines. The focus of this paradigm shift is the human, who is constantly confronted with new challenges. As the complexity of processes increases, the demands placed on the work to be

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performed increase significantly. It is expected that employees will cope with the increasing range of tasks in their daily work routine as usual. Shortened periods of action, however, require an increased understanding and ability to learn, which cannot or only partially be guaranteed with proven training and support measures.

At the same time, providers of industrial equipment, such as machine tool manufacturers, face increasing customer demand for services that complement or even replace their traditional product-based offering. A recent example is the Equipment-as-a-Service (EaaS) offering by DMG MORI,[1] one of the world's leading manufacturers of machine tools. Within this service, customers enroll for an annual subscription combined with an hourly usage fee. The subscription not only includes machine delivery, commissioning and maintenance, but also the training of machine operators. However, the training of machine operators is a challenging endeavor, since operators have to travel to a training center for multiple days and are unavailable for value adding activities during this time. Thus, training services that can be accessed on-demand and location-independent would be favored from the perspective of a machine tool manufacturer and machine operator. While currently available e-learning systems and instructional videos partly satisfy this need, they come with a major drawback: They cannot ensure that the machine operator can transfer the acquired theoretical knowledge onto the real machine tool.

Within this work, we propose a novel, previously unexplored solution to mitigate the issue by harnessing the digital twin (DT). This DT is comprised of a fully virtualized machine tool that can be accessed through virtual reality (VR) technology. By these means, operating, maintenance, and repair procedures can be trained without requiring the real machine tool. This is not only useful for new operators, but also for simulating changes in work procedures, re-training experienced operators, and knowledge transfer between production facilities. Unlike prior approaches, which require the cumbersome remodeling of both, machine tool behavior and geometry, our DT enables additional services even beyond the main use-case of operator training. Such additional services include virtual commissioning of new machines, run-in of new production processes and virtual process setups, providing insight, if and how a desired product can be manufactured on a given machine.

In combination, these opportunities will shorten the time-to-market for the machine tool manufacturer. Furthermore, the machine operator will benefit from a significant reduction in the time between ordering a machine tool and its productive use. These benefits can be only realized by having the machine tool's DT at hand, which will result in a competitive advantage for the machine manufacturer and create further value (e.g. through increased sales or novel monetization strategies).

[1] https://de.dmgmori.com/produkte/payzr.

2 Related Work

The DT of a machine tool can be defined as an entire representation of a machine, comprising geometric data, machine control, as well as live data from the real machine (Davis et al., 2012; Grieves & Vickers, 2017). This replaces former hardware-in-the-loop approaches (Dierssen, 2002) and enables various industrial applications, such as maintenance planning for aircrafts (Kraft, 2016) and optimizing production processes for punching machines (Moreno et al., 2017).

While these approaches do not yet have a maturity level to be widely used in industry, leading software companies in mechanical engineering are creating their own packages for the DT as a platform for establishing the it in a wider context (Magargle et al., 2017). However, according to Luo et al. (2019), the DT requires the availability of sensor data stemming from the real machine e.g., for deep learning prediction of service intervals (Luo et al., 2020), motion compensation (Liu et al., 2021), or for an automated machine reconfiguration (Leng et al., 2020). Thus, the DT always follows the behavior of the real machine tool. This paradigm limits the potentials for DT-enabled value creation to the cases, where the real machine tool is operational and has already produced enough data for the desired analysis. Another substantial element, which has yet been investigated by only few works, is the interface through which the DT can be accessed by the machine operator (Ma et al., 2019). For this interface, VR technology is highly favorable, since it allows the machine operator to interact with the DT in an analogue manner than with the real machine tool. In this context, prior works have already investigated on utilizing VR technology for machine tool training (Hirt et al.. 2021), commissioning (Pérez et al., 2020), and industrial workplace analysis (Gorobets et al., 2021).

3 Contribution

Based on the identified research gap and the machine tool operators' demand for novel services, we develop a concept for implementing a DT, which can be accessed through VR technology. This concept is envisioned for the use case of machine tool operator training, which traditionally comes with numerous disadvantages.

Current training of machine operators is conducted through: (i) a hands-on training on a new machine, (ii) having a hands-on training on an arbitrary machine for the same purpose, or (iii) visiting a training center, which is operated by the machine tool manufacturer. All three approaches come with specific disadvantages:

(i) When the new machine tool is delivered to the machine operator's site, no trained personnel is available. This leads to a delay in utilizing the machine tool for value-adding activities. Further, the machine tool consumes energy and raw materials also during training. Additionally, during training the likeliness of machine damage due to faulty operation is increased. Moreover, a second person is required as an instructor.

(ii) The machine operator to be trained by an instructor only gains basic knowledge, but not the specific skills required for the new machine. Again, the machine being used for training is non-productive for this period of time and requires raw materials and energy for the training.
(iii) The person to be trained has to travel and is thus not available for production and operating other machines. Again, an instructor is required and the machine consumes energy and raw material during the training.

Based on available software packages, we develop a concept for a VR extension for the DT of a machine tool, which allows the machine operator to be fully immersed and to behave similarly as with a real machine, including real walking and interaction with the virtualized human-machine interface. We employ a first person learning perspective, which is proven to be more effective than the third person perspective, which is typically used in traditional training (Hirt et al., 2021). The concept also comprises a software architecture that allows for a seamless integration of such a virtual learning environment into existing business processes and data flows (see Fig. 1).

The novelty of this concept is that it significantly reduces the modeling effort, since it automatically retrieves data from existing sources, such as the virtualized machine control, virtual machine and tooling geometry, as well as its simulation model for control commands. Moreover, this concept also proceeds from an animated machine to a simulated machine, since it also integrates the virtualized machine control in real-time. Since the data, which is combined and integrated within a game engine can also be deployed standalone, the machine operators that access the DT are not required to set up any additional software. This also allows for connecting multiple stakeholders with the same DT in real time, which is beneficial for collective learning and problem solving (see Fig. 2).

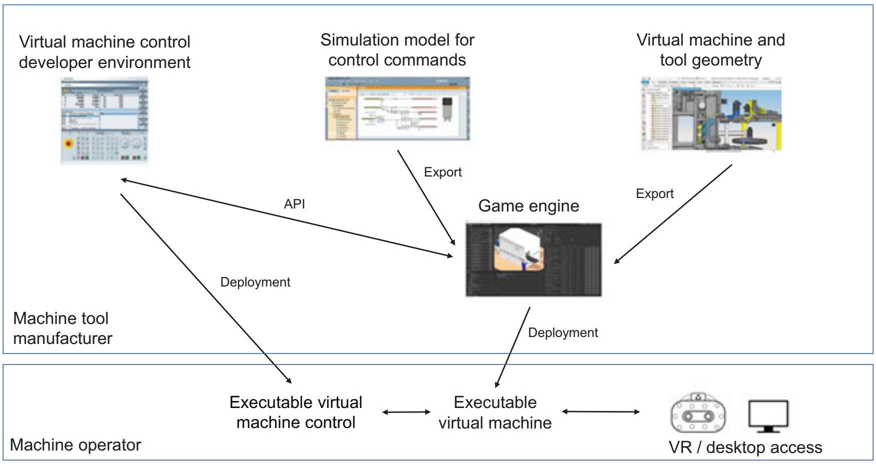

Fig. 1 The concept of the proposed VR extension for the DT of a machine tool

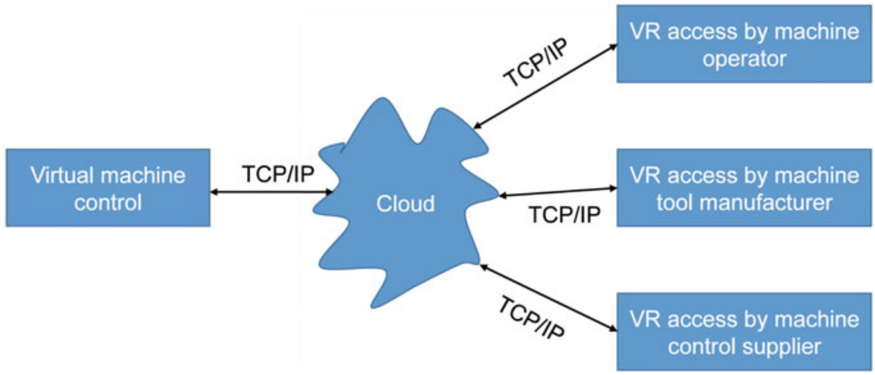

Fig. 2 Connecting multiple stakeholders with the same DT in real-time

4 Initial Implementation

In a first implementation, we show the feasibility of the developed concept within a training scenario for using the virtualized machine control along with the virtual machine. Figure 3 provides an overview of a machine operator's view in VR, which is provided by the HTC Vive Pro VR System including the Vive Wireless Adapter.

Within the training scenario, the machine operator is instructed to do the following tasks:

Fig. 3 The machine operator's view in VR, including an assignment board on the left and the virtual machine tool including the virtualized machine control on the right

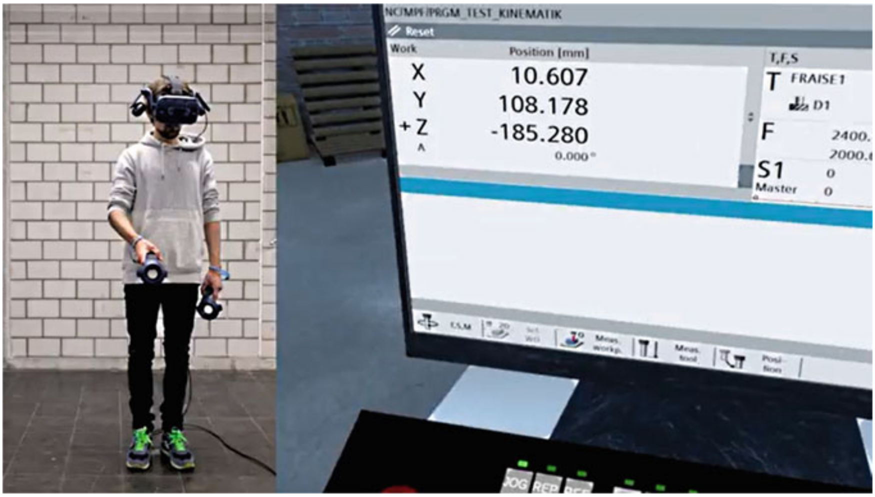

Fig. 4 A machine operator accessing the machine's DT through VR (left) and a VR view of the virtualized Human-Machine Interface (HMI) (right)

– Pick up safety helmet in left cabinet
– Put on helmet
– Pick up work piece
– Place work piece in machine
– Replace air filter
– Close door

Whenever a task is completed, the machine operator presses a button on the game controller to switch to the next task. Once these initial tasks are completed, the machine operator has to overwrite the programmable logic controller (PLC) variables to access the machine control and to run the machine in a manual jog mode (see Fig. 4).

Afterwards, the machine can be run in auto mode, which allows the user to observe the program sequence. Finally, the user can access and read the machine simulation data.

5 Conclusion and Future Work

Within this work, we have proposed and initially implemented a VR extension for the DT of a machine tool. The preliminary implementation focuses on a training scenario for machine operators. Future work will focus on the verification of the training scenario within a user study with machine operators as participants. Furthermore, additional use cases will be implemented and verified along the machine tool life cycle, such as virtual commissioning, virtual process setups and virtual run-in of new processes. Finally, the concept should be generalized by implementing different types of machine tools and rolled out by integrating the VR extension for the DT of machine tools in the service portfolio of machine tool manufacturers.

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References

Davis, J., Edgar, T., Porter, J., Bernaden, J., & Sarli, M. (2012). Smart manufacturing, manufacturing intelligence and demand-dynamic performance. *Computers & Chemical Engineering, 47*, 145–156. https://doi.org/10.1016/j.compchemeng.2012.06.037

Dierssen, S. (2002). Systemkopplung zur komponentenorientierten Simulation digitaler Produkte. Ph.D. thesis, ETH Zurich, Switzerland. https://doi.org/10.3929/ETHZ-A-004449420

Gorobets, V., Holzwarth, V., Hirt, C., Jufer, N., & Kunz, A. (2021). A VR-based approach in conducting MTM for manual workplaces. *International Journal of Advanced Manufacturing Technology, 117*(7–8), 2501–2510. https://doi.org/10.1007/s00170-021-07260-7

Grieves, M., & Vickers, J. (2017). Digital twin: Mitigating unpredictable, undesirable emergent behavior in complex systems (pp. 85–113). Springer, Cham. https://doi.org/10.1007/978-3-319-38756-7_4

Hirt, C., Spahni, M., Kompis, Y., Jetter, D., & Kunz, A. (2021). Virtual reality training platform for a computer numerically controlled grinding machine tool. *International Journal of Mechatronics and Manufacturing Systems, 14*(1), 1–17. https://doi.org/10.1504/ijmms.2021.115460

Kraft, E. M. (2016). The air force digital thread/digital twin-life cycle integration and use of computational and experimental knowledge. In *54th AIAA aerospace sciences meeting*. https://doi.org/10.2514/6.2016-0897

Leng, J., Liu, Q., Ye, S., Jing, J., Wang, Y., Zhang, C., Zhang, D., & Chen, X. (2020). Digital twin-driven rapid reconfiguration of the automated manufacturing system via an open architecture model. *Robotics and Computer-Integrated Manufacturing, 63*, 101895. https://doi.org/10.1016/j.rcim.2019.101895

Liu, K., Song, L., Han, W., Cui, Y., & Wang, Y. (2021). Time-varying error prediction and compensation for movement axis of cnc machine tool based on digital twin. IEEE Trans. Ind. Inf. 109–118. https://doi.org/10.1109/TII.2021.3073649

Luo, W., Hu, T., Ye, Y., Zhang, C., & Wei, Y. (2020). A hybrid predictive maintenance approach for cnc machine tool driven by digital twin. *Robotics and Computer-Integrated Manufacturing, 65*, 101974. https://doi.org/10.1016/j.rcim.2020.101974

Luo, W., Hu, T., Zhang, C., & Wei, Y. (2019). Digital twin for cnc machine tool: Modeling and using strategy. *Journal of Ambient Intelligence and Humanized Computing, 10*(3), 1129–1140. https://doi.org/10.1007/s12652-018-0946-5

Ma, X., Tao, F., Zhang, M., Wang, T., & Zuo, Y. (2019). Digital twin enhanced human-machine interaction in product lifecycle. *Procedia CIRP, 83*, 789–793. https://doi.org/10.1016/J.PROCIR.2019.04.330

Magargle, R., Johnson, L., Mandloi, P., Davoudabadi, P., Kesarkar, O., Krishnaswamy, S., Batteh, J., & Pitchaikani, A. (2017). A simulation-based digital twin for model-driven health monitoring and predictive maintenance of an automotive braking system. In *Proceedings of the 12th International Modelica Conference*, Prague, Czech Republic, May 15–17, 2017 (pp. 35–46). Linköping University Electronic Press. https://doi.org/10.3384/ecp1713235

Moreno, A., Velez, G., Ardanza, A., Barandiaran, I., de Infante, Á.R., & Chopitea, R. (2017). Virtualisation process of a sheet metal punching machine within the industry 4.0 vision. *International Journal on Interactive Design and Manufacturing (IJIDeM), 11*(2), 365–373. https://doi.org/10.1007/s12008-016-0319-2

Pérez, L., Rodríguez-Jiménez, S., Rodríguez, N., Usamentiaga, R., & García, D. F. (2020). Digital twin and virtual reality based methodology for multi-robot manufacturing cell commissioning. *Applied Sciences, 10*(10), 1–18. https://doi.org/10.3390/APP10103633

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Value Creation with Digital Twins in the End-of-Lifecycle Phase of Smart Products: Applied Data Resources in Academic Literature

Gianluca Galeno, Linard Barth, Matthias Ehrat, and Umut Demiriz

Abstract Smart products generate data during their entire life cycle. The usage of data during the first two lifecycle phases (beginning-of-life and middle-of-life) of a product is well researched. This study aims to investigate the origin, and the value creation of data that takes place in the final phase of the lifecycle through a systematic literature review. The findings are classified in a two-dimensional manner. A first dimension splits the data category into product-, context- and customer-related data and the second dimension splits the data sources into external, internal and thing related sources. Most of the data resources exploited for end-of-life decisions in the literature can be associated to the data category product, originating from the sources thing and internal system. The results show that use cases such as disposal, recycling, reuse, and refurbishment, which generate end-of-life value using life cycle data, are rarely described in the academic literature.

Keywords Value creation · End-of-life · Data resources

1 Introduction

Digitalization is a megatrend that has been changing our society on a large scale for decades. One of the more recent phenomena within this megatrend is the Internet of Things (IoT), which refers to the networking of physical products via the Internet. The further development and progress in information and communication technologies will transform traditional products into smart connected products (SCP), which will enable new kinds of intelligent services (Dawid et al., 2016). The concept of the Digital Twin (DT) is hereby seen as a key technology (Barbieri et al., 2019). Although research and applications regarding value creation with DTs are continuously emerging (Shen et al., 2021), many questions and topics still require further investigation (Zheng et al., 2018). One of the most interesting topics is the potential

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contribution of DTs to closed resource loops and the circular economy (Rocca et al., 2020).

2 Background

The initial description of a DT by Grieves (2003) defines a DT as a virtual representation of a physical product, from which it receives data and to which it provides information to optimize processes. Since then, the definition of DTs has been enriched over time, from a digital representation of a physical asset to an evolving digital profile (Malakuti et al., 2019). Conclusive further work has primarily focused on the BoL and MoL phases of the product lifecycle. There is, however, also a plethora of possibilities of DT (or smart products and services) applications in the EoL-Phase, which are not yet fully explored (Landahl et al., 2018; Negri et al., 2017). It is therefore of great interest which degree of fidelity is sufficient for which use cases, especially for the so far neglected EoL use cases. Within this paper the EoL use cases of disposal, reuse, recycling, and refurbishment described by Kiritsis (2011) are differentiated. DTs are a representation of a product (Grieves, 2005; Grieves & Vickers, 2016) and its processes (Rosen et al., 2015). A first category consists of product-related data describing the state and behavior of a product or an asset. A second category includes contextual data to make sense of and form the basis for knowledge-based decisions (e.g., Damjanovic-Behrendt & Behrendt, 2019; Detzner & Eigner, 2018; Malakuti et al., 2018; Tao et al., 2019; Wuest et al., 2015). A third category are customer-related data, such as ownership, configuration, usage preference or data relevant to customer relationship management (Fuchs & Barth, 2018). Companies collect data from integrated control systems of the product, internal enterprise systems and third-party sources (Barth et al., 2020). The DT receives data, especially at the instance level, directly from the embedded information system (EIS) of the product or asset itself, which are also referred to as “things”. The non-embedded systems can be divided into internal and external information systems connected to the DT. First, DT concepts leverage, integrate, and recombine content from internal information systems (Holler et al., 2016). Second, DT leverage, integrate, and recombine content directly from appropriate external information systems. The framework proposed by Barth et al. (2020) describes a holistic DT approach for companies seeking to create value in both internal and external processes that affect the entire life cycle of their products. The aim of this literature review is therefore to make a systematic contribution to closing the research gap on value creation in the EoL phase, which is still relatively little researched compared to the other lifecycle phases.

3 Methodology

The three research questions addressed in this paper are (a) "Which use cases mentioning value creation with data of smart products in the EoL are described" (b) "To which EoL sub-phase can they be assigned to?" (c) "Which data resources are used in these use cases to add value in the EoL phase?". To answer these questions, a systematic literature review according to vom Brocke et al. (2009) was conducted.

Google Scholar was chosen as database for relevant article search due to its wide range of scholarly articles available. A total number of 405 papers was found by keyword search and relevant papers have been filtered according to Table 1.

These 15 articles were further analyzed with the aim to identify data applications for value creation in the EoL phase and to count their frequencies. For this paper the systematization of the data resources, more precisely three data sources and three data categories, are used to classify the lifecycle data described in EoL use cases. By distinguishing these data sources and data categories, a 3 × 3 matrix for the systematic analysis and presentation of the described data sets is obtained. The nine fields that result from the 3 × 3 matrix, are referred to as data resources A-I, as shown in Table 2. The base for this classification system stems from the digital twin conceptual reference framework from Barth et al. (2020).

Finally, sub-classification for data resources A-I was conducted. If different data types within the same data resource were mentioned, an appropriate term was determined (e.g., data resource A contains the data types sensor data and battery life

Table 1 Overview of literature search and filtering process

Search string/Synonym groups	Synonym group 1: "Digital twin" OR "Virtual counterpart" OR "Digital counterpart" OR "Digital artifact" OR "Product avatar" OR "Cyber-physical equivalence" OR "cyber physical equivalence" OR "Product shadow" OR "Smart product" OR "Smart system" OR "Cyber physical product" **AND** Synonym group 2: "End-of-lifecycle" OR "EoL" OR "End of lifecycle" **AND** Synonym group 3: "Data" OR "Information" **AND** Synonym group 4: "Reuse" OR "Retire" OR "Disposal" OR "Recycling" OR "Disassembly" OR "Resale" OR "Circular economy"
Search results (Google Scholar)	405 Articles
Selection by title	129 Articles (containing at least one synonym of group 1 and one of synonym from group 2–4
Selection by abstract	45 Articles (containing at least one of the synonyms from group 1–4
Selection by article	13 Articles (containing relevant content)
Backward search	+2 Articles
Total	15 Articles included for this review

Table 2 Utilized classification system for the nine data resources based on the 3 × 3 matrix

		Category		
		Product	Customer	Context
Source	Thing	Data resource A	… B	… C
	Internal system	… D	… E	… F
	External system	… G	… H	… I

information). A count of frequencies for each data type was conducted. Additionally, each paper was further analyzed to classify and count the EoL phases based on the four subphases of recycling, reuse, disposal, and refurbishment according to Kiritsis (2011).

4 Results

The results of this systematic review revealed practical and theoretical data applications for value creation in EoL phase of smart products. Of the 15 papers reviewed, 11 describe the use of data for the recycling purposes. 5 mention a reuse scope. In 2 cases the added value from the data is deployed for a better disassembly/disposal process. Waste reduction, general decision support for EoL and refurbishment are each mentioned once in 3 different papers. Table 3 shows the count of frequencies of the data resources A-I used, according to the classification system in Table 2.

Most mentioned data resources are A and D, with a frequency of 12 and 13 respectively. The third most mentioned data resource is F, with a frequency of 6 cases. Data resource E and data resource I are both mentioned in 5 cases and data resource G in 4 different cases. The least mentioned data resources, with 1–3 cases were B, C and H.

By shifting the point of view towards the three data categories the following can be stated: The most mentioned data category is product with 29 cases. Within this category, the two most prominent data sources are thing with 12 mentions (e.g., *infrared sensor* data (Jiang et al., 2019; Lee et al., 2015; Pham et al., 2019)) and internal system (e.g., *3D* models (Lai et al., 2020; O'Grady et al., 2021; Riedelsheimer et al., 2020; Rocca et al., 2020)) with 13 applications cases. Least mentioned is external system, with 4 (e.g., *user posts* (Wuest et al., 2015) and *usability information* (Rocca et al., 2020)). Secondly most common category is contextual data, with a frequency of 14. The most prominent data source within this category is internal systems in 6 cases (e.g., *washing information* (Riedelsheimer et al., 2020)), followed by external systems such as quotas (Kintscher et al., 2020), in 5 cases and thing with 3 cases (e.g., *geographical information* (Wuest et al., 2015)). The fewest mentioned category is customer data with a total of 8 mentions. 5 from internal system, such as *metadata from users* (Kintscher et al., 2020, 2021; Stankovski et al., 2009), 2 from

Table 3 Count of frequency of the data resources

Cases, N = 15		Category						
		Product	References	Customer	References	Context	References	$\sum$
Source	Thing	**12** A	Jiang et al. (2019), Kintscher et al. (2020, 2021), Kondoh et al. (2021), Krishnakumari et al. (2021), Lai et al. (2020), Lee et al. (2015), Morello et al. (2013), Pham et al. (2019), Rocca et al. (2020), Stankovski et al. (2009), Wuest et al. (2015)	**2** B	Lai et al. (2020), Pham et al. (2019)	**3** C	Lee et al. (2015), Soldatos et al. (2021), Wuest et al. (2015)	**17**
	Internal system	**13** D	Jiang et al. (2019), Kintscher et al. (2020), Kondoh et al. (2021), Lai et al. (2020), Lee et al. (2015), Morello et al. (2013), O'Grady et al. (2021), Pham et al. (2019), Riedelsheimer et al. (2020), Rocca et al. (2020), Soldatos et al. (2021), Stankovski et al. (2009), Wuest et al. (2015)	**5** E	Kintscher et al. (2020, 2021), Pham et al. (2019), Riedelsheimer et al. (2020), Wuest et al. (2015)	**6** F	Lee et al. (2015), Pham et al. (2019), Riedelsheimer et al. (2020), Soldatos et al. (2021), Stankovski et al. (2009), Wuest et al. (2015)	**24**
	External system	**4** G	Kintscher et al. (2020, 2021), Rocca et al. (2020), Wuest et al. (2015)	**1** H	Lai et al. (2020)	**5** I	Kintscher et al. (2020, 2021), Pham et al. (2019), Soldatos et al. (2021), Wuest et al. (2015)	**10**
	$\sum$	**29**		**8**		**14**		**51**

Table 4 Classification and frequencies of data types of the nine data resources

Cases, N = 15		Category		
		Product	Customer	Context
Source	Thing	**A**: Sensor data (6) Battery SoH (5) Malfunctioning data (2) Dissasemblability/weight (1)	**B**: User data (2)	**C**: Temperature (2) GPS & environ. data (1) Acoustic signals (1)
	Internal system	**D**: Product/material data (12) 3D/CAD Models (5) Maintenance history (4) Process data (3) Product history data (3) Production/manufacturing data (3) Disassembly data (2)	**E**: User history (3) User metadata (3)	**F**: Usage Data (6) Socio-environ. data (2)
	External system	**G**: Disassembly process data (2) Usability feedback (2)	**H**: Customer feedback (1)	**I**: Market data (4) Quotas (1) Dismantler data (1) Collaborative services (1)

thing (e.g., *operational data* (Lai et al., 2020)) and 1 case describes data usage from external system (*customer feedback* (Lai et al., 2020)).

By shifting the point of view towards the data sources the following can be stated: Highest frequency is represented by internal systems with 24 observing in total, followed by the source thing in 17 cases and external sources with 10 mentions.

The distribution of the data categories (product, customer, context) within the sources (thing, internal system, external system) varies. From the 17 cases within the source thing, 12 (70.58%) belong to the category product (data resource A). From the 24 cases within the source internals systems 13 (54.17%) belong to the category product (data resource D). In both cases this makes out the most prominent category. Whereas within the source external system only 40% are from the category product (data resource G). Here, the most prominent category is context with a frequency of 5 (50%).

Further, data types within the 9 different data resources A-I can be defined as shown in Table 4.

5 Discussion

It can be stated that the application of data for value creation in the EoL still remains a rarely discussed and researched field. All the articles reviewed describe data usage for EoL purposes, whereby recycling was the most mentioned case. A motivation towards a circular economy by deploying data from smart products seems to exist but remains little mentioned in the literature. In this paper only efforts for a circular economy in the EoL were considered. Alternatives exist, where midlife update of capital equipment is shown to have potential to also facilitate the implementation of the circular economy effectively (Khan et al., 2020). Nearly 50% of all data resources and types include the data category product from thing or internal systems (data resources A and D). It appears that these data resources contribute the most to EoL value creation. All papers mention at least one case of application of these data resources. A potential explanation may lie in the nature of the underlying data types (e.g., *sensor data*, *3D* and *CAD models*, *material information*). Most of this data is available already before or right after product market launch and remains a valuable information source throughout the whole life cycle. This early-stage data seems to be simple to access for supporting decision-making during the EoL. This is also reflected in the high proportion of the data category product within the sources thing and internal systems.

Data resources E, F and I have nearly half as many described cases compared to the data resources A and D. The most mentioned data types within these data resources are represented by *usage data*, *market data* and *user history*. This data resources still represent an important source for EoL value creation. The data type *user data* (e.g., *CRM*, *payment data*) with a frequency of 6 mentioned cases in total also plays a relatively important role in the EoL. This seems plausible, as during the end of a products lifecycle, e.g., dismantlers, need information about the user when it comes to recycle or dispose the product correctly. Data types such as *quotas*, *collaborative services* and *socio-environmental*, belonging to the data resource I, are less mentioned for EoL value creation. They seem to represent more an additional information source for the user during the usage phase and are less useful for EoL decisions.

The least mentioned data resources for EoL decision-making are B, C and H. Nonetheless, by having a closer look to the different data types underlying this data resources a few arguments can be sated: The most represented data type is *user data*, with 2 mentions in two different papers. This data type provides general information about how and how long a customer used a product. The origin of the information is more on a behavioral base. This may be a reason why this data types play a less important role during the EoL. Even though, this type of information could be crucial when it comes to reusing a product and the next generation of user may be interested in this kind of data. Data types *temperature*, *geographical information data*, *customer feedback* show low frequency as well. This data may need to be involved from external sources, which could be barrier to integrating this data. C*ustomer feedback* shows the lowest frequency of the data resources. An argument here could be that for EoL decisions *customer feedback* is not taken in consideration because it represents an external opinion and, therefore, seems to be less suitable for EoL decisions. However, the relatively small scientific representation of applications of data usage for EoL value creation implies a careful view about the topic. Additional prudence is required, as only a single data base was used for the literature search.

6 Conclusions and Recommendations

The findings present an overview of which data resources and data types find meaningful applications during the EoL. The results show that data driven value creation in EoL still occurs little. Therefore, practical contributions should be considered for the future. So far, the attention to value creation through data exploitation was mostly considered for BoL and MoL. In this paper use cases which generate data driven value during the EoL are presented. Nevertheless, further research avenues arise and are of great importance to continue filling the gap between theory and practice. Research avenues could be: (i) Which data types are best suited for a closing-the-loop strategy? (ii) Does a merge of BoL and MoL data generate a new form of useful EoL data and (iii) Which additional data types for value creation in EoL exist?

References

Barbieri, C., West, S., Rapaccini, M., & Meierhofer, J. (2019). Are practitioners and literature aligned about digital twin. In *26th EurOMA Conference Operations Adding Value to Society. Conference Paper*.

Barth, L., Ehrat, M., Fuchs, R., & Haarmann, J. (2020). Systematization of digital twins: Ontology and conceptual framework. In *3rd International Conference on Information Science and Systems (ICISS 2020). Conference Proceedings*, March 19–22, 2020, Cambridge, UK. ACM. https://doi.org/10.1145/3388176.3388209

Brocke, J. V., Simons, A., Niehaves, B., Niehaves, B., Reimer, K., Plattfaut, R., & Cleven, A. (2009). Reconstructing the giant: On the importance of rigour in documenting the literature search process. In *ECIS 2009 Proceedings*. Paper 161.

Damjanovic-Behrendt, V., & Behrendt, W. (2019). An open source approach to the design and implementation of digital twins for smart manufacturing. *International Journal of Computer Integrated Manufacturing, 32*(4–5), 366–384. https://doi.org/10.1080/0951192x.2019.1599436

Dawid, H., Decker, R., Hermann, T., Jahnke, H., Klat, W., König, R., & Stummer, C. (2016). Management science in the era of smart consumer products: Challenges and research perspectives. *Central European Journal of Operations Research, 25*(1), 203–230. https://doi.org/10.1007/s10100-016-0436-9

Detzner, A., & Eigner, M. (2018). A digital twin for root cause analysis and product quality monitoring. In *Proceedings of the DESIGN 2018 15th International Design Conference* (pp. 1547–1558). https://doi.org/10.21278/idc.2018.0418

Fuchs, R., & Barth, L. (2018). Wie Smart Connected Products Kunden emotionalisieren. In Rueger et al. (Eds.), *Emotionalisierung im digitalen Marketing: Erfolgreiche Methoden für die Marketingpraxis* (pp. 89–103).

Grieves, M. (2003). *Digital twin: Manufacturing excellence through virtual factory replication.* Grieves LLC.

Grieves, M. (2005). Product lifecycle management: The new paradigm for enterprises. *International Journal of Product Development, 2*(1/2), 71–84.

Grieves, M., & Vickers, J. (2016). Digital twin: Mitigating unpredictable, undesirable emergent behavior in complex systems. *Transdisciplinary Perspectives on Complex Systems, 85–113*,. https://doi.org/10.1007/978-3-319-38756-7_4

Holler, M., Uebernickel, F., & Brenner, W. (2016). Digital twin concepts in manufacturing industries—A literature review and avenues for further research. In *2016 18th International Conference on Industrial Engineering (IJIE)*, Seoul, Korea.

Jiang, H., Yi, J., Zhou, K., & Zhu, X. (2019). A decision-making methodology for the cloud-based recycling service of smart products: A robot vacuum cleaner case study. *International Journal of Computer Integrated Manufacturing, 32*(1), 58–71.

Khan, A. M., West, S., & Wuest, T. (2020). Midlife upgrade of capital equipment: A servitization-enabled, value-adding alternative to traditional equipment replacement strategies. *CIRP,* 232–244.

Kintscher, L., Lawrenz, S., & Poschmann, H. (2021). A life cycle oriented data-driven architecture for an advanced circular economy. *Procedia CIRP, 98*, 318–323.

Kintscher, L., Lawrenz, S., Poschmann, H., & Sharma, P. (2020). Recycling 4.0-digitalization as a key for the advanced circular economy. *Journal of Communication, 15*(9), 652–660.

Kiritsis, D. (2011). Closed-loop PLM for intelligent products in the era of the Internet of things. *Computer-Aided Design, 43*(5), 479–501.

Kondoh, S., Kishita, Y., & Komoto, H. (2021). Adaptive decision-making method of life cycle options by using process data collected over multiple life cycle stages. *Procedia CIRP, 98*, 382–387.

Krishnakumari, P. K., Kumar, H. D., Kulkarni, S., & Sauter, E. M. (2021). Industry 4.0 and circular economy digitization and applied data analytics. In *An introduction to circular economy* (pp. 349–367). Springer.

Lai, Y., Wang, Y., Ireland, R., & Liu, A. (2020). Digital twin driven virtual verification. In *Digital twin driven smart design* (pp. 109–138). Academic Press.

Lee, J., Ardakani, H. D., Yang, S., & Bagheri, B. (2015). Industrial big data analytics and cyber-physical systems for future maintenance & service innovation. *Procedia CIRP, 38*, 3–7.

Landahl, J., Panarotto, M., Johannesson, H., Isaksson, O., & Lööf, J. (2018). Towards adopting digital twins to support design reuse during platform concept development. In *Nord Design 2018*, August 14–17, 2018, Linköping, Sweden.

Malakuti, S., Goldschmidt, T., & Koziolek, H. (2018). A catalogue of architectural decisions for designing IIoT systems. *Lecture Notes in Computer Science,* 103–111. https://doi.org/10.1007/978-3-030-00761-4_7

Malakuti, S., Schlake, J., Ganz, C., Harper, K. E., & Petersen, H. (2019). Digital Twin: An Enabler for New Business Models.

Morello, B. C., Ghaouar, B., Varnier, C., & Zerhouni, N. (2013, October). Memory tracking of the health state of smart products in their lifecycle. In *Proceedings of 2013 International Conference on Industrial Engineering and Systems Management (IESM)* (pp. 1–7). IEEE.

Negri, E., Fumagalli, L., & Macchi, M. (2017). A review of the roles of digital twin in CPS-based production systems. *Procedia Manufacturing, 11*, 939–948. https://doi.org/10.1016/j.promfg.2017.07.198

O'Grady, T. M., Brajkovich, N., Minunno, R., Chong, H. Y., & Morrison, G. M. (2021). Circular economy and virtual reality in advanced BIM-based prefabricated construction. *Energies, 14*(13), 4065.

Pham, T. T., Kuo, T. C., Tseng, M. L., Tan, R. R., Tan, K., Ika, D. S., & Lin, C. J. (2019). Industry 4.0 to accelerate the circular economy: A case study of electric scooter sharing. *Sustainability, 11*(23), 6661.

Riedelsheimer, T., Dorfhuber, L., & Stark, R. (2020). User centered development of a digital twin concept with focus on sustainability in the clothing industry. *Procedia CIRP, 90*, 660–665.

Rocca, R., Rosa, P., Sassanelli, C., Fumagalli, L., & Terzi, S. (2020, June). Industry 4.0 solutions supporting circular economy. In *2020 IEEE International Conference on Engineering, Technology and Innovation (ICE/ITMC)* (pp. 1–8). IEEE.

Rosen, R., von Wichert, G., Lo, G., & Bettenhausen, K. D. (2015). About the importance of autonomy and digital twins for the future of manufacturing. *IFAC-Papers OnLine, 48*(3), 567–572. https://doi.org/10.1016/j.ifacol.2015.06.141

Shen, Z.-J.M., Wang, L., & Deng, T. (2021). Digital twin: What it is, why do it, related challenges, and research opportunities for operations research. https://doi.org/10.2139/ssrn.3777695

Soldatos, J., Kefalakis, N., Despotopoulou, A. M., Bodin, U., Musumeci, A., Scandura, A., Aliprandi, C., Arabsolgar, D., & Colledani, M. (2021). A digital platform for cross-sector collaborative value networks in the circular economy. *Procedia Manufacturing, 54*, 64–69.
Stankovski, S., Lazarević, M., Ostojić, G., Ćosić, I., & Puric, R. (2009). RFID technology in product/part tracking during the whole life cycle. *Assembly Automation.*
Tao, F., Zhang, H., Liu, A., & Nee, A. Y. (2019). Digital twin in industry: State-of-the-art. *IEEE Transactions on Industrial Informatics, 15*, 2405–2415.
Wuest, T., Hribernik, K., & Thoben, K.-D. (2015). Accessing servitisation potential of PLM data by applying the product avatar concept. *Production Planning & Control, 26*(14–15), 1198–1218. https://doi.org/10.1080/09537287.2015.1033494
Zheng, Y., Yang, S., & Cheng, H. (2018). An application framework of digital twin and its case study. *Journal of Ambient Intelligence and Humanized Computing, 10*(3), 1141–1153. https://doi.org/10.1007/s12652-018-0911

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Coworking Between Customers and Service Divisions in the B2B Business—With a Deeper Focus on Field Service

Marleen Mühlberger, Thomas Sautter, Shaun West, and David Harrison

Abstract The work concept of coworking has emerged in recent decades and coworking spaces offer an attractive environment and a casual and appealing atmosphere. Generally, coworking is understood as the flexible rental and termination of office space, workstations, or even creative spaces. The use is attractive for start-ups, traditional companies—especially development teams—and self-employed people. These are open work and communication areas where people can make contacts and exchange ideas with like-minded people. The philosophy and mindset of coworking will be analyzed in this paper against the background of customer relationships, especially in field service activities. Field Service Management stands for the optimized deployment planning of a company's mobile resources to handle service or maintenance orders. The resources include internal and external technical staff in the field, vehicles, and other tools or machines.

Keywords Coworking · Collaboration · Field service

1 Introduction

In recent years the perception of coworking has changed a greatly and it has become more popular. A core element of New Work is not only the work-life balance as in classic working life, but the connection of work and life (Graf & Petek, 2020). The idea of coworking is appearing more and more often in our world. There are lectures, conferences in which the culture of coworking is mentioned again and again, from shared offices to coworking spaces. These can be set up and designed in very different ways. A coworking space is generally a place where different people share an infrastructure without working for the same company. Most users of coworking spaces

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are freelancers or start-ups. The essence of coworking spaces is characterized by community and togetherness as well as exchange with others, building professional relationships and networks. Through this exchange, the novices gain the courage for self-realization and the encouragement to tackle new things or tips that help them to proceed in the best way. Reflection and motivation are elementary components of coworking (Bukvic, 2020). The new technologies that arise as a result of change are also an elementary component of collaboration. These can not only be used in daily business, but also especially in the after sales area and in the field service area (Graf & Petek, 2020).

The Coronavirus crisis in particular has changed the world of work and demands new concepts for the workplace and working hours. Free-thinking employees should create new innovations in the future in order to create even more efficient solutions, "Because it's about more than just office design" (Graf & Petek, 2020). In the future, teamwork will be more and more desirable and a department should achieve its goal as a team, with fewer lone fighters, because more can be achieved together. The creative chaos should motivate employees to get more out of their tasks and to produce solutions as efficiently and innovatively as possible (Graf & Petek, 2020).

In the following paper, the area of field service management will be considered, in order to highlight a concrete field of coworking (e.g., co-locating, collaboration, and other forms of collaborative working). The field service area of a company is one of the most important fields in turnover. For example, when repairs are needed and service is required is becoming increasingly important for companies, as it is crucial for customer satisfaction. In a narrower sense, the term 'field service' stands for the optimized deployment and planning of a company's mobile resources to handle service or maintenance orders. The resources include both internal and external field service staff. Vehicles and machines are also used, which can make service more efficient and innovative. In particular, the innovation of VR glasses enables mechanics to save long driving times and provide help quickly by virtually putting themselves in the customer's shoes through the glasses.

To elaborate all these different streams and possibilities the research question for this paper is: has coworking between customers and service in mid-size industrial companies had a positive impact, such as higher customer satisfaction, higher customer loyalty and therefore higher sales to the business?

2 Literature Review

The workstyle of the future, which is triggered by the massive changes of digitalization, makes us discuss what good work looks like and how we ourselves would like to work. Since the beginning of the 2000s, the term "change" has gained more and more importance. This change continues to this day and unfolds in ever more detail, in the direction of digitalization and globalization. Continuous change is becoming a permanent task for every company, every organization, and every individual (Rütten & Bathen, 2018).

The world of work is changing, and identifying these changes is the first step in understanding them. According to the categorization carried out by the Frauenhofer Institute for Labour Economics and Organization, the world of work is divided up as follows (Hirsch-Kreinsen, 2019).

There are some potential benefits and risks with coworking. Potential benefits include social interaction in coworking spaces, increased autonomy through choice of work location, improved work-life balance, and reduced stress through reduced travel time. Other possible benefits are the development of new ideas and knowledge transfer through interaction, higher flexibility and lower costs. However, risks include the violation of data protection and data security of sensitive information, and the deterioration of relationships with colleagues and team members due to the lack of a physical presence in the company (Hirsch-Kreinsen, 2019). A major advantage of coworking spaces is the flexibility to rent and cancel workspaces and meeting rooms (Bukvic, 2020). Digitization enables spatial decentralization to be realized in real-time communication across the world. New forms of communication and collaboration are emerging, and one consequence of this is coworking spaces. Decentralization also involves new working relationships (Hackl, 2017).

Due to the current social upheavals, and driven by the worldwide megatrends of digitalization, urbanization, globalization, and mobility, it is exciting how far and how fast the journey will go. Driven by new technologies and artificial intelligence, all possibilities are open. With digitalization, job profiles have also shifted. Many traditional professions are disappearing, and new ones are emerging. Many things only have to be controlled once they have been produced. The physically hard work is also becoming less and less; machines and robots are taking over. In the future, the focus will be on health, exercise, and sport. As we move less and less in our professional environment, it is all the more important to engage in sports outside of work in order to stay healthy (Bukvic, 2020).

There are many opportunities and challenges in the new working world 5.0. A look at the world of work 5.0 reveals at least five elementary topics: competence requirements, lifelong learning, changed working conditions, the way of earning an income, and data sovereignty and control options (Prieß, 2020).

3 Methodology

It was determined that empirical research would be used to answer the research question. The research results should be objective, reliable and valid and in order to achieve these criteria, the quantitative method was chosen and the overview of the methodology is shown in Fig. 2. In a survey conducted by the online provider umfrageonline.de, a selected group of people had the opportunity to give their assessment. The potential participants received a link to take part in the survey (Klein, 2017).

This research question is to be considered not only on the basis of existing literature. A characteristic of quantitative methods is when hypotheses are derived from the research question. These hypotheses are then validated with more appropriate

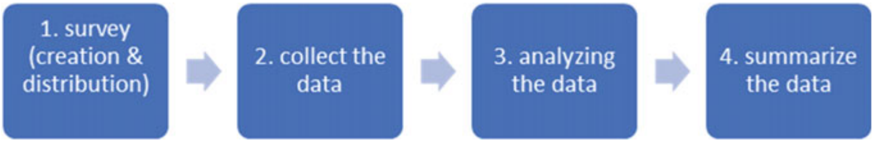

Fig.2 Overview of the methodology applied in this study

methods using numbers and statistical correlations. There should be no influence from the researcher, i.e., the participants should be unbiased towards the topic and reflect their own opinion (Prieß, 2020).

In a second step, the data collection and data entry were considered. As this is a software-based solution, the collection and recording of data occurs at the same time and in the same organization. The creation of questionnaires and the drawing of a sample was done scientifically. When using quantitative methods, large amounts of data are generated, which can be efficiently compressed and analyzed using standard office applications. The target group of the survey was clearly defined in advance: companies in the European region, regardless of size, in order to be able to create as comprehensive a picture as possible (Prieß, 2020). For the data analysis, the tool from "umfrageonline.de" was used for an initial evaluation of the data. The raw data could be downloaded and the exported file could then be further analyzed with the help of Excel, and graphics could be created with the help of Think Cell, in order to be able to present the results graphically (Prieß, 2020).

4 Results

4.1 General Information from the Participants from the Survey

In total 44 people participated in the survey entitled "Coworking between Customers & Service with a focus on field service". The survey was conducted from 24.08. to 06.09.2021. Most of the participants are from Germany (43% of the respondents), another large part of the respondents (25%) are from Turkey, followed by Italy and Russia with 7% each. The size of the companies in which the participants work varies. 59% work in companies with up to 999 employees. 41% of the participants work in a larger company with more than 1,000 employees.

4.2 Possibilities for Coworking

When asked in which area opportunities for coworking are seen, 72% identified training and 64% online support for clients as a possible area. 61% identified trouble shooting, followed by common order handling with 33% as a possible area. Other possible areas for coworking are pilot projects, design engineering, management, distribution, spare parts logistics and at the end it is a question of organization, technical equipment, and trust.

4.3 Challenges to Prepare Areas for Coworking

In order to implement coworking and bring it into one's own company, certain areas have to be defined. Internally, in relation to one's own company, it is difficult to prepare the individual areas for coworking. In the survey, respondents could choose between not difficult, slightly difficult, neutral, difficult, and very difficult. Regarding logistics, 35% think that it is difficult to implement coworking. 38% are of the opinion that it is difficult to implement operations and to make progress with coworking. In the area of marketing and sales, 30% are neutral, while 27% see it as not difficult to implement coworking. For the service area, the answers are very mixed, and the majority (30%) believe that it is difficult to implement coworking in this area.

Regarding the external view, the majority (32%) stated that it is slightly difficult to prepare the customer relationship area for coworking. Regarding the supply chain area, 30% of the responses were slightly difficult and neutral. In the area of logistics, 32% see it as difficult to introduce coworking in this area. Regarding the service area, most respondents considered it slightly difficult or neutral to implement coworking in this area.

4.4 Experience with Coworking

66% of the respondents already had experience with coworking. Of these, 37% of respondents started coworking one year ago, 47% in the last five years and 17% in the last ten years.

4.5 Positive Influence of Coworking

The positive influence of coworking on different areas of business could be classified in the survey with the three levels low, medium, and high. The influence of coworking is medium for the area of sales according to 41% of the respondents. For the area of profit, the influence is low for 50% of respondents. For the area of speed, 50% think it has a low impact and for the area of “easy to handle process”, 63% of the respondents think that it has a medium influence.

4.6 Effort to Solving Challenges in Coworking with Customers

In the survey, the participants could rank different areas that were given. The rating had five categories. From very challenging, challenging, to neutral, easy, and very easy. The internal process is seen as challenging by 50% of the respondents. The area of compliance is seen as neutral by 32%. The area of technical difficulties is seen as challenging by 47% of respondents. A distribution of opinions can be seen in IT. Here the opinions are very mixed and range from challenging to neutral to easy. With 37% of the respondents, the majority is of the opinion that speed in execution is challenging. The participants also rated ambient, external process, general acceptance, and relationships as challenging. Quality was rated neutral.

4.7 Potential Coworking

58% of the respondents want to expand the business model and continue to develop it. In response to the question of whether cooperation is planned, 49% of the respondents answered in the positive. Potential coworking cases in their business model for the respondents are, for example. “VR glasses for inspection of a loco”, “VR glasses for field service”, “VR glasses to be online connected with the client” or “Coworking is potentially very beneficial in Field Service. Using modern tools can accelerate the communication and then, the speed of technical problem solving. We are now obviously facing times when recruiting, training, and retaining competent service engineers is a real challenge. Coworking can be part of the solution.” Furthermore, the participants answered, “We will practice together with our affiliated company and already have the first departments here that are implementing this (R&D).” “Coworking with the company TSA could be useful to develop the service business in Italy on generators and electrical engines” and “solving the warranty cases”. In addition, the keywords were “Joint venture” and “Consulting, Sales”. Another idea as a potential coworking case in the business environment “wherever a neutral and fresh perspective is necessary” and, “Execution of maintenance and repair operations and faults together”.

5 Discussion

Coworking's origin was as a method to cooperate with shared offices, that workers, especially freelancers and new start-ups, could use when needed for reasonable costs. Often, shared services were also provided, like common secretarial or administration services, to enable young firms—mostly one-man-shows or with only a small number of employees—to concentrate on their main business. This idea of coworking became a business model in the modern Service world, and the COVID-19 pandemic forced firms and employees to practice this way of collaboration overnight.

To share jobs, personnel, workshops, equipment or spare parts between customers and the contracting company requires a common understanding and alignment on the problem to be solved, or the service being offered. A new sphere of possibilities is arising because a service job requires a combination of some of these resources in order to be on time and complete the project. Realizing such collaborations is opening new dimensions in execution speed and being effective on resources spent. But it's not only having the idea or the willingness to do it. To prepare a company for collaboration or coworking, a drastic change from traditional process-driven step by step execution is required. The starting point is the mindset of people, the organization, the management and later on, the culture of the company, with flexible processes and a willingness to adapt the business to fit the needs of a customer, or to agree with the client who is doing what, how and when. The supply chain will be delivering individual parts or kits instead of following a fixed parts process and the supervisors will be in close contact with the customers' organizations to align the details and—if necessary, on the project plan with clear responsibilities and timelines. By being flexible in the order or project execution there are challenges in the commercial areas and procedures. This documentation should be aligned with the customer in the beginning of the collaboration to avoid discussions and misunderstandings and with internal areas to avoid questions and to ensure a quick and effective order-to-cash process.

Coworking with customers offers new possibilities to increase customer satisfaction, because orders can be fulfilled quickly and more cost efficiently. From the sales perspective it creates the possibility to get additional orders by being more cost effective, but also lose the part of sales the client works on or brings to the deal. The decision on whether an organization will enter into this method of collaboration is driven by the markets, the competition, and the demands of the customers.

COVID-19 pushed the world—and the Service world—into new realities overnight. Business travelling was immediately stopped due to governmental restrictions and the strict requirements of customer organizations. And with that scenario the requirements on service solutions changed within days. When in the past field service engineers went to the customer to fix a problem, do a repair, hold a training session or help with other service support, the needs didn´t change, but the physical presence was impossible. The only possibilities have been digitally enabled solutions such as Virtual Reality glasses or digital communication to deliver what was done face to face by people in the past.

Financially, the impact on sales is normally not that high, because parts of the business are executed by the customer and it's another way of doing business. Being quicker than the competition could lead to more possibilities that have been done by others in the past, and therefore, in new areas there could be an increase in business, but mostly coworking helps to defend the existing market shares, businesses, and customers. From a profit perspective the effect could be positive if the customer pays for speed or a reduction of downtime. If the business is just another way of handling orders the influence on the profit level will be moderate. In cases of defending market shares the opportunity costs should be taken into consideration.

From the managerial implication coworking requires—like New Work methodologies—a different style of management from the past. Managing a traditional service business with spare parts or workshop and field service operations to meet customer needs and demands is not enough. Coworking requires the management to define a clear strategy on the way of doing these collaborations from a top line view. Next to that, processes, tools, resources in manpower have to be provided—embedded in the right service culture.

The academic implications are on many different areas driven by the worldwide megatrends of digitalization, urbanization and globalization. New Work methods, digitally enabled services, change process and collaboration with customers implicate the academic discussions and need to be taken in consideration.

6 Conclusion and Recommendations

In conclusion, it is noted that many use coworking and want to expand it even more in the future. The use has increased immensely in recent years, not least due to Covid-19, as many employees were forced to work from their homes. Through new workplace and working time models, in the future it is important to promote free thinkers and to develop creative innovations. Not only inventive solutions and efficient approaches are needed, but also the ability to work together and achieve goals as a team. In coworking spaces, which can be set up individually, not only an infrastructure is provided, but also the meeting of different people with many ideas for new products.

Especially in the service area, there is still a lot of potential for collaboration and coworking, and it can definitely be expanded, as many opportunities have not yet been exhausted. For example, by using VR glasses, service calls can be carried out much faster and the customer has shorter downtimes. Optimization can also be carried out more often via the VR glasses in order to provide the customer with the best possible result. This means that there are no longer travel costs and the customer can become more efficient in a cost-effective manner and, for example, optimize production. The employee is also spared long, tiring journeys, waiting at the airport, and long car journeys. He can easily network with the customer from home and have virtual insight into the machine to tell the customer what he should do, install, or program. This not only eliminates long downtimes, but also saves valuable resources such as time and money.

References

Bukvic, R. (2020). *Die coworking evolution—Wie wir zukünftig leben und arbeiten*. Redline Verlag.

Graf I., & Petek, R. (2020). New Work, Home Office & Raumkonzepte der Zukunft.

Hackl, B., et al. (2017). *New Work: Auf dem Weg zur neuen Arbeitswelt*. Springer Gabler.

Hirsch-Kreinsen. (2019). *New Work—Wie die Digitalisierung die Arbeitswelt verändert—Potenzial- und Risikoanalyse für produzierende Unternehmen*; Lingener Studien zu Management und Technik; Hermann Witte, Reinhard Rauscher, Michael Ryba, Band 13 (p. 25).

Klein, A. (2017). *Wissenschaftliche Arbeiten schreiben*. Mitp Verlag GmbH & Co. KG.

Prieß, A. (2020). *Digital Overload Management—Modernes Zeitmanagement als Überlebenshilfe für die New Work*. Haufe.

Rütten, I., & Bathen, S. (2018). *New Work Styles—Impulse zu neuen Arbeitsmodellen im digitalen Zeitalter*; BoD—Books on Demand, Norderstedt.

Marleen Mühlberger explored the different models of co-working between field service and customers. During COVID-19 the amount of co-working has increased with customers. The increasing digitalization, coupled with new working styles, has enabled co-working within firms. The study presented the finding of a survey of 44 participants in Europe. In it, 66% responded that they have experience of co-working, with it being considered very beneficial to field services as it supports joint problem-solving. Almost 60% expect it to increase, and they think it is a valuable way to secure sales, maintain (or improve) customer experience, and maintain margins.

Thomas Sautter started his career inat the army in Germany with leading functions in infantry and tank battallions, and as a communication officer and training expert to the US Forces in Germany. He then spent 7 years in the construction industry as a leader of a business unit with the management tasks and acquisition, order handling and cash management. Starting 2002 at Voith in Service as the project manager for a JV with Deutsche Bahn to found and create a common Service location by including the best processes and organizations of both companies, including a new facility for 300 people. He developed Ssales experience in different functions with the main task for MRO and spares. In 2008 he took take over the responsibility for a newly founded service business line Service for one product. Ddeveloping service growth and new services with new departments like Service Product- and Project- Management. The iIntegration of other Sservice areas into this successful growing system built up to 350 MEUR responsibility and 900 employees globally in 2020. Sautter's Mmain focus in all organizations has been for customer centric approaches, flexibility, speed, and a mindset to perform. Since 2020 he has been responsible for Europe for all New Build and Service Business @ Voith Turbo Mobility in Europe, with in the main markets of Rail, Commercial vehicles and Marine mobility. His Sspecialized tasks include selling and adding digital products and sServices to the company's traditional products.

Shaun West gained a PhD from Imperial College in London, then worked for over 25 years in several businesses related to industrial services. He started his industrial career with AEA Technology before moving to National Power, where he developed and sold services to external businesses. After studying at HEC (Paris) for an MBA, he moved to GE Energy Services, modeling and negotiating long-term service agreements. At Sulzer, he drafted the strategy that led to the service division tripling in size over 10 years and executed part of the strategy by acquiring a 220M CHF service business. Now at the Lucerne University of Applied Sciences and Arts, he is the Professor of Product-Service System Innovation. He focuses his research on supporting industrial firms to develop and deliver new services and service-friendly business models. He is a member of the advisory board for the ASAP Service Management Forum and a member of the Swiss Alliance of Data-Intensive Services. He lives close to Zurich with his wife and two children. He climbs, skis, and runs.

Smart Service Enabled Innovation Approaches

Market Segmentation of Industrial Smart Services: A Buyer-View of the Relation Between Value of Data and Performance Orientation

Luis E. Prato V.

Abstract The aim of this paper is to develop a more sophisticated methodology for market segmentation of Industrial smart services. Prior research in the service literature has focused less to assess the attractiveness of digital transformation (i.e. data captured, transformed, and analyzed) for this purpose. Moreover, the intrinsic performance orientation from a buyer perspective has been seldom discussed in the literature. A proposed framework sheds light after conducting 29 interviews with firms active in construction and metals production environments. Qualitatively, the study unveiled the importance of the holistic understanding of both operation and purchasing considerations required towards the supply management of smart services as the main strengths of this framework.

Keywords Digital transformation · Industrial smart services · Performance-based

1 Introduction

The seminal studies of Lightfoot et al. (2013), Neely (2009) and Baines (2009) suggest, that servitization plays an important role in the transition of manufactures from pure product business models; towards the delivery of service offerings in industrial environments. However, the unprecedented rise of digital technologies (Ardolino et al., 2018) has empowered entirely new digital business models (Opresnik & Taisch, 2015). Indeed, servitised manufacturers look into more opportunities to adopt more product-service-systems (PSS) (Lightfoot et al., 2013), through the implementation of Industrial smart services. According to Chowdhury et al. (2018) and Allmendinger and Lombreglia (2005) the term smart services describes a new generation of services as the result of the combination of data collected from connected products and information from other additional field sources. Nowadays; the seamless integration between the physical (e.g. product related human-services) and virtual (e.g. digital

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and analog information) worlds have offered majors advantages for B2B markets to achieve this goal.

Nevertheless, there are still several complications in the field of Industrial smart services for their fully adoption in B2B markets. Mainly, suppliers still face reluctancy from buyers to accept these novel services during the purchasing process (Stoll et al., 2021). One reason is that resulting market segments do not truly recognize the value of data capabilities and performance-orientation embedded in such smart industrial services (West et al., 2021). Indeed, implicit in the process of measuring value through behavioral segmentation, are the central concepts of "purchasing behavior" and "benefits' impact (Beane & Ennis, 1987). However, this topic has received less attention. Second, the manner these markets are segmented appears to be underdeveloped, as the "buyer purchasing criteria" in these organizations tilt towards more product-based business models rather than service-based businesses (Valk, 2008). And third, publications devoted to market segmentation (Beane & Ennis, 1987) usually investigate this phenomenon from a supplier perspective rather than the buyer-view. Moreover, it seems that the mismatch of business goals between buyers and suppliers, as well as the fair recognition of the value of digital capabilities and performance-orientation of these services become recognizable sources for lack of reciprocal business relationships. Furthermore, the understanding of a buyer-view on market segmentation in a post-COVID era entails more attention in times of turbulence for suppliers. In this paper, the author proposes a market segmentation framework including a buyer-view, that encompasses a higher relevance to the procurement (buying) process of Industrial smart service offerings. The aim is to investigate the following research question (RQ): "How to define a market-segmentation; while considering the value provided by digital capabilities and performance-orientation contained in industrial smart services?

2 Literature Review

2.1 Industrial Smart Services: Digital Capabilities and Performance-Orientation

Firms engaged in Industrial Smart services should exploit all their resulting digital capabilities from technology assets (i.e. sensor, monitoring, control, and analytics) to create an augmented value in industrial operations. Previous literature has distinguished four distinct digital capabilities: first, *data capturing capability* (Porter & Heppelmann, 2014), to enable firms to measure field data at an unimaginable lower cost. For this capability to be effective, technology assets should be aligned to sense, monitor, and collect information from connected products with the lowest human involvement. Indeed, if this capability is present firms may collect field operational data on product usage and performance for smart services to exist. Second, the ability of firms to transmit data remotely from connected products has a remarkable impact on the maintainability, availability and reliability of those assets. This *data connectivity* capability (Porter & Heppelmann, 2014, 2015) empowers the use of cloud-based communication to optimize information exchange of functionally of connected products and their performance in field operations. Third, *data transformation* (Porter & Heppelmann, 2014, 2015; Lee et al., 2014) refers to the data processing ability in which available data are transformed into actionable and valuable information. The main rationale of development of these capabilities is to allow firms to act preventively (Rymaszewska et al., 2017) rather than reactive due to the presence of new digitally-enabled competitive advantages (Porter & Heppelmann, 2015).

Finally, the interpretation capability (Daft & Weick, 1984) of data is commonly embedded into the well-known data analytical capability (Porter & Heppelmann, 2014, 2015). However, both are interrelated to enable the technical ability of the organizations for the analysis of processed field data (i.e. the product and service). While the former concentrates on the conversion of data into analytical insights. The letter aims to utilize this interpretive capability to add value by developing actionable measures for the optimization of operations and processes (Ulaga & Werner, 2011). The key of the latter is the combination of field operations insights, product and domain understanding all together.

Furthermore, the leverage of these digital capabilities allow to industrial smart services to pave the way towards performance-based business models (Selviaridis & Wynstra, 2015). Whereas the performance-orientation of smart services should be comprehensibly assessed. If so, it’s imperative to shift towards the emphasis on specification and evaluation of performance (outputs and outcomes), rather than required the inputs, activities or processes achieved by suppliers (Martin, 2007). In one hand, outputs defined as the direct results of the service activity, whereas outcomes are defined as the value derived from a given service (Bonnemeier et al., 2010; Ng et al., 2009).

2.2 Segmentation in Industrial B2B Markets

The supplier perspective of market segmentation is commonly based on the attractiveness to market potential, when positioning services (Easingwood & Vijay, 1989; Gilmour et al., 1976; Payne et al., 1993). Furthermore, the treatment of this cornerstone concept of modern marketing. Although, this is sophisticated in B2B industrial markets, yet lightweight in the service literature. Bonoma and Benson (1984), first indicated how key characteristics of buyers such as demographics, operations, situational and personal considerations are important to separate a market into groups of firm- and/or prospective customers.

Additional considerations may be also necessary due to the complex and multidimensional nature of this process. Often, suppliers neglect the purchasing consideration of the buying firm as the means of segmentation. The overall analysis of buyers often is devoid of variables that can provide a more clear indication regarding risk, while other factors can influence purchasing behavior (Beane & Ennis, 1987). Often variables such as the formal organization of the procurement function, the power structures, the nature of buyer–supplier relationships, the general purchasing policies, and the purchasing criteria (Bonoma & Benson, 1984, p. 6) are touched shallowly, but not comprehensively assessed from a buyer's view. Especially; a more clear purchasing criterion requires higher attention, when addressing the performance orientation of these services in light of the advances in digital transformation.

On the other hand, previous research confirms, that the procurement (buying) functions are considered as barriers for selling the services (Stoll et al., 2020).Mainly, because tools and mechanisms for buying products are employed, when these firms purchase services (Valk, 2008). Thus, the understanding of this buyer view certainly is beneficial as most of the frameworks have a great focus on aiming to maximize value of suppliers' resources and profit impact (Beane & Ennis, 1987) in businesses facing economic, environmental, and technological transformation. Opposite, buyers historically are more inclined to focus on supplier segmentation according to performance measurement (Neely, 2005), examining the importance of collaboration and interaction needed from procurement (Weele, 2018). Furthermore, the buyer view of this dimension is seldom mentioned when purchasing industrial smart services as most organizations are mainly get used to purchase products rather than services.

3 Methodology

This paper presents a market segmentation framework - one based on the nature of employment of digital capabilities (value of data) and performance-orientation provided embedded into industrial smart services. The framework seeks to tap from a buyer-view previous studies by Bonoma and Benson (1984). The author has a special interest to understand more deeply two considerations from the aforementioned model: operations (i.e. product or service use, technology, capabilities) and purchasing (i.e. formal organization of the function, power structures, nature of buyer–supplier relationships, general purchasing policies, and the purchasing criteria). Qualitative data was collected through semi-structured interviews done to both, a supplier (SMART) engaged in dyadic relationships with seven buying companies (BCs) See Table 1.

These relationships had at least a contract or service level agreement (SLA) signed at the moment of data collection. A purposive sampling approach was taken, and all firms are active in construction and metals production environments at global scale. A prewritten interview guideline contained 21 questions on aforementioned considerations, in order to generate information about value of data and performance-orientation of smart industrial services. The answers provided the guidance enough, for the foundational framework.

Table 1 Sample job titles and companies (buyers and supplier)

Job categories N = 29	SMART	BC1	BC2	BC3	BC4	BC5	BC6	BC7	Total
Product engineering management	2		1	1	2				6
R&D/Digital transformation	3	1	1						5
Business development	5								5
Contract management					1				1
Operations	3		1	1	2	1		1	9
Procurement and corporate development					2		1		3
Total	13	1	3	2	7	1	1	1	29

4 Results

The transcripts were coded into five categories: procurement/contracting strategy, outsourcing appetite, purchasing behavior decisions, digital strategy maturity and true value of digital. These categories were grouped to develop a simplified two-dimensional framework shown below Fig. 1. The horizontal axis contains the results of the first three categories in consecutive order. This dimension describes the performance-orientation of smart-services and its relation with the purchasing considerations from Bonoma and Benson (1984). The vertical axis summarizes the insights obtained about the value of data namely, technology assets and their related digital capabilities, which corresponds to the operations consideration establish from the same author (Bonoma & Benson, 1984). The fundamental premise was to develop a market segmentation based on four resulting archetypes (groups of similar buyers) as follows.

The logic for the proposed framework acknowledges the value of data and performance-orientation as main criteria to form four resulting quadrants. Segment A and B represents the starting point of available smart services offerings. Buyers expect foundational capturing and connectivity, however the performance orientation varies according to their purchasing approach, highly contracting strategy and willingness to let others do some core activities. Furthermore, segments B and D follow similar logic with a higher level of aggregation. The logic underneath considers the utilization of such data to achieve performance, either outputs or outcomes, in industrial processes and operations through smart services. Thereof, the aggregation of several layers of digital capabilities are enablers to deliver such value. However, the buyers will determine if these digital capabilities should be either outsourced

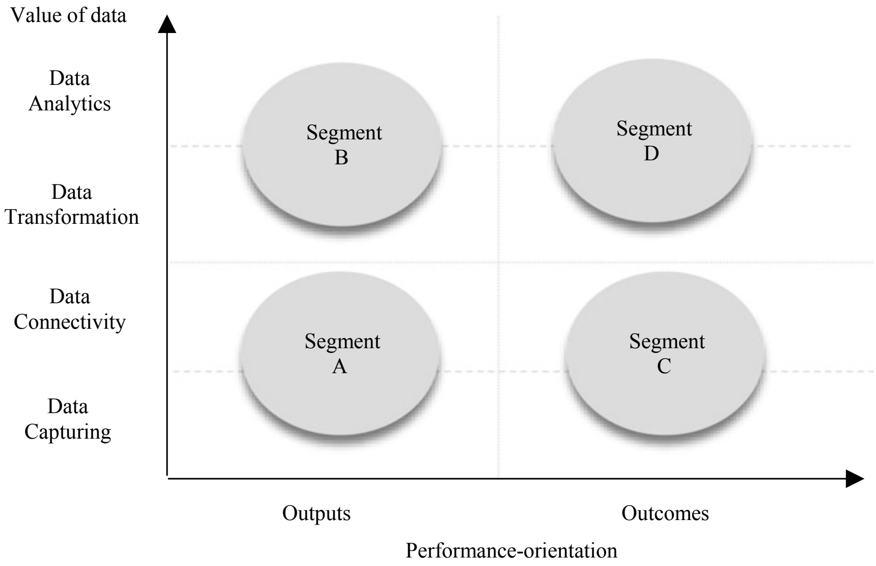

Fig.1 Framework representation

or insourced according to the type of their procurement/contracting strategy, digital maturity and outsourcing appetite for it.

5 Discussions

In this study, the RQ is answered by using the overview of Bonoma and Benson (1984) on key characteristics of buyers such as operations- and purchasing considerations. Commonly, market segmentation is based on the attractiveness to market potential rather than the key characteristics of buyers described above.

The operational dimension of the buyers are closely related to the service use and applicability of the technology through developed capabilities. Indeed, this study shown that the value of data will depend, not only on the digital maturity of organizations, but also on the degree buyer–supplier interdependencies and flexibility to make sense of the data already collected, and processed. Furthermore, supplier and buyers may have upgraded tangibles assets (i.e.; sensors, IoT, Cloud computing, platforms, analytics), however their intangible assets or digital capabilities (i.e. data capturing, data connectivity, data transformation, data analytics) may be still underdeveloped. Thus, the latter becomes the central piece to evaluate the value of data, as organizations require the employment of proper of capabilities to extract such value. Therefore, the buying firms seek more collaborative relations to employ the analytical or interpretative capabilities to optimize business processes and performance from the use of information (field data intelligence). Also, partnerships fail to materialize, unless suppliers do not exercise more comparative or complementary capabilities (i.e. product or domain knowledge) rather than competing for the same responsibilities as their counterparts. These findings also confirmed that; in terms of performance orientation (i.e., total cost of ownership, outputs, outcomes), the buying firms rely on suppliers to deliver on procurement/contracting strategy. Indeed, this reflects how certain responsibilities (i.e. do-it myself, let others to do it partially or fully, do it together) for these services may be outsourced to suppliers. Therefore, formal organization of the buying function, nature of buyer–supplier relationships and general purchasing policies of the buying firm are key pieces of the puzzle for their adoption as well. This finding is very much interconnected to previous findings (Stoll et al., 2021; West et al., 2021; Valk, 2008), where a purchasing approach for buying products may constrain their outsourcing appetite, when these firms purchase services.

6 Implications

Previous segmentation practices revolve around the use of secondary data (e.g., demographics, country, revenue, service application), although behavioral segmentation is acknowledged in B2B markets. Nonetheless, this paper presents an alternative in lights of digital transformation in performance-based relationships. Also, it reflects the alignment of goals between buyers and suppliers, type of purchasing behavior, and more importantly the value of data provided by smart-services to boost buyer experience. Practitioners may use these initial findings to refine their internal policies for development (i.e. suppliers) and procurement (i.e. buyers) of smart services.

7 Conclusions, and Recommendations

The findings acknowledge that market segmentation is a complex and multi-dimensional process, when approaching the purchasing of novel industrial smart services. Also, the procurement process for smart-services offerings need a more holistic treatment of this phenomenon, as most product-based business fails to comprehend these differences. Suppliers rarely asses the purchasing dimension (i.e. procurement/contracting strategy, outsourcing appetite, purchasing behavior decisions) of buyers during the process of market segmentation. Further research is recommendable to the servitization research community to continue the development of more generalizable results. On the other hand, the purchasing and supply management (PSM) should pay attention to the subject of procurement of smart-services, as this clerical function has evolved into a more professional organization in buying firms.

References

Allmendinger, G., & Lombreglia, R. (2005). Four strategies for the age of smart services. *Harvard Business Review, 83*(10), 131–145.

Ardolino, M., Rapaccini, M., Saccani, N., Gaiardelli, P., Crespi, G., & Ruggeri, C. (2018). The role of digital technologies for the service transformation of industrial companies. *International Journal of Production Research, 56*(6), 2116–2132.

Baines, T. (2009). The servitization of manufacturing: A review of literature and reflection on future challenges. *Journal of Manufacturing Technology Management, 20*(5), 547.

Beane, T., & Ennis, D. (1987). Market segmentation: A review. *European Journal of Marketing*.

Bonnemeier, S., Burianek, F., & Reichwald, R. (2010). Revenue models for integrated customer solutions: Concept and organizational implementation. *Journal of Revenue and Pricing Management, 9*(3).

Bonoma, T., & Benson, P. (1984). Evaluating market segmentation approaches. *Industrial Marketing Management, 13*(4), 257–268.

Chowdhury, S., Haftor, D., & Pashkevich, N. (2018). Smart product-service systems (Smart PSS) in industrial firms: A literature review. *Procedia CIRP, 73*, 26–31.

Daft, R., & Weick, K. (1984). Toward a model of organizations as interpretation systems. *Academy of Management Review, 9*(2), 284–295.

Easingwood, C., & Vijay, M. (1989). Positioning of financial services for competitive advantage. *Journal of Product Innovation Management, 6*(3), 207–219.

Gilmour, P., Borg, G., Duffy, P. A., Johnston, N. D., Limbek, B. E., & Shaw, M. R. (1976). Customer service: Differentiating by market segment. *International Journal of Physical Distribution, 7*(3), 141–148.

Lee, J., An Kao, H., & Yang, S. (2014). Service innovation and smart analytics for industry 4.0 and big data environment. *Procedia CIRP, 16*, 3–8.

Lightfoot, H., Baines, T., & Smart, P. (2013). The servitization of manufacturing: A systematic literature review of interdependent trends. *International Journal of Operations and Production Management, 33*(11), 1408–1434.

Martin, L. (2007). Performance-based contracting for human services: A proposed model. *Public Administration Quarterly, 31*(2), 130–158.

Neely, A. (2005). The evolution of performance measurement research: Developments in the last decade and a research agenda for the next. *International Journal of Operations and Production Management, 25*(12), 1264–1277.

Neely, A. (2009). Exploring the financial consequences of the servitization of manufacturing. *Operations Management Research, 1*(2), 103–118.

Ng, Maull, & Yip. (2009). Outcome-based contracts as a driver for systems thinking and service-dominant logic in service science: Evidence from the defence industry. *European Management Journal, 27*(6), 377–387.

Opresnik, D., & Taisch, M. (2015). The value of big data in servitization. *International Journal of Production Economics, 165*, 174–184.

Payne, J., Bettman, J., & Johnson, E. (1993). *The adaptive decision maker*. Cambridge University Press.

Porter, M., & Heppelmann, J. (2014). How smart, connected products are transforming competition. *Harvard Business Review, 2014*(November), 96–112.

Porter, M., & Heppelmann, J. (2015). How smart, connected products are transforming companies. *Harvard Business Review, 2015*(October), 1–39.

Rymaszewska, A., Helo, P., & Gunasekaran, A. (2017). IoT powered servitization of manufacturing—An exploratory case study. *International Journal of Production Economics, 192*(March), 92–105. Elsevier B.V.

Selviaridis, K., & Wynstra, F. (2015). Performance-based contracting: A literature review and future research directions. *International Journal of Production Research, 53*(12).

Stoll, O., West, S., Gaiardelli, P., Harrison, D., & Corcoran, F. (2020). The successful commercialization of a digital twin in an industrial product service system (pp. 275–282). Springer International Publishing.

Stoll, O., West, S., & Hennecke, L. (2021). Procurement of advanced services within the domain of servitization: Preliminary results of a systematic literature review. In Progress in IS (pp. 73–81).

Ulaga, W., & Werner, R. (2011). Hybrid offerings: How manufacturing firms combine goods and services successfully. *Journal of Marketing, 75*(6), 5–23.

van der Valk, W. (2008). Service procurement in manufacturing companies: Results of three embedded case studies. *Industrial Marketing Management, 37*(3), 301–315.

Van Weele, A. J. (2018). *Purchasing and supply chain management: Analysis, strategy, planning and practice*, 7th edn. Cengage Learning EMEA, Andover.

West, S., Wenting, Z., & Stoll, O. (2021). The contracting of advanced services based on digitally—Enabled product-service systems (pp. 228–237). Springer International Publishing.

Can Market Segmentation Support the Creation of Digitally-Enabled Product-Service Systems?—A Semi-Systematic Literature Review

Eugen Rodel and Paul Ammann

Abstract Research increasingly covers digitalization as a driver of servitization towards digitally-enabled product-service systems (PSS). These systems call for new business models and value co-creation for the development and delivery of value propositions. However, the success of a PSS strategy is dependent on the involved actors. Market segmentation is a process of examining and grouping customers and targeting them with specific value propositions. Companies can then benefit from a better understanding of customer needs and a differentiated marketing strategy that leads to competitive advantages. It seems that market segmentation could support the creation of digitally-enabled PSS. However, there seems to be only scarce literature that builds a connection between the two research fields. Therefore, this paper uses a semi-systematic literature review to identify and apprise the state of knowledge. Of the ten papers found to be relevant, only one paper can answer the research question fully. The results show a clear research gap. Nonetheless, the analysis indicates that the topic of market segmentation is often discussed in combination with value co-creation. Examining segmentation in this context could further the understanding of how a digitally-enabled PSS architecture based on market segmentation can improve an industrial business-to-business (B2B) company's competitive position.

Keywords Product-service system · Segmentation · Value co-creation

1 Introduction

The development and delivery of digitally-enabled PSS require value co-creation and therefore a deep understanding of the customer and its needs and wants. B2B market segmentation assists a company in profiling its customers and furthermore

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in customizing value propositions for a selected segment. Although it appears that market segmentation could support companies to create value in the context of PSS, it seems that the two fields of research are rarely addressed together. Therefore, a semi-systematic literature review should shed light on the integration of market segmentation in industrial companies with servitization strategies.

2 Literature Review

Servitization is understood as “the innovation of an organisation’s capabilities and processes to shift from selling products to selling integrated products and services that deliver value in use” (Baines et al., 2009, p. 547). The move promises growth in the areas of finances (e.g. profit margin), strategy (e.g. competitive advantage) and marketing (e.g. customer relationship) (Baines et al., 2009). So-called PSS, a mix of goods and service to satisfy customer needs (Tukker & Tischner, 2006), are a way to implement a servitizing strategy in industrial firms (Baines et al., 2009). Newer studies consider digitalization as a driver and enabler of servitization towards advanced services such as outcome-based contracts (Grubic & Jennions, 2018) based on digitally-enabled PSS (Pirola et al., 2020) that include monitoring, control, optimization, and autonomous functions (Kohtamäki et al., 2019). The success of a PSS strategy is highly dependent on a company’s management of complexity, such as that of the variety of activities and numbers of actors involved (Zou et al., 2018). Additionally, advanced PSS require new business models and demand value co-creation for the development and delivery of value propositions (Kohtamäki et al., 2019). Value co-creation shifts the focus to a multi-actor process where the supplier supports the customer in identifying the customer’s needs and in the execution of the customer’s own process to jointly create value (Garcia Martin et al., 2019). This implies a transition towards the service-dominant (S-D) logic (Vargo & Lusch, 2008). Considering a company’s role in value co-creation, West et al. (2021) proposed a framework for supporting value creation along a lifecycle model in the context of digitally-enabled PSS.

Regarding usage-based and solutions-oriented digital business models, Witell (2021, p. 111) stressed “the need to identify the right customer segments for digital services”. Segmentation, defined as “an ongoing and iterative process of examining and grouping potential and actual buyers with similar product needs into subgroups that can then be targeted with an appropriate marketing mix in such a way as to facilitate the objectives of both parties” (Mitchell & Wilson, 1998, p. 431), creates benefits such as, among others, a better understanding of customer’s needs and wants as well as the development of specific products and differentiated marketing strategies (Balci & Cetin, 2017). Although segmentation is considered as the heart of any marketing strategy (Morgan et al., 2019), research literature on this topic can be described as fragmented and stagnating. To assist further development Mora Cortez et al. (2021) provided an updated literature review. In their framework, the authors have shown that the B2B market segmentation process consists of four specific, interrelated steps. Important elements in this context are variables for the formation of B2B market segments. Well-known macro-variables are, for example, industry type and geographic location (Abratt, 1993). Customers may also be classified into strategic accounts or key accounts (Rangan et al., 1992). Recently, the focus has shifted towards micro-variables with specific attention given to customer needs (Albert, 2003), relationships (Windler et al., 2017), and collaboration (Freytag & Clarke, 2001). In this vein, persona is another concept to segment customers (Salminen et al., 2021). Some studies discuss segmentation in a particular context such as the type of offering, where attributes of products are assessed to understand costumer needs (Mora Cortez et al., 2021). Segmentation is then based on tangible goods (e.g. Fell et al., 2003), services (e.g. Zeng et al., 2011) or solutions (e.g. Windler et al., 2017).

In view of the demand for segmentation in digital business models (Witell, 2021) and the obvious lack of research in this field, the following research question arises: "how is market segmentation supporting the creation of digitally-enabled PSS according to existing research literature?".

3 Methodology

A semi-systematic literature review (Snyder, 2019) was chosen in this study to identify relevant literature that answers the research question, to capture the state of knowledge as well as detect existing gaps, and to understand the interplay between the two research fields PSS and segmentation. Figure 1 shows the process that was followed.

The first step in the process included preliminary search queries in the Web of Science (WoS) database. Due to the few and inaccurate results, the search strategy was refined using a combination of keywords in the format (TS = ("business-to-business") OR TS = ("b2b")) AND (*Keyword_1) AND (*Keyword_2). *Keyword_1 and *Keyword_2 were selected according to Table 1, leading to a total of 20 search queries. Then, the resulting data set was cleaned by reading the titles and

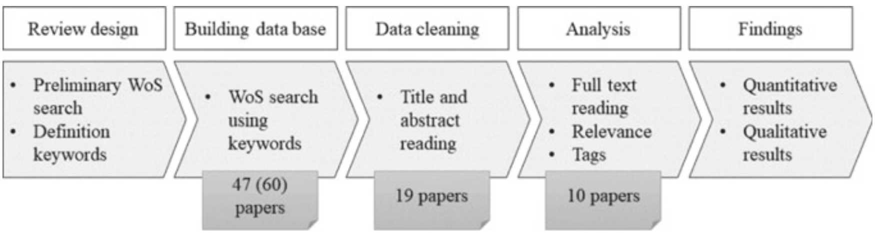

Fig. 1 Process followed for the literature review

Table 1 Keyword-strings used for the search queries in the Web of Science database

*Keyword_1	*Keyword_2
TS = (segment*)	TS = ("product-service system") OR TS = ("product-service systems") OR TS = ("product service system")
TS = ("persona") OR TS = ("personas")	TS = ("solutions") OR TS = ("solution")
TS = ("customer needs") OR TS = ("customer need")	TS = ("servitization")
TS = ("targeting")	TS = ("service-dominant logic") OR TS = ("service dominant logic") OR TS = ("sd logic") OR TS = ("s-d logic")
	TS = ("co-creation")

abstracts to choose the papers for a full text review. The full texts were read to evaluate the relevance of the papers' content to the research question. Therefore a 5-point Likert scale (5* = highly relevant, 4* = relevant, 3* = interesting (neither relevant nor barely relevant), 2* = barely relevant, 1* = not relevant) was applied. Papers with a rating lower than 3* where eliminated from the final list of papers. Finally, each of the remaining papers was analyzed regarding relevant topics, reasons for the relevance of the paper and tags corresponding to the main topics covered in literature review (#servitization, #pss, #d-en pss, #co-creation, #s-d logic, #segmentation, #variables, #context). The results of the final analysis were reviewed and adjusted where necessary by the second author to get unbiased results.

4 Results

The keyword search returned a total of 60 matches (see Fig. 1). Due to the search strategy using a combination of keywords, a paper may appear in multiple search queries, therefore the data set consists of 46 unique papers, either from the document type "articles" or "proceedings papers". The cleaning process led to 19 papers. In the full text analysis, ten papers were found to be relevant or interesting. Only one paper was found that fully answers the research question.

An analysis of the assigned tags shows that both topics #segmentation and #variables appear in nine papers each, followed by #co-creation (eight papers) and #s-d logic (four papers). It is evident that the topic of segmentation is often discussed in combination with value co-creation.

5 Discussion

Table 2 shows an overview of the five papers that were rated as highly relevant (5*) or

Table 2 Results from the analysis of the full papers rated as highly relevant or relevant

References	R	Tags
Windler et al. (2017)	5*	#pss, #co-creation, #s-d logic, #segmentation, #variables, #context
Balci and Cetin (2017)	4*	#segmentation, #variables, #context
Eggert et al. (2018)	4*	#servitization, #co-creation, #s-d logic, #segmentation
Falkenreck and Wagner (2021)	4*	#servitization, #d-en pss, #co-creation, #segmentation, #variables
West et al. (2020)	4*	#servitization, #pss, #co-creation, #s-d logic, #variables

relevant (4*), along with the assigned tags. Subsequently, their content is summarized and reasons for their relevance to the research question are given.

The work of Windler et al. (2017) is the only publication rated as highly relevant. The authors developed and applied a methodology for identifying, assessing, and segmenting customers for business solutions. Using 21 criteria in the two dimensions "quality of the relationship to date" and "customer's potential for future solution partnership", four customer segments were identified that help suppliers to determine customer attractiveness. The used criteria include topics such as contracts, relationship, and value co-creation that play all a major role in PSS. In a similar paper (Jüttner et al., 2013), the case of the Swiss company Bosshard is illustrated, whose customer relationship management system evaluates each customer according to its "solution readiness" to offer different value propositions to different stakeholders.

Similar to the first study, Balci and Cetin (2017) developed a segmentation framework to profile container shipping customers, using segmentation variables considering customers' needs, strategic importance and demographics to provide customized marketing offerings. Although the study's context is the container shipping market and services, it provides a comprehensive discussion on market segmentation.

In their review regarding customer value as the basis of B2B marketing, Eggert et al. (2018) discuss the communication of value propositions to business markets. They point out that relatively little attention is paid in literature to address different levels of decision makers and that more research is needed in this field to guide managers.

Falkenreck and Wagner (2021) identified digitalization capabilities, satisfaction with existing relationships and trust in Internet of Things (IoT) credibility to drive the perceived value of IoT-based B2B business models. The drivers differ for business-to-government customers. Therefore, they recommend treating these two target groups differently before joint-venturing and co-creating value.

In their study, West et al. (2020) described how customer journey mapping can support relationship building throughout the entire lifecycle of PSS. Although no reference to segmentation is made, the study highlights the many actors involved in the value creation process and how they can be addressed by the creation of personas.

Besides these previous studies, five others were rated as interesting (3*). These studies do not answer the research question but nevertheless provide some ideas on how segmentation could be applied in a PSS environment. For example, the paper by Athaide et al. (2018) highlights the need to incorporate targeting and product strategy considerations when deciding between engaging in unilateral or bilateral relationships with customers when developing new products. Further, Müller et al. (2018) developed a customer segmentation model regarding Digital, Social Media, and Mobile Marketing in industrial buying based on variables such as buying frequency, function of the buyer, and industry sector. Then, O'Brien et al. (2020) demonstrated an algorithm for a B2B segmentation that integrates both customer behavior and marketing effectiveness. Next, Songailiene et al. (2011) elaborated a conceptualization of supplier perceived value. The identified value dimensions could help to explain why the same company uses relational or transactional approaches to customers. And finally, Wu et al. (2019) showed a model for segmenting value-based offerings for business customers of cloud based IT-services. The paper gives an idea of how to segment the customers of these services and price the services provided.

5.1 Academic Implications

The results of this study show that there are only minimal studies that provide a clear answer to the question of how segmentation is supporting the creation of PSS. This points to a research gap. Similar gaps that support this finding were stated by other authors (Eggert et al., 2018; Falkenreck & Wagner, 2021; Windler et al., 2017). Examining segmentation in the context of type of offering (goods, service and solutions) and value co-creation could improve the knowledge about segmentation and digitally-enabled PSS.

5.2 Industrial Implications

Segmentation and servitization are linked to different benefits and opportunities for industrial manufacturers (Baines et al., 2009; Balci & Cetin, 2017). Nonetheless, guidance on how segmentation is to be conducted in practice is scarce (Clarke & Freytag, 2008). There is a need for a clear direction on how and when companies can strengthen their competitive position through a digitally-enabled PSS architecture based on market segmentation.

6 Conclusions and Recommendation

This study shows that there is very limited research building a connection between the two research fields B2B market segmentation and PSS. Only few papers could be identified that cover both and/or similar topics and only one answers the research question fully. Precise details about frameworks and the practical implementation of a segmentation supporting PSS are missing. In addition, the studies cover a wide range of different approaches, so there is no clear focus. The question remains whether interest in the subject of this study is really so small, or whether the search was carried out in the wrong direction. However, there is also evidence that market segmentation can support the creation of digitally-enabled PSS. Though there are more questions than answers: What is the purpose of segmentation within the context of PSS? How do B2B companies use market segmentation to find suitable customers for the development of PSS? How can segmentation make PSS creation and delivery a success? What kind of market segmentation and variables must be used? At what point in the value co-creating process are customers segmented? And how is such a segmentation process implemented in practice? All these questions put the topic of market segmentation and digitally-enabled PSS up for further discussion and research.

References

Abratt, R. (1993). Market segmentation practices of industrial marketers. *Industrial Marketing Management, 22*(2), 79–84. https://doi.org/10.1016/0019-8501(93)90033-4

Albert, T. C. (2003). Need-based segmentation and customized communication strategies in a complex-commodity industry: A supply chain study. *Industrial Marketing Management, 32*(4), 281–290. https://doi.org/10.1016/S0019-8501(02)00204-3

Athaide, G. A., Zhang, J. Q., & Klink, R. R. (2018). Buyer relationships when developing new products: A contingency model. *Journal of Business & Industrial Marketing, 34*(2), 426–438. https://doi.org/10.1108/JBIM-02-2018-0091

Baines, T. S., Lightfoot, H. W., Benedettini, O., & Kay, J. M. (2009). The servitization of manufacturing: A review of literature and reflection on future challenges. *Journal of Manufacturing Technology Management, 20*(5), 547–567. https://doi.org/10.1108/17410380910960984

Balci, G., & Cetin, I. B. (2017). Market segmentation in container shipping services: A qualitative study. *Management Research Review, 40*(10), 1100–1116. https://doi.org/10.1108/MRR-01-2017-0012

Clarke, A. H., & Freytag, P. V. (2008). An intra- and inter-organisational perspective on industrial segmentation: A segmentation classification framework. *European Journal of Marketing, 42*(9/10), 1023–1038. https://doi.org/10.1108/03090560810891127

Eggert, A., Ulaga, W., Frow, P., & Payne, A. (2018). Conceptualizing and communicating value in business markets: From value in exchange to value in use. *Industrial Marketing Management, 69*, 80–90. https://doi.org/10.1016/j.indmarman.2018.01.018

Falkenreck, C., & Wagner, R. (2021). From managing customers to joint venturing with customers: co-creating service value in the digital age. *Journal of Business & Industrial Marketing*, ahead-of-print. https://doi.org/10.1108/JBIM-02-2020-0100

Fell, D. R., Hansen, E. N., & Becker, B. W. (2003). Measuring innovativeness for the adoption of industrial products. *Industrial Marketing Management, 32*(4), 347–353. https://doi.org/10.1016/S0019-8501(02)00232-8

Freytag, P. V., & Clarke, A. H. (2001). Business to business market segmentation. *Industrial Marketing Management, 30*(6), 473–486. https://doi.org/10.1016/S0019-8501(99)00103-0
Garcia Martin, P. C., Schroeder, A., & Ziaee Bigdeli, A. (2019). The value architecture of servitization: Expanding the research scope. *Journal of Business Research, 104*, 438–449. https://doi.org/10.1016/j.jbusres.2019.04.010
Grubic, T., & Jennions, I. (2018). Do outcome-based contracts exist? The investigation of power-by-the-hour and similar result-oriented cases. *International Journal of Production Economics, 206*, 209–219. https://doi.org/10.1016/j.ijpe.2018.10.004
Jüttner, U., Windler, K., Michel, S., & Thol, C. (2013). Solution readiness—a guiding framework for supplier firms. *Marketing Review St. Gallen, 30*(4), 52–63. https://doi.org/10.1365/s11621-013-0256-4
Kohtamäki, M., Parida, V., Oghazi, P., Gebauer, H., & Baines, T. (2019). Digital servitization business models in ecosystems: A theory of the firm. *Journal of Business Research, 104*, 380–392. https://doi.org/10.1016/j.jbusres.2019.06.027
Mitchell, V.-W., & Wilson, D. F. (1998). Balancing theory and practice: a reappraisal of business-to-business segmentation. *Industrial Marketing Management, 27*(5), 429–445. https://doi.org/10.1016/S0019-8501(98)00002-9
Mora Cortez, R., Højbjerg Clarke, A., & Freytag, P. V. (2021). B2B market segmentation: A systematic review and research agenda. *Journal of Business Research, 126*, 415–428. https://doi.org/10.1016/j.jbusres.2020.12.070
Morgan, N. A., Whitler, K. A., Feng, H., & Chari, S. (2019). Research in marketing strategy. *Journal of the Academy of Marketing Science, 47*(1), 4–29. https://doi.org/10.1007/s11747-018-0598-1
Müller, J. M., Pommeranz, B., Weisser, J., & Voigt, K.-I. (2018). Digital, Social Media, and Mobile Marketing in industrial buying: Still in need of customer segmentation? Empirical evidence from Poland and Germany. *Industrial Marketing Management, 73*, 70–83. https://doi.org/10.1016/j.indmarman.2018.01.033
O'Brien, M., Liu, Y., Chen, H., & Lusch, R. (2020). Gaining insight to B2B relationships through new segmentation approaches: Not all relationships are equal. *Expert Systems with Applications, 161*, 113767. https://doi.org/10.1016/j.eswa.2020.113767
Pirola, F., Boucher, X., Wiesner, S., & Pezzotta, G. (2020). Digital technologies in product-service systems: A literature review and a research agenda. *Computers in Industry, 123*, 103301. https://doi.org/10.1016/j.compind.2020.103301
Rangan, V. K., Moriarty, R. T., & Swartz, G. S. (1992). Segmenting customers in mature industrial markets. *Journal of Marketing, 56*(4), 72. https://doi.org/10.1177/002224299205600406
Salminen, J., Jung, S. G., & Jansen, B. J. (2019). The future of data-driven personas: A marriage of online analytics numbers and human attributes. In: J. Filipe, A. Brodsky, S. Hammoudi, & M. Smialek (Eds.), *ICEIS 2019 - Proceedings of the 21st International Conference on Enterprise Information Systems* (pp. 608–615). SciTePress. https://doi.org/10.5220/0007744706080615
Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research, 104*, 333–339. https://doi.org/10.1016/j.jbusres.2019.07.039
Songailiene, E., Winklhofer, H., & McKechnie, S. (2011). A conceptualisation of supplier-perceived value. *European Journal of Marketing, 45*(3), 383–418. https://doi.org/10.1108/03090561111107249
Tukker, A., & Tischner, U. (2006). Product-services as a research field: Past, present and future. Reflections from a decade of research. *Journal of Cleaner Production, 14*(17), 1552–1556. https://doi.org/10.1016/j.jclepro.2006.01.022
Vargo, S. L., & Lusch, R. F. (2008). From goods to service(s): Divergences and convergences of logics. *Industrial Marketing Management, 37*(3), 254–259. https://doi.org/10.1016/j.indmarman.2007.07.004
West, S., Stoll, O., Østerlund, M., Müller Csernetzky, P., Keiderling, F., & Kowalkowski, C. (2020). Adjusting customer journey mapping for application in industrial product-service systems. *IJBE, 11*(3), 275, 2020. https://doi.org/10.1504/IJBE.2020.10032987

West, S., Zou, W., Rodel, E., & Stoll, O. (2021). Value co-creation in digitally-enabled product-service systems. In: M. Kohtamäki, T. Baines, R. Rabetino, A. Z. Bigdeli, C. Kowalkowski, R. Oliva, & V. Parida (Eds.), *The Palgrave handbook of servitization* (pp. 403–417). Springer International Publishing. https://doi.org/10.1007/978-3-030-75771-7_26

Windler, K., Jüttner, U., Michel, S., Maklan, S., & Macdonald, E. K. (2017). Identifying the right solution customers: A managerial methodology. *Industrial Marketing Management, 60*, 173–186. https://doi.org/10.1016/j.indmarman.2016.03.004

Witell, L. (2021). Business models for digital service infusion using AI and big data. In: M. Kohtamäki, T. Baines, R. Rabetino, A. Z. Bigdeli, C. Kowalkowski, R. Oliva, & V. Parida (Eds.), *The Palgrave handbook of servitization* (pp. 103–115). Springer International Publishing. https://doi.org/10.1007/978-3-030-75771-7_7

Wu, C., Buyya, R., & Ramamohanarao, K. (2019). Value-based cloud price modeling for segmented business to business market. *Future Generation Computer Systems, 101*, 502–523. https://doi.org/10.1016/j.future.2019.06.013

Zeng, F., Yang, Z., Li, Y., & Fam, K.-S. (2011). Small business industrial buyers' price sensitivity: Do service quality dimensions matter in business markets? *Industrial Marketing Management, 40*(3), 395–404. https://doi.org/10.1016/j.indmarman.2010.08.008

Zou, W., Brax, S. A., & Rajala, R. (2018). Complexity in product-service systems: Review and framework. *Procedia CIRP, 73*, 3–8. https://doi.org/10.1016/j.procir.2018.03.319

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Enable Service Interaction and Value Co-Creation for Small and Medium-Sized Enterprises Through an Innovation-Method-Framework

Hanno Kalkhofer, Nicola Moosbrugger, Annette Ulmer, and Martin Dobler

Abstract Small and medium-sized enterprises often face resource deficits and therefore depend on cooperating with other actors to stay innovative in a competitive environment. Establishing and maintaining actual co-creation and service interaction strategies however is challenging. A reason for this is the complexity of finding methodologies and tools to create valuable outcome and the lack of knowledge of collaboration toolsets, also in virtual environments. This paper introduces an Innovation-Method-Framework consisting of innovation methods for increased service interaction and value co-creation among service stakeholders. Also, toolsets for the framework's practical application are provided.

Keywords Service-dominant logic · Service interaction · Value co-creation · Collaboration · Digital collaboration tools

1 Introduction

In comparison to large enterprises, SMEs often face resource shortages in, for example, knowledge, human resources, financial resources, etc. (Lee et al., 2010). They tend not to have specialised research and development departments or institutionalised innovation management for their products and services. Additionally, their activities and operations are governed less by formal rules and procedures in general, showing a lower degree of standardisation and formalisation. Their processes are incremental and heuristic (Dufour & Son, 2015). As a consequence, SMEs need to

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cooperate strongly with others to compensate these competitive disadvantages. Establishing and maintaining strategies that allow for the co-creation of value however is challenging (Eikebrokk et al., 2021).

These circumstances motivate us to investigate into the theory of Service-Dominant Logic, an approach to explaining value creation in networks of exchanging actors, to explore how the application of its concepts of service interaction and value co-creation can be increased. The centre of this motivation is to elaborate a framework to facilitate service interaction and value co-creation for SMEs. This motivation is accompanied with the research question of **how a framework to increase service interaction and value co-creation can look like**. The theory of Service-Dominant Logic (S-D Logic) (Vargo & Lusch, 2004, 2008, 2016) is used as the theoretical background of this paper at hand. Its axioms of service interaction and value co-creation build the base of the research performed. As a result, an Innovation-Method-Framework is presented to determine adequate approaches to manage service interaction and value co-creation—*thus service innovation*—especially in SMEs. The Innovation-Method-Framework is applied in practice through a hypertext toolbox and a digital collaboration toolbox which enables value co-creation and service interaction in a virtual workspace.

This scholarly paper at hand is composed of four chapters. Chapter 1 introduces the paper and presents the research motivation. Chapter 2 presents the methodology and the theoretical background. Chapter 3 presents the findings of our research: a framework to increase value co-creation and service interaction. Chapter 4 concludes the paper and provides the implications for theory and practice.

2 Theoretical Background and Methodology

Chapter two is composed of two sections that present the theoretical background of this research and the methodology within this paper.

2.1 Theoretical Background: Service-Dominant Logic

S-D Logic, which was first presented in 2004 by Vargo and Lush, is a counterpart to the traditional Goods-Dominant Logic (Vargo & Lusch, 2004) and denotes the shift from a goods-dominated to a service-dominated mindset in economy. The concept of S-D Logic explains not only the change in economy from tangible to intangible goods but also draws attention to the service and the process itself (Vargo & Lusch, 2004, 2008, 2016) (e.g. production vs. resourcing). Out of the eleven foundational premises (FP) and the five axioms (AX) defined in S-D Logic, the premise about service interaction (FP1/AX1) and value co-creation (FP6/AX2) are of crucial importance for SMEs cooperating in competitive environments (Eikebrokk et al., 2021).

Value co-creation is about collaboration of heterogenous actors (in a value chain) to create greater value than can be achieved by an individual (Neghina et al., 2015). Through resource integration, potential resources and competences get exchanged and developed by all actors (incl. resource integrators). Thus, these resources turn into valuable resources that support creating greater value (Gummesson & Mele, 2010). To fully comprehend the whole process of value creation it is crucial to understand how actors get the possibility to operate as resource integrators and contribute to value co-creation. This can be achieved through service interaction. By creating a dialogue between all actors of the network, where knowledge is shared to create new knowledge, resources are exchanged, and mutual learning processes are initiated. Actors interact instead of merely converse (Gummesson & Mele, 2010). The core of the concepts of value co-creation and service interaction is therefore depicting the whole process of innovation as a network-centred mechanism where all actors are co-creators of value. The main focus lies on creating a strong network consisting of multiple stakeholders, profiting not only of the innovations generated in the network but benefiting through sharing expertise and keeping information flows transparent (Lusch & Nambisan, 2015). Being and especially staying innovative are key factors for companies to keep a competitive advantage and even exploit new markets (Dustin et al., 2014).

In the course of the investigation into service interaction and value co-creation, a lack of innovation methods for their implementation and increase could be identified.

2.2 Methodology

To further investigate this lack, a narrative literature review was conducted on both, innovation methods and processes as well as on value co-creation and service interaction. Web search engines indexing scholarly literature like Google Scholar or Semantic Scholar were used, as well as the physical library holdings of the University of Applied Sciences Vorarlberg. Through skimming and scanning, a preselection of the most suitable literature was made followed by an in-depth analysis to get to a final selection. We found that existing frameworks clustering innovation methods were not applicable to the S-D Logic use-case. Therefore, a new framework was developed, entitled Innovation-Method-Framework which is described in more detail in the following section. Afterwards, applicable innovation methods were sorted accordingly and interlinked to create a hypertext toolbox that enables to put the framework into practice.

Regarding the selection of innovation methods for the framework, attention was directed towards including methods with varying degrees of actor participation, different time horizons and levels of abstraction—from setting up an overall innovation process up to the conduction of specific tasks. Attention has also been paid to ensuring the compatibility of the selection with the notions of service interaction and value co-creation. All have a sufficient relation to their three main dimensions, elaborated by (Marcos-Cuevas et al., 2016): (I) Linking—mobilising social connections and networks, (II) Materialising—operational practices related to the production of a value co-creating offering, and (III) Institutionalising—organisational practices related to the design of institutions and structures to capture and retain value created.

3 Innovation-Method-Framework for Increased Service Interaction and Value Co-creation

Chapter three is composed of three sections that present the design process of the Innovation-Method-Framework, the framework as a whole and its use.

3.1 Design and Innovation-Method-Framework Development

Based upon the applied literature review, a variety of innovation methods is identified and the requirements for the Innovation-Method-Framework is derived. The Innovation-Method-Framework is a clustering system of innovation methods that are suitable for and enable structured service interaction and value co-creation processes (especially for SMEs). It links the current practices of innovation management with the implications of regarding innovation from a service-dominant viewpoint. This enables SMEs strongly depending on value co-creation and service interaction to fully develop their potential and strengthen their competitiveness.

The Innovation-Method-Framework makes a broader range of innovation methods available and explains and structures them in an easy-to-understand manner, presented in an easy-to-use digital format. It clusters innovation methods based on their degree of aggregation and time horizon, reflecting the management level: strategic, tactical, operational (Koreimann, 1987), and the executive level of companies.

As depicted in Fig. 1, the framework consists of four layers accordingly: (1) Innovation Process, (2) Actions, (3) Intermediary Methods and (4) Micro Methods. They provide a selection of a variety of methods that fit the requirements of value co-creation and service interaction and help stakeholders to find the most suitable set of innovation methods for specific challenges. The 4-layered sorting system reflects the granularity and duration of the identified methods in a continuum from general to specific. The number of methods presented in every layer increase, which is caused by the layer's granularity: as only one innovation process is used, multiple actions are chosen. And each action itself is comprised of several intermediary methods. Only the micro-methods are capsule methods that need no further methods.

Layer 1: Innovation Process. This layer contains four innovation process methods which are considered systematic approaches of doing innovation in a long-term perspective: *(I) Design Thinking, (II) Open Innovation and Co-Creation, (III) Innovation Labs*, and *(IV) Participatory Processes*. They present options for

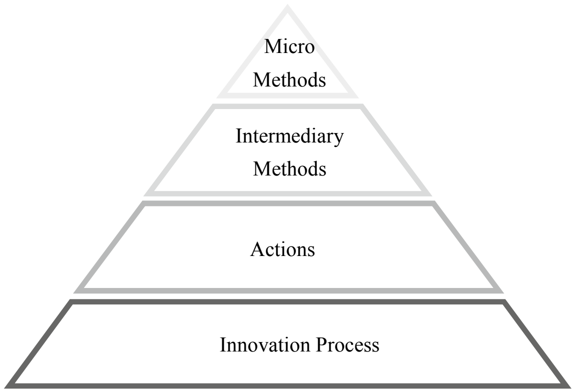

Fig. 1 Innovation-Method-Framework

the strategic innovation management that defines the basis of the processes and organisational structures with regard to innovation activities. The innovation process methods selected for the Innovation-Method-Framework act as guidelines to structure the over-all innovation process. They can be associated with a distinctive set of measures applied and capitalised in the following layers.

Each of the innovation process methods is built around the notion that the consideration and integration of knowledge generated outside organisational borders are indispensable. The innovation processes suitable for value co-creation and service interaction feature a iterative approach instead of a linear succession of innovation phases, as this allows for a continuous improvement of value-of-use for customers (Ye & Kankanhalli, 2013; Brown & Katz, 2019).

Also, these innovation processes integrate diverse stakeholders in the innovation process, taking advantage of operant resources for strategic benefit by leveraging the knowledge available through resources from outside the organisation. Through integrating the customers or beneficiaries in various phases in the innovation process, the attractivity of ideas, concepts and services can be demonstrated (Schumacher, 2008) and subsequently improved. Organisations need to structure themselves to be able to leverage the distributed landscape of knowledge, exploit it, and stay in close connection with its source (Chesbrough, 2003). It is therefore a strategic decision which innovation process to follow.

Layer 2: Actions. Layer 2 proposes six different macro methods for the conduction of different actions that occur during the over-all innovation process (Layer 1), e.g. workshops, online platforms, conferences etc. Actor-generated institutional arrangements coordinate value co-creation; hence the innovation process needs to be implemented by creating opportunities for co-creation. The choice of actions is a tactical decision influenced by the innovation phase which is currently being run through: idea generation, conversion and diffusion (Hansen & Birkinshaw, 2007). Actions shape the implementation of the chosen innovation process, as they determine the involvement of actors in the process. Workshops for example integrate a relatively small number of different actors while conferences host a larger number.

The actions also set the time frame in which the actors actively co-create, as they have a starting and end point.

Layer 3: Intermediary Methods. Layer 3 includes eleven intermediary methods that determine *what* is done during the layer 2 actions or macro methods. Intermediary methods can be understood as tool clusters with different possible tools (micro methods) to use with. The methods are chosen to engage multiple actors for value co-creation and enable service-oriented innovation by focusing on the service-in-use. For example, an analysis of strengths, weaknesses, opportunities and threats (SWOT analysis), is a proven tool that helps actors to reflect on their product or business model from different perspectives and hence enables them to shift from product-centred value chains to service-oriented value chains (Namugenyi et al., 2019). Brainstorming is an example for a method that engages a number of actors in a creative setting, allowing them to cooperate and thus co-create value propositions. Which method to use is an operational decision, based not only on the action and actors involved, but also determined by the resources available and other constraints, such as a physical or virtual setting of the action.

Layer 4: Micro Methods. Layer 4 is a curation of micro methods designed to enable SMEs to use creativity, research and decision-making methods, by giving them comprehensible, easy-to-use instructions. In total, thirty-four micro methods are identified as relevant for increased service interaction and value co-creation and assigned to layer 4. They shape the execution of the intermediary methods and cover a short time horizon. For example, a SWOT analysis can be performed by doing first a brainwriting session to determine strengths and weaknesses, afterwards a pinboard moderation to determine opportunities and threats. Layer 4, thus, is an executive layer and grounds on different principles of creative problem solving. These tools exactly describe how a certain task in the service interaction process is conducted and executed, defining number and roles of people, timeframe and material needed (such as: pinboards, pencils, cameras, etc.).

3.2 Innovation-Method-Framework in Use—Hypertext Toolbox and Digital Collaboration Toolbox

The Innovation-Method-Framework can be used in a linear but also non-linear way and is put into practice with the creation of a hypertext toolbox.

As exemplarily depicted in Fig. 2. Hypertext Toolbox, the methods are linked to each other and to sub-methods via a hyper-link structure, which matches fitting higher-level methods to the lower-level methods. For each method, the user is hence presented with ways to implement this method. This hyper-text structure fulfils the SMEs' need to easily access information on innovation methods. It allows users to conveniently navigate through the content of the Innovation-Method-Framework as well as quickly find combinations of appropriate methods including a detailed description for each.

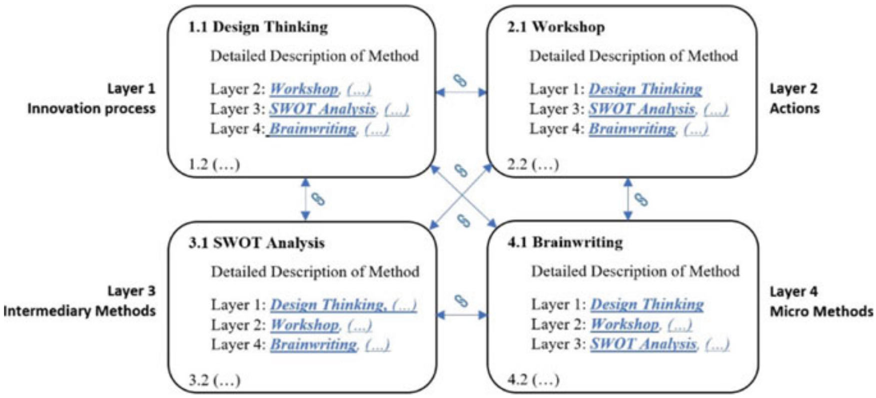

Fig. 2 Hypertext toolbox

To be able to transfer the innovation process to a virtual setting and to use the Innovation-Method-Framework in this context, a digital collaboration toolbox is developed complementarily. In a concept matrix (Webster & Watson, 2002) digital tools are structured, which allows an easy selection of the appropriate tools for the desired functionality and the different requirements of service interaction and co-creation. Additionally, each tool is hyper-linked to a detailed description that helps making decisions.

4 Conclusion and Discussion

The Innovation-Method-Framework offers SMEs ways to implement and adapt models of systematic innovation approaches by linking various methods shaping the overall innovation process with interconnectable innovation methods of different abstraction levels and ranges that can be used from a strategic to executive level. This simplifies the decision for innovation methods and provides SMEs with a structured overview of suitable methods for increased value co-creation and service interaction.

Integrating stakeholders like customers along the value chain reduces risks in the development of products and services due to innovations being created and validated collaboratively. This is especially attractive for SMEs who have difficulties to acquire venture capital (Schumacher, 2008). The methods proposed in the Innovation-Method-Framework take into account the network nature in the creation of value supporting the connection of different actors at various levels of aggregation. Also, they enable obtainment and integration of knowledge through a systematic approach, helping actors in a service exchange to assume their role as resource integrators and turning a mere dialogue between actors into service interaction.

In collaborative innovation processes, the Innovation-Method-Framework supports reducing the complexity of managing external relations: It presents a collection of techniques that can be used in collaborative work, planning, coordinating tasks, and conducting events in various phases of the innovation process. It includes both methods suitable for large and diverse groups, as well as techniques that can be used to perform specific tasks that may arise during the process (problem analysis, knowledge gathering, idea generation, -exploration, -selection, and -evaluation etc.).

Additionally, the digital tools allow the transfer of the innovation processes—designed through the usage of the Innovation-Method-Framework—into a virtual setting. Geographical distances and exceptional circumstances that make physical contact difficult depict no obstacles and transaction cost in innovation networks can be reduced.

Overall, it should be noted that the elaboration of the framework and the selection of the methods are so far a theoretical effort. The selection represents a first preselection based on the authors literature research and can be extended. Also, for the fine tuning of the Innovation-Method-Framework it is further necessary to apply it in a real business case to test and verify its applicability and usefulness for cross-organisational service interaction and value co-creation. In addition, it is planned to use the Innovation-Method-Framework in a teaching context to expose it to critical discourse in order to be able to derive possibilities for improvement.

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References

Brown, T., & Katz, B. (2019). Change by design: How design thinking transforms organizations and inspires innovation. Revised and Updated edition. HarperBusiness, An imprint of HarperCollinsPublishers.

Chesbrough, H. (2003). *Open innovation: The new imperative for creating and profiting from technology*. Harvard Business School Press.

Dufour, J., & Son, P.-E. (2015). Open innovation in SMEs—towards formalization of openness. *Journal of Innovation Management, 3*(3), 90–117. https://doi.org/10.24840/2183-0606_003.003_0008

Dustin, G., Bharat, M., & Jitendra, M. (2014). Competitive advantage and motivating innovation. *Advanced Management, 7*(1), 1–7.

Eikebrokk, T. R., Garmann-Johnsen, N. F., & Olsen, D. H. (2021). Co-creation in networks of SMEs: a conceptual model of the co-creation process. *Procedia Computer Science 181*, 360–366. https://doi.org/10.1016/j.procs.2021.01.179

Gummesson, E., & Mele, C. (2010). Marketing as value co-creation through network interaction and resource integration. *Journal of Business Market Management, 4*(4), 181–198. https://doi.org/10.1007/s12087-010-0044-2

Hansen, M. T., & Birkinshaw, J. (2007). The innovation value chain. *Harvard Business Review,* 85(6), 121–130, 142.

Koreimann, D. S. (1987). *Management*, *3*, Wesentl. erw. Aufl. Oldenbourg.

Lee, S., Park, G., Yoon, B., & Park, J. (2010). Open innovation in SMEs—An intermediated network model. *Research Policy, 39*(2), 290–300. https://doi.org/10.1016/j.respol.2009.12.009
Lusch, R. F., & Nambisan, S. (2015). Service innovation: A service-dominant logic perspective. *MIS Quarterly, 39*(1), 155–175. https://doi.org/10.25300/MISQ/2015/39.1.07
Marcos-Cuevas, J., Nätti, S., Palo, T., & Baumann, J. (2016). Value co-creation practices and capabilities: Sustained purposeful engagement across B2B systems. *Industrial Marketing Management, 56*, 97–107. https://doi.org/10.1016/j.indmarman.2016.03.012
Namugenyi, C., Nimmagadda, S. L., & Reiners, T. (2019). Design of a SWOT analysis model and its evaluation in diverse digital business ecosystem contexts. *Procedia Computer Science, 159*, 1145–1154. https://doi.org/10.1016/j.procs.2019.09.283
Neghina, C., Caniëls, M. C. J., Bloemer, J. M. M., & van Birgelen, M. J. H. (2015). Value cocreation in service interactions: Dimensions and antecedents. *Marketing Theory, 15*(2), 221–242. https://doi.org/10.1177/1470593114552580
Schumacher, J. (ed) (2008). *European living labs: A new approach for human centric regional innovation*, 1. Aufl. WVB.
Vargo, S. L., & Lusch, R. F. (2004). Evolving to a new dominant logic for marketing. *Journal of Marketing, 68*(1), 1–17. https://doi.org/10.1509/jmkg.68.1.1.24036
Vargo, S. L., & Lusch, R. F. (2008). Service-dominant logic: Continuing the evolution. *Journal of the Academy of Marketing Science, 36*(1), 1–10. https://doi.org/10.1007/s11747-007-0069-6
Vargo, S. L., & Lusch, R. F. (2016). Institutions and axioms: An extension and update of service-dominant logic. *Journal of the Academy of Marketing Science, 44*(1), 5–23. https://doi.org/10.1007/s11747-015-0456-3
Webster, J., & Watson, R. T. (2002). Analyzing the past to prepare for the future: Writing a literature review. *MIS Q., 26*(2), xiii–xxiii.
Ye, J., & Kankanhalli, A. (2013). Exploring innovation through open networks: A review and initial research questions. *IIMB Management Review, 25*(2), 69–82. https://doi.org/10.1016/j.iimb.2013.02.002

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Ecosystems for Value Co-creation

Actors' Network Analysis and Bi-Directional Value Exchange Matrix Development for Living Labs: KTH Live-In-Lab Case Study

Elena Malakhatka and Per Lundqvist

Abstract In the scientific literature and in practice, quite a lot of attention is paid to the actors' network analysis in living labs. Still, there is a lack of studies on value exchange between different actors in living laboratories. This study selected the distributed structure of the actors' network in living lab since most European residential laboratories function according to this model. In the course of this exploratory study, we conducted two workshops: the first with participants from several European residential laboratories to discuss and co-design a framework for analyzing the exchange of value between different stakeholders, and the second workshop—case study, where the proposed framework was applied on the actors network of the existed living laboratory—KTH Live-in-Lab. As a result, we got a detailed picture of the network of actors and value exchange within the value co-creation model for KTH Live-in-Lab (Smart Home Services project).

Keywords Actors' network analysis · Value exchange system · Living lab · Smart home services

1 Introduction

Most living laboratories work with a diversified ecosystem of different kinds of partners, actors, and stakeholders with varying levels of involvement. Still, the topic of living lab's actors' analysis as a network is understudied, especially observing the actors' network through the prism of value exchange system. In this paper, we specifically focus on the actors network (not stakeholders or partners) to highlight the involvement of the broader group of people in the process, not only those who play a decisive role in the process. Most of the living lab still statically presenting the actors ecosystem. In one of the recent contributions (Mitchell et al., 2017), made a study on actors' dynamism, and how the engagement may vary, depending on the different relationships between actors in a network. This exploratory study is one of

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the first attempts to bring an actors' network analysis and value exchange system into the living lab research domain. The main goal of this exploratory study was to co-design an easy to use by different actors framework for analyzing the value exchange between different actors of living lab. An additional step of this study was to test proposed framework on the actors' network of existing living laboratory and reflect on the necessity of such tool and future development of the framework and way to apply it at practice. As a result, we have come to some conclusions that may contribute to the study of the synthesis between actors' network theory and value exchange mechanism in the context of living laboratories.

2 Theoretical Background

The theoretical background of the study is based on two supportive theories: actors' network analysis and value exchange within the value creation model. Actors' network analysis (ANA) as a part of social network theory (SNT) is the process of investigating social structures using networks and graph theory (Borgatti & Ofem, 2010). It characterizes networked structures in terms of nodes and the ties, edges, or links that connect them. Value exchange within value creation model take a commercial idea beyond the binary user-supplier value chain to more complex, symbiotic transactional network among multiple participants, each of which may create and consume value. Synthesis of proposed theories can bring valuable results for organizational management domain and innovation acceleration within living labs' context.

The concept of a living lab refers to the involvement of multiple stakeholders, including users, in the exploration, co-creation, and evaluation of innovations within a realistic setting (Ballon & Schuurman, 2015; Dutilleul et al., 2010; Leminen et al., 2012). Living labs as approaches include experimentation and co-creation with multiple actors in order to design, try, test, or validate ideas, products, services, or stuff. Usually, activities follow an iterative process with feedback (Veeckman & Graaf, 2015), over a period of time to provide a coherent base or knowledge building. Knowledge sharing among the actors is critical (Walt et al., 2009). Through the process of partnerships between public–private domains, an understanding of an initial idea and demand can be gained (Niitamo et al., 2006). The authors at (Voytenko et al., 2016) mention trust, involvement of members in the innovation process, access to adequate knowledge regarding the problem environment, state-of-the-art ICT tools and methodologies, and good governance as critical for nurturing communities. In (Almirall & Wareham, 2008) living labs described as '*service providing organization for innovation and R&D*', where resources are offered within the areas of competency, local actors, partners and stakeholders, ICT infrastructure, operational methodology, and recourses. According to the early definition by Grimble and Wellard (1997), '*stakeholder analysis can be defined as a holistic approach or procedure for gaining an understanding of a system (…) by means of identifying the key actors and stakeholders and assessing their respective interests in the system*'. A network that ties the involved actors together could facilitate the flow of information, enhance transparency, minimize risks and potentially lead to innovation acceleration (Cheung & Rowlinson, 2011; Prell et al., 2009; Rowley, 1997a; Zedan & Miller, 2015). Based on the definition of a value creation model, which comprises actors and their exchange of value within a framework of collaboration principles, the value of each stakeholder can be identified (Kirchhoff et al., 2001). It is important to notice, that most of the living labs are driven by universities and academia is playing a crucial role in the living lab actors' network. In the specific context of universities, there must be said, that the creation of partnerships to improve the sustainable development of their communities is seen applicable mostly for research projects and public engagement (Parker, 2002). How universities are managing relations with different actors, through which technologies and to what extent is a research field that is growing. One of the most evident shifts is, in fact, the end of the view of actors' relationships as a dyadic approach (Rowley, 1997b), organizational centered, and the born of an ecosystemic view with multiple-actors, that in most of the case is issue-based (Roloff, 2008).

3 Methodology

To apply existing theoretical knowledge in the fields of ANA and value exchange within the value co-creation model in the context of living laboratories, we have divided the methodology into four phases: theoretical background, value exchange framework co-developed with several EU living Labs, Actors network analysis of selected living lab and value exchange analysis of one R&D project within selected living lab. The holistic research process is presented on the Fig. 1 below**.**

During the first phase we have organized a participatory workshop with 32 participants representing 8 different EU living labs from 6 countries (the workshop was a

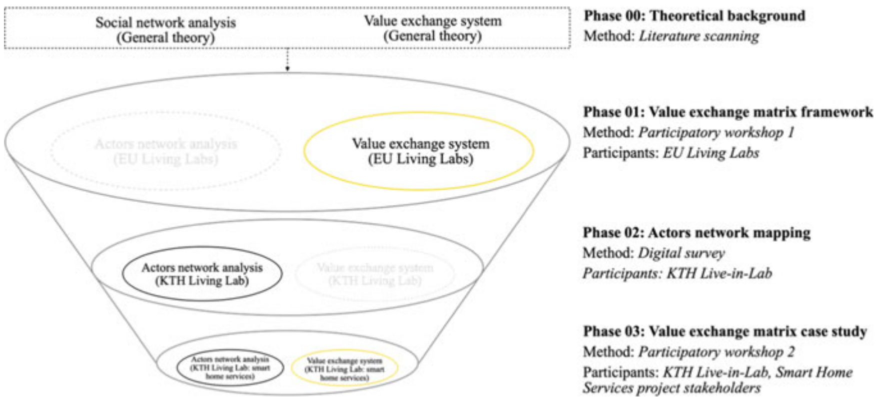

Fig. 1 Research methodology framework and process

part of Urban Living Lab Summit organized by AMS Institute). The main purpose of the workshop was to discuss the existed approaches and practices for both actors' network analysis and value exchange system at living labs in EU. The Workshop was organized in the form of mentimeter session, where we were able to collect data in the real time and co-design a framework for value exchange analysis of multiple actors' networks at living labs.

During the phase two, we selected one living for applying discussed during the phase one approach to analyze actors' network and bi-directional value exchange framework. For the case study, we have selected a living laboratory from Sweden—KTH Live-in-Lab, which focus is sustainable building operation and building technology acceleration. In this study we have decided to classify KTH Live-in-Lab actors by the connection to the specific research project. This approach was suggested by most of the living labs from the first workshop and could help to see a more diverse network and actual and potential relationship between them. More than fifty different stakeholders from KTH Live-in-Lab were involved into the digital survey and homogeneously represented public and private sectors.

During the phase three we have chosen one of the projects at KTH Live-in-Lab R&D portfolio–Smart Home services for a more detailed analysis of the value exchange mechanism.

4 Results

4.1 Value Exchange Matrix Framework

Most participants emphasized the need for a deeper analysis of the relationship between actors and value exchange mechanisms. In the scientific literature and in practice, quite a lot of attention is paid to the actors' network analysis in living labs, but there is a lack of studies on the topic of value exchange between different actors in living laboratories. All participants of the workshop acknowledged the use of *distributed structure* of the actors' network in their living labs. According to the literature, most European residential laboratories function according to this model (Leminen et al., 2016). Main conclusions related to the framework for value exchange analysis were:

- start with bi-directional high level value exchange model;
- use an easy to understand by different types of stakeholders' framework.

The result of this workshop was co-development of matrix for the bi-directional value exchange between key actors of living laboratory Fig. 2

Additional proposal by the participants of the workshop was to separate the actors network analysis and value exchange analysis on two consecutive steps to avoid the confusion and model overload.

Fig. 2 Value exchange matrix framework

4.2 *Actors' Network Analysis and Value Exchange Matrix: KTH Live-In-Lab*

Different approaches to the analysis of actors in various living laboratories were identified and discussed during the first workshop. Most of the participants analyze actors according to the type of actor's role and the degree of involvement. The approach to the study actors from the social network theory was perceived positively by many. Additionally were proposed Knowledge Network Analysis, ethnographic methods, group dynamics theory, and agent-based modeling. Separately, it was suggested to add an aspect of trust and analysis of time frames for future studies.

General map of KTH Live-in-Lab actors built around an R&D portfolio and research topics and presented at Fig. 3a. For a more illustrative example of value exchange mechanism, we chose one project within KTH Live-in-Lab R&D portfolio—*Smart Home Services*. As developing the high technology for smart home

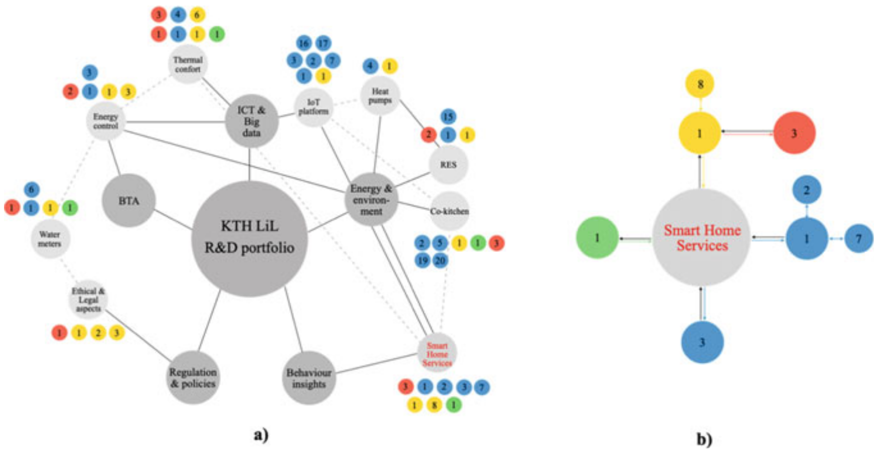

Fig. 3 KTH Live-in-Lab actors' network built around R&D domains: all active actors (left), Smart Home Services project network (right)

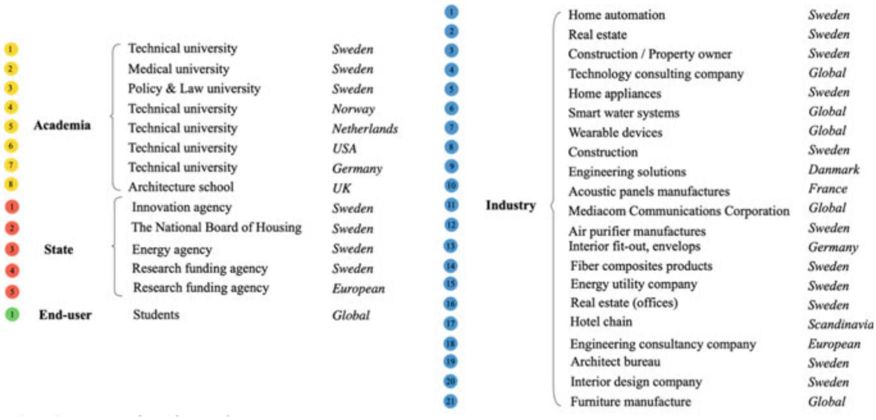

Fig. 4 KTH Live-in-Lab actors

services and providing various service offerings are realized through partnership, synergies among actors from diverse areas are required (Freeman, 1984). Constructing multi-dimensional partnership allows involved actors to take advantage of professional knowledge, advanced technology and high quality products or services of other companies and lower system costs at the same time [23, 24]. Methods to analyze stakeholders' needs and to help their communication and involvement can contribute to smart home services development involving a variety of actors. Using this example, we considered how the actors' network analysis and value exchange system could be combined. Figure 3b shows a more detailed map of the actors in selected research project, which indicates that some of the actors are directly related to the research project of the living lab, and some are associated with some of the actors (which is confirmed by the distributed structure of the actors' network of selected living lab).

The full list of KTH Live-in-Lab actors is presented at Fig. 4 below.

As you can see from the Fig. 5, different types of actors have different value priorities in relation to the living laboratory. So, for example, we see that it is important for academic actors to get actual data and access to industrial partners, while the living labs itself must be able to work with the scientific method and long-term perspective that the academy can provide. In the case of industrial actors, the most important thing for them is the possibility of open innovation and testing new products and services in a real-life setting. At the same time, the industry can provide the possibility of scaling and additional funding for the living labs. When it comes to government organizations, core values are built around policies and regulations improvements. If we summarize the results obtained, we can see that the proposed vale exchange matrix allows for a more structured analysis of the actors involved in residential laboratories. In addition, even in general terms, understanding what value and needs different actors have and what a living laboratory can give in return.

Fig. 5 Value exchange matrix between key actors at KTH Living Lab (smart home services project) and Living Lab as organization

5 Discussion and Conclusion

It is important to note that this research is at an early stage, and more fundamental contributions to theoretical knowledge and more detailed testing of primary hypotheses are under development. Nevertheless, certain results are already taking place at this initial stage.

We have tried to focus on the relationship between the actors' network theories and value exchange mechanisms during this pre-study. We have tested a very simplified overlap of these theories at two different levels: macro-level—representatives of living labs from Europe and micro-level—representatives of a research project within one living laboratory. We want to share a few preliminary findings. First, the collation of different actors' networks and the value exchange system analysis have enormous potential for cross-collaboration within different types of actors. Such an analysis brings a certain degree of transparency to the actors' network, creates a premise for sharing strategies, co-strategies, co-creation, and closer collaborations. Secondly, the practice of a bi-directional value exchange mechanism between different actors helps to identify both tangible and intangible values and enable better understand of the relationships between actors, which can benefit the quality of relations and a more sustainable partnership in the future. Here we would also like to highlight that open innovation is a key driver of the diversified value proposition. Thirdly, the proposed approach of exploring actors' networks can help to zoom in and zoom out to the actors' constellations. Forth, the selected research project—'Smart home services' has the largest network constellation within R&D portfolio at KTH-Live-in-Lab. In addition, we would like to note that a large part of the work of living laboratories is sacred with access to data and the ability to test new products and services, which creates a fertile ground for more intensive involvement of smart services in these R&D portfolio and cross projects collaboration. The clear picture of involved actors and their value propositions can help to understand the network value and identify possible collaborators within R&D portfilio.

Even though the proposed method for analysing the actors' network and the value exchange system is rather simplified and static, this simple first step can become the basis for studying the actors' network at living labs in time. For example, if the proposed value exchange matrix is filled in twice a year for several years, it is possible to trace how the actors' network and the actors' exchange value system change.

We also planning to explore in the future how to make proposed approach more systematic and use more advance ANA theories with more quantitative data capturing. Combination of qualitative and quantitative data about actors' network withing the whole life cycle of living laboratory is required.

References

Ackermann, F., & Eden, C. (2011). Strategic management of stakeholders: Theory and practice. *Long Range Planning, 44*(3), 179–196.

Almirall, E., Wareham, J. (2008). Living labs and open innovation: Roles and applicability. *eJOV Electronic Journal for Virtual Organizations and Networks, 10*, 21–46.

Ballon, P., Schuurman, D. (2015). Living labs: Concepts, tools and cases. *Info*, *17*.

Borgatti, SP., & Ofem, B. (2010). Social network theory and analysis. *Social Network Theory and Educational Change*, 17–29.

Cheung, Y. K. F., & Rowlinson, S. (2011). Supply chain sustainability: A relationship management approach. *International Journal of Managing Projects in Business, 4*, 480–497.

Dutilleul, B., Birrer, F.A., Mensink, W. (2010). Unpacking European living labs: Analysing innovation's social dimensions. *Central European Journal of Public Policy*, *4*, 144490.

Freeman, R. E. (1984). Strategic management: a stakeholder approach. Boston, MA: Pitman.

Grimble, R., & Wellard, K. (1997). Stakeholder methodologies in natural resource management: A review of principles, contexts, experiences and opportunities. *Agricultural Systems, 55*(2), 173–193.

Kirchhoff, B. A., Merges, M. J., & Morabito, J. (2001). A value creation model for measuring and managing the R&D portfolio. *Engineering Management Journal, 13*(1), 19–22.

Leminen, S., Westerlund, M., Nyström, A.-G. (2012). *Living Labs as Open-Innovation Networks.* Ottawa, ON, USA: Carleton University.

Leminen, S., et al. (2016). The effect of network structure on radical innovation in living labs. *Journal of Business & Industrial Marketing.*

Mitchell, RK., Lee, JH, & Agle, BR. (2017). Stakeholder prioritization work: The role of stakeholder salience in stakeholder research. In *Stakeholder management*. Emerald Publishing Limited.

Niitamo, V.-P., Kulkki, S., Eriksson, M., Hribernik, K.A. (2006). State-of-the-art and good practice in the field of living labs. In *Proceedings of the 2006*

Parker, LD. (2002). It's been a pleasure doing business with you: a strategic analysis and critique of university change management. *Critical Perspectives on Accounting*

Prell, C., Hubacek, K., & Reed, M. (2009). Stakeholder analysis and social network analysis in natural resource management. *Society and Natural Resources, 22*, 501–518.

Roloff, J. (2008). Learning from multi-stakeholder networks: Issue-focussed stakeholder management. *Journal of Business Ethics, 82*(1), 233–250.

Rowley, T. J. (1997a). Moving beyond dyadic ties: A network theory of stakeholder influences. *Academy of Management Review, 22*, 887–910.

Rowley, TJ. (1997b). Moving beyond dyadic ties: A network theory of stakeholder influences. *Academy of Management Review, 22.4*, 887–910.

Van Der Walt, J. S., Buitendag, A. A., Zaaiman, J. J., & Van Vuuren, J. J. (2009). Community living lab as a collaborative innovation environment. *Issues in Informing Science and Information Technology, 6*, 421–436.

Veeckman, C., & Van Der Graaf, S. (2015). The city as living laboratory: Empowering citizens with the citadel toolkit. *Technology Innovation Management Review, 5*, 6–17.

Voytenko, Y., McCormick, K., Evans, J., Schliwa, G. (2016). Urban living labs for sustainability and low carbon cities in Europe: Towards a research agenda. *Journal of Cleaner Production.*

Zedan, S., & Miller, W. (2015). Using relationship mapping to understand sustainable housing stakeholders' actions. In *Sustainable Human–Building Ecosystems* (pp. 204–213). American Society of Civil Engineers (ASCE), Pittsburgh, Pennsylvania, USA. https://doi.org/10.1061/9780784479681.022.

Moving Beyond Manufacturing: Building a Research Agenda for Servitizing Service Firms and Ecosystems

Jamie Burton, Chris Raddats, Vicky Story, Shaun West, and Judy Zolkiewski

Abstract Researchers are building increasing competence in the area of servitization with respect to manufacturing and more recently digital servitization. A much smaller volume of work considers the value of servitization for service organizations and ecosystems, despite early recognition that servitization is applicable to service providers, manufacturers, and other actors such as distributors. This provides an opportunity to move beyond manufacturing to explore how servitization applies and manifests in service providers. The paper uses concepts from Service-Dominant Logic (SDL) and Service Science and focuses on key business activities undertaken by actors in an ecosystem and considers them for independent service providers (ISPs); that is, not companies acting as distributors for manufacturers' products. Thus, this paper builds a research agenda for this embryonic research area, combining key strands of existing manufacturer-based research and applying them to a service provider context. We consider how the characteristics of ISPs might lead to differences to manufacturer-focused servitization. We use exemplar vignettes to bring some of these issues to life and illustrate how ISPs may be better placed than manufacturers to address these key business activities to implement servitization.

Keywords Servitizing service firms · Ecosystems · Service-dominant logic

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1 Introduction

Servitization describes a transformational process through which companies use services to create additional customer value, predominantly in the business-to-business (B2B) domain (Vandermerwe & Rada, 1988). Since the publication of this seminal paper, several hundred others have been written about the topic, with a recent focus on digital servitization; that is, how digital technologies are used to help develop new services and/or improve existing ones (Paschou et al., 2020; Sjödin et al., 2020). The overwhelming majority of papers about servitization focus on how manufacturers add services to their traditional product offerings, despite Vandermerwe and Rada (1988) conceiving that servitization can also apply to service companies. If we envisage servitization as a journey from offering services that support a supplier's products to those that support customers' operations (Mathieu, 2001), it is clear that service providers can also develop offerings to better support their customers' operations.

Another major theme in recent servitization research has been the adoption of an ecosystem perspective; that is, recognition that servitization is not just a phenomenon for and by the focal manufacturer but one that encompasses other actors in an ecosystem for effective value co-creation, such as customers, distributors, and suppliers (Raddats et al., 2019). Within this theme, several papers focus on the need for manufacturers to access additional capabilities that are required for successful servitization, which they may lack in-house (Story et al., 2017). In this regard, service providers may also need capabilities from their ecosystem to servitize.

While there appear to be similarities between how product- and service-focused companies undertake servitization, it is likely that there are also differences. Before these can be identified, it is necessary to revisit the debate about whether services are different from products (goods). Within the academic community, this issue is often considered through the lens of service-dominant logic (SDL) (Vargo & Lusch, 2004). Thus, should we consider products and services separately (goods-dominant logic or GDL) or in combination together, with 'service' (SDL) used to create value-in-use with customers (Vargo & Lusch 2008)? If both product and service firms aim to create value-in-use with their customers, then it might be that the offerings and capabilities that underpin them are similar for both types of firms. However, while both product and service firms may ultimately aim to create value-in-use, there is a fundamental difference in how it is created with the former possessing deep knowledge and capabilities about its products, which are difficult for non-OEM service firms to replicate. This forces the latter to think more creatively and flexibly about the new service value that they might offer.

Our starting point then is that there may be both differences and similarities in how servitization manifests for product and service firms. In this paper, we aim to build a research agenda for this emerging research area, using SDL to bring together some of the key strands of existing manufacturer-based research and apply them to a service provider context. We also consider the servitizing firms from the perspective of Service Science, which is the study of service systems and service innovation (Maglio & Spohrer, 2008). By employing both the lens of SDL and Service Science, we hope to start the process of bringing a unifying perspective to servitization research.

2 Literature Review

The literature review applies both the lenses of SDL and Service Science by considering the former in a servitization context and then the latter as part of a discussion about ecosystems.

2.1 Service Dominant Logic in a Servitization Context

SDL has been developed as a unified paradigm that does away with the distinction between products and services (Brodie et al., 2019a). While its applicability is designed to be universal, it has received considerable attention in B2B marketing research. For example, Vargo and Lusch (2011) used the actor-to-actor (A2A) concept to posit a networked, systems-orientation approach to value creation. In this regard, SDL has some similarities to, and draws upon, the IMP approach to B2B marketing (Ford, 2011). A2A value co-creation, particularly between suppliers and customers, is an important area for B2B research. For example, Aarikka-Stenroos and Jaakkola (2012) show that SDL provides a framework for how value co-creation develops in professional service firms and their customers through activities such as diagnosing needs, designing and implementing solutions, and managing value conflicts.

SDL has been applied in relatively few papers about servitization and these are reviewed here. Windahl and Lakemond (2010) developed a typology of four integrated solutions that manufacturers provide to their customers with increasing supplier/customer inter-dependence and potential for value co-creation: rental, maintenance, operational, and performance offerings. As manufacturers develop more advanced offerings (i.e., guaranteeing performance), they increasingly need to balance GDL and SDL, with value co-creation central to providing product-service solutions (Sjödin et al., 2016). In a paper based on a case study of engine manufacturer Rolls Royce, Ng et al. (2012) compare value through exchange (GDL) and value-in-use (SDL) when considering the company's value-creating activities (e.g., technical query resolution speed). Focusing on value-in-use activities results in Rolls Royce having a better understanding of how to adapt, modify, and enhance their value propositions to deliver greater effectiveness and efficiency. Ng et al. (2012) note the implications of these findings for service providers in terms of not having a 'provisioning' mentality (GDL) but instead considering customer resources in creating value (SDL), which can drive innovation through collaboration and cooperation.

While the application of SDL in servitization research has been limited, it is clear that a move to unified product/service offerings (e.g., solutions) is more in keeping with the notion of a service logic (Grönroos, 2006) rather than having separate product and service offerings (GDL). SDL tends to focus on the service-good dichotomy, to promote the dominance of service. However, the creation of value via digital technology is perhaps neither good nor service; it is something else. Grönroos (2006, p.12) highlights that the Nordic School view is that "goods do not render services" and neither do customers "consume goods as services"; goods are just one type of resource active within a process and it is this process that is consumed. Digital technology then is yet another resource within a process, realized via capabilities surfaced through A2A interaction.

Fundamentally, servitization involves a set of change processes (Kohtamäki et al., 2021). For example, a service firm developing new digital services has to make substantial changes to develop skills to create them, but these are not necessarily to do with service or product. Zhou et al. (2021) utilize two SDL micro-foundations 'resource liquefaction' and 'resource integration' as part of a study about how digital servitization can impact firm performance. Resource liquefaction concerns how digitalization can decouple resources, so, for example, data from devices can be decoupled from the devices themselves to increase opportunities for innovation. By contrast, resource integration for servitization involves firms combining resources from different actors, so utilizing other actors' capabilities in the ecosystem (see Sect. 2.2). Through this approach, basic and advanced services are found to reinforce each other's positive effects on a manufacturer's market performance (Zhou et al., 2021).

2.2 *The Ecosystem Perspective*

Manufacturers have historically played a lead and dominant role, acting as the prime actor in their value supply chains. Their monopoly position in the creation of the physical good at the center of the value chain provides a degree of power over other actors, as long as the market is not disrupted. When these manufacturers subsequently engage in servitization there is still potential to maintain their position as the prime if the good still plays a central role in value delivery (Burton et al., 2017). However, where the gravity of value creation is increasingly dependent on service, there is perhaps less inherent power with any one actor relating to the creation of physical goods. Instead, maintaining an edge within a service ecosystem may rely on constant innovation, communication and co-ordination of value sharing as demonstrated by digital service providers through developments in information and communication technologies (ICTs) (Barrett et al., 2015).

Recognition of the roles that multiple actors (focal firms, customers, suppliers, competitors, regulators, and more) can play in the co-creation of value within networks through engagement behaviors has been recognized for a while (Normann, 1984; Gummesson, 2010; Brodie et al., 2019b). Maglio and Spohrer (2008), as part of the Service Science agenda, set out to categorize and explain this crystallization of value co-creation within service systems via considering the interwoven interests of these various actors and recognizing the roles of four key resource types: operant people and organizations, and operand information and technologies (Maglio & Spohrer, 2008, 2013). It is via facilitating value propositions that reconfigure access to each other's resources that service systems are formed and operate (Maglio & Spohrer, 2013). Coordinated actions are planned and assessed by actors via symbolic processing of valuing and communicating (Maglio & Spohrer, 2013).

Story et al. (2017) provide a multi-actor perspective for the identification of the capabilities required for servitization in an ecosystem. We use the 'key business activities' presented in this paper to develop a framework to identify the important aspects of servitization for independent service providers (ISPs), compared to those for servitizing manufactures. These key business activities are 'innovation', 'interaction processes', 'actor insight', 'business culture evolution', 'working with other actors', 'infrastructure development and management'. Story et al. (2017) consider these business activities from the perspectives of the manufacturer, distributor, and customer. In this paper, we focus on ISPs rather than distributors which are often tied to supplying services for certain manufacturers' products.

3 Findings

In adopting a service system perspective, it becomes clear that servitization involving business model **innovation** can take place whether the original value proposition is a product or a service. The process of servitization causes market disruption, but the focal disrupter can be one of a range of actors. The degree of business model innovation involved in servitization can then determine the extent of the change required; whether for a manufacturer it be basic services added to an existing product or involve the company transforming from manufacturer to service provider. ISPs are also innovative and can develop new offerings to better support their customers' operations. Take the case of logistics provider DHL. In addition to its traditional shipping and delivery service products, it offers customers a range of additional services and solutions such as supply chain design consultancy, risk assessment and management, warehousing, and insurance. Thus, DHL has developed value-added services to address customers' operational needs and desired value outcomes, which extend the scope of its traditional service products.

Interaction processes are the customer's operational processes within which the manufacturer's products need to fit. Manufacturers' expertise generally has to do with their products, rather than how customers use the products in operational settings. It is, therefore, likely that ISPs are better positioned to address this business activity than manufacturers, since they may already utilize replicable service methodologies that are transferable to the customer environment. For example, energy provider RWE offers other energy providers a range of consultancy services that cover the full value chain, from planning and building energy assets to decommissioning them. Using its knowledge as a customer of manufacturers' products, it can 'speak the same language' as other energy providers and share its expertise in process optimization with them.

Actor insight is a prerequisite of offering more advanced services and ISPs will probably be more easily be able to do this than manufacturers since there is less requirement to understand how product provision translates into the customer's operational processes. Take for example Hexagon, a global service provider that uses sensor technologies to offer data-based solutions to customers in a range of industries, helping them to optimize the performance of their products. The data that Hexagon can access about product performance offers less capacity for identifying equipment faults than that which an OEM may be able to access from using its sensors. However, the data is broader, in the sense that it can be captured from a range of OEMs' products within the customer's ecosystem to help optimize the product estate. Thus, servitizing ISPs can become a threat to traditional manufacturers through shifting the locus of power away from the actor creating the tangible product resource to the actor creating an intangible process; which can be a new service provider.

Business culture evolution can also be key for ISPs' success in servitizing, although this evolution is less pronounced than for manufacturers. This is because ISPs already have a service culture, albeit not necessarily one that is proficient at developing and delivering advanced services. An example of this evolution is facilities management provider Mitie. In their building services division, they shifted from a narrow focus on staff skills for physical infrastructure care and maintenance to embracing a broader skillset focused on delivering excellence in the customer experience. It should be borne in mind that not needing to transform a manufacturing culture to a service culture is an advantage for ISPs since this transformation is often problematic for manufacturers and rarely completed successfully, other than exemplars such as IBM, which successfully transitioned from a computer manufacturer to service and software provider.

ISPs may also need capabilities from **working with other actors** in their ecosystem to servitize. Consider IT service provider DXT Technology, which provides IT solutions globally. Within the context of digital servitization, the company partners with cloud computing providers Microsoft and Oracle. DXT Technology's customers' in-house applications can be moved to the cloud; for example, Oracle's ERP applications can be migrated to Oracle Cloud Infrastructure. Thus, DXT Technology relies on partners to deliver its customer solutions. A challenge for ISPs is that they often cannot access the same technical data as an OEM but are likely to be more credible partners, since they do not have proprietary products to sell that may compromise attempts to work with other product suppliers.

Infrastructure development and management is a critical advantage that many ISPs have over manufacturers; that is, they have a more comprehensive field service organization. For example, in the UK, telecommunications service provider Telent has a nationwide field force that can install, commission, and integrate different technologies in a diverse range of operational locations and environments. The requirement to possess a large field force may diminish as digital technologies help suppliers to remotely manage product estates and fix some faults, but this still appears an important differentiator that an ISP may have over a manufacturer.

Through the above analysis, we can see differences between manufacturers and ISPs in terms of key business activities for servitization. However, arguably the main overarching difference between these types of organizations is product incumbency, with manufacturers, on the one hand, benefiting from deep technical knowledge about their products but lacking credibility as a provider of vendor-agnostic offerings (Raddats & Easingwood, 2010). ISPs, on the other hand, benefit from perceived independence from any one manufacturer but may lack deep technical knowledge of the supplied products. Thus, having both deep technical knowledge and perceived independence, in terms of being able to provide customers with vendor-agnostic solutions, is a challenge, although some service providers have managed to overcome it. For example, consider Babcock International, an international aerospace, defense, and security services company. In 2008, the company acquired the services arm of VT Group, which was a UK-based warship builder. While the warship building arm of the company was acquired by BAE Systems, the services arm was procured by Babcock International, so the deep technical knowledge of the manufacturer was captured by the service provider, which can provide solutions independent from any single OEM.

4 Conclusion

This paper sets out to explore how servitization has applicability for ISPs as well as manufacturers. Although servitization was originally conceived as being relevant to service providers as well as manufacturers, this aspect has largely been ignored in the literature. Using concepts from SDL and Service Science this paper starts to frame a research agenda in this area. It does this by taking several key business activities used by a range of actors in the servitization ecosystem and considers their applicability for ISPs. Prior work has considered these business activities for distributors; that is, service providers that are tied to servicing certain manufacturers' products. The paper reveals that many of these business activities are already undertaken by ISPs and in many respects, they have advantages in undertaking them more successfully than manufacturers; for example, an ISP is more likely than a manufacturer to have processes and service methodologies that align with those of the customer. ISPs are the overlooked actor in the servitization 'story', and our paper starts to address this important oversight.

While this paper has provided vignettes from ISPs to support its arguments, there is a need to explore the topic further; for example, through case studies or through the collection of more vignettes (or a combination of the two approaches). Equally, a more detailed consideration of business activities, such as the resource configurations, resource integration and processes required by different actors to bring about servitization would further enlighten this topic.

References

Aarikka-Stenroos, L., & Jaakkola, E. (2012). Value co-creation in knowledge intensive business services: A dyadic perspective on the joint problem-solving process. *Industrial Marketing Management, 41*(1), 15–26.

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

Brodie, R. J., Fehrer, J. A., Jaakkola, E., & Conduit, J. (2019a). Actor engagement in networks: Defining the conceptual domain. *Journal of Service Research, 22*(2), 173–188.

Brodie, R. J., Löbler, H., & Fehrer, J. A. (2019b). Evolution of service-dominant logic: Towards a paradigm and metatheory of the market and value cocreation? *Industrial Marketing Management, 79*, 3–12.

Burton, J., Story, V. M., Raddats, C., & Zolkiewski, J. (2017). Overcoming the challenges that hinder new service development by manufacturers with diverse services strategies. *International Journal of Production Economics, 192*, 29–39.

Ford, D. (2011). IMP and service-dominant logic: Divergence, convergence and development. *Industrial Marketing Management, 40*(2), 231–239.

Grönroos, C. (2006). Adopting a service logic for marketing. *Marketing Theory, 6*(3), 317–333.

Gummesson, E. (2010). The future of service is long overdue. In P. P. Maglio, C. A. Kieliszewski, & J. C. Spohrer (Eds.), *Handbook of service science* (pp. 625–642). Springer.

Kohtamäki, M., Rabetino, R., Einola, S., Parida, V., & Patel, P. (2021). Unfolding the digital servitization path from products to product-service-software systems: Practicing change through intentional narratives. *Journal of Business Research, 137*, 379–392.

Maglio, P. P., & Spohrer, J. (2008). Fundamentals of service science. *Journal of the Academy of Marketing Science, 36*(1), 18–20.

Maglio, P. P., & Spohrer, J. (2013). A service science perspective on business model innovation. *Industrial Marketing Management, 42*(5), 665–670.

Mathieu, V. (2001). Product services: From a service supporting the product to a service supporting the client. *Journal of Business and Industrial Marketing, 16*, 39–61.

Ng, I., Parry, G., Smith, L., Maull, R., & Briscoe, G. (2012). Transitioning from a goods-dominant to a service-dominant logic: Visualising the value proposition of Rolls-Royce. *Journal of Service Management, 23*(3), 416–439.

Normann, R. (1984). *Service management: Strategy and leadership in service businesses.* Wiley.

Paschou, T., Rapaccini, M., Adrodegari, F., & Saccani, N. (2020). Digital servitization in manufacturing: A systematic literature review and research agenda. *Industrial Marketing Management, 89*, 278–292.

Raddats, C., & Easingwood, C. (2010). Services growth options for B2B product-centric businesses. *Industrial Marketing Management, 39*(8), 1334–1345.

Raddats, C., Kowalkowski, C., Benedettini, O., Burton, J., & Gebauer, H. (2019). Servitization: A contemporary thematic review of four major research streams. *Industrial Marketing Management, 83*, 207–223.

Sjödin, D. R., Parida, V., & Wincent, J. (2016). Value co-creation process of integrated product-services: Effect of role ambiguities and relational coping strategies. *Industrial Marketing Management, 56*, 108–119.

Sjodin, D., Parida, V., Kohtamaki, M., & Wincent, J. (2020). An agile co-creation process for digital servitization: A micro-service innovation approach. *Journal of Business Research, 112*, 478–491.

Story, V., Raddats, C., Burton, J., Zolkiewski, J., & Baines, T. (2017). Capabilities for advanced services: A multi-actor perspective. *Industrial Marketing Management, 60*, 54–68.

Vandermerwe, S., & Rada, J. (1988). Servitization of business: Adding value by adding services. *European Management Journal, 6*, 314–324.

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

Vargo, S., & Lusch, R. (2008). From goods to service(s): Divergences and convergences of logics. *Industrial Marketing Management, 37*(3), 254–259.
Vargo, S. L., & Lusch, R. F. (2011). It's all B2B… and beyond: Toward a systems perspective of the market. *Industrial Marketing Management, 40*(2), 181–187.
Windahl, C., & Lakemond, N. (2010). Integrating solutions from a service-centred perspective: Applicability and limitations in the capital goods industry. *Industrial Marketing Management, 39*, 1278–1290.
Zhou, D., Yan, T., Dai, W., & Feng, J. (2021). Disentangling the interactions within and between servitization and digitalization strategies: A service-dominant logic. *International Journal of Production Economics, 238*, 108175.

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Methods Supporting a Shared Servitization Framework

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Abstract The transformation process from a product-oriented company to a service-oriented company is known as servitization. The following research focuses on how a shared understanding of servitization can be enhanced through the application of business model design methods and discusses the role of co-creation in this process. The continuous adaptation of the business model is crucial to move from the exploration phase to the engagement phase in the servitization process and to overcome the tipping points between these two phases through a common understanding and conviction. The research at hands ads to literature as it discusses how a business model analysis, and the applied methods support the development of a shared understanding.

Keywords Servitization · Business model · Shared framework

1 Introduction

Equipment manufacturers no longer only provide products to their customers but many offer additional services or even so called "smart" services. Smart services, such as predictive maintenance offerings, are based on digital technologies i.e. sensors, actuators, which enable data gathering, its analysis and interpretation. Collecting data through these smart services can help the customer to optimize efficiency and effectiveness in the usage of the machines (Gebauer et al., 2017). However, many of these companies struggle to change their business from a product-oriented to a service-oriented business (Baines et al., 2017; Martinez et al., 2017).

There is a common understanding that different value perceptions and unclear value-capture approaches are likely to lead to failure, resulting in a digital paradox where companies struggle to achieve expected revenue growth (Gebauer et al., 2020;

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Sjödin et al. 2020a). Obstacles are (a) the right sequence of phases for changing the business logic, (b) barriers in management cognition, and (c) companies not being able to modify the key business models components (Gebauer et al., 2020). To overcome the obstacles and to lower the digital paradox, a shared servitization framework with a clear business model understanding and clear market positioning, fully shared and elaborated servitization objectives and targeted users are central (Polova & Thomas, 2020). The research at hand highlights the role of a shared servitization framework within the servitization process. In doing so, we discuss methods which support companies in concretising a new business model and with this how to achieve a shared servitization framework.

1.1 Servitization

Servitization is a topic of growing importance (Baines et al., 2020; Zhang & Banerji, 2017). Servitization does not refer to the offering itself but to the change process related to transform a firm from being a product-focused company to a service and customer-oriented company (Martinez et al., 2017). This process is neither smooth nor unidirectional and needs a wide array of changes in organizational capabilities, structures, offerings and processes (Kohtamäki et al., 2019; Martinez et al., 2017).

Baines et al. (2020) introduce the servitization progression model consisting of four macro-stages: (1) exploration, (2) engagement, (3) expansion and (4) exploitation. The first step, exploration, is about understanding the market and how the new (advanced) service concept can play a role in the growth. Engagement seeks about the evaluation of the concept until the potential is accepted internally and externally (i.e., with pilot customers, management support). The progression of servitization is dependent on tipping points that could hinder the passage to the next stage (Baines et al., 2020): "The tipping points are triggered when the case for support is sufficiently strong, whether in terms of personal conviction or organisational permission, so that consent is achieved to move on to the following transformation stage." Companies switch from exploration to engagement only when senior management are confident that a viable business opportunity exists. A shared framework, such as the business model analysis, may be important to trigger the tipping point.

1.2 Business Models as a Shared Framework

Each member of a group has assumptions, or frames, that drives him or her in his and her action (Hey et al., 2007). According to Schön (1994) frames can be defined as underlying structures of beliefs, perception and appreciation. The prior creation of documents alone does not guarantee that all members will later have a shared frame; rather, each member's frame does evolve with the project progression. In research, "frameworks" are used to structure and to provide guidance for researcher. Using this guidance, the researcher can check whether the results are confirmed by the framework or derive discrepancies (Imenda, 2014). So, a framework can be defined as a structure or a guidance for ideas and rules which are used to make decisions.

Therefore, a business model can be understood as a shared framework in which the ideas and basic concepts of the future service are made visible to everyone, negotiated, and discussed. A one-off definition of the business model is not sufficient, as the basic idea changes as the idea progresses. Therefore, the business model must be adapted regularly. We follow the understanding of Palo et al. (2019), Kowalkowski et al. (2017), Mason and Spring (2011) in their view as servitization as a process in which business models are transformed. Business models can frame and organize action in the servization process (Palo et al., 2019). Additionally, the business model can also be a management tool for creating a shared understanding between individuals and groups to share what the firm does or might do (Mason & Springer, 2011).

A business model enfolds different dimensions describing which (1) technology, (2) market offering and (3) network architecture/value chain is needed to implement the new offering. With respect to databased services, Deflorin et al. (2017) add the dimension (4) connectivity. Connectivity is the central starting point for any databased service i.e. predictive maintenance as it allows the data gathering and its transfer. It describes which investments are needed to get access to the data. In addition, they explicitly highlight (5) revenue mechanism as another key dimension as this discussion is needed to understand how revenues are generated and where costs occur.

1.3 Co-creation

Today, value is often created through co-creation from internal and external sources (e.g. universities, research institutes, individuals) (Lee et al., 2012). According to Sjödin et al. (2020b), traditional innovation processes should be replaced by agile co-creation processes, which are characterized by creating value between provider and customer in multiple iteration, linked with quick feedback loops and rapid changes. Taking this potential of co-creation into account, methods to concretize the dimensions of the business model, and to generate the shared understanding, should overcome the firm boundaries and apply a co-creation approach with customers and/or suppliers.

To summarize, servitization is the transformation of a company from being a pure product provider to being a service provider. Common frameworks can be defined as a set of beliefs or assumptions shared by several individuals that can be considered as a guideline. A business model represents such a framework. We analyse how, based on co-creation, a business model can be concretized to achieve a shared understanding on the business idea and with this to trigger the tipping point between exploration and engagement phase.

2 Methodology

This study follows a mixed-method approach, combining qualitative multi-case study with action research (Coughlan & Coghlan, 2002). For this purpose, a theoretical sampling was chosen by analysing two industrial companies. The chosen companies are currently implementing predictive maintenance as a new service. Their servitization process started in February 2019 and is still ongoing. Company A is a supplier to manufacturing companies with 200 employees in Switzerland and its head office is in the Netherlands. Company B is a medium sized Swiss machine producer which is part of an international company with its headquarters in Germany.

The companies have successfully completed the exploration phase and are cooperating with pilot customers (engagement phase). Both companies have an interdisciplinary project team consisting of employees from product development, sales, services, marketing and controlling.

Within-case analysis was based on detailed workshop results (transcripts, flipcharts, templates, poster sessions etc.) stemming from 13 group meetings as well as eight semi-structured interviews with company representatives. The discussion of the business models according to Deflorin et al. (2017) was the starting point of the analysis. The eight methods (see Table 1) to concretize the business model analysis were applied with support of the research team who was responsible to document the data as well as to reflect the achievement. The interviews covered the identification of the practices based on the Functional Resonance Analysis Method (FRAM) (Hollnagel, 2017). The business model dimensions were continuously adapted based on the additional insights gained, leading to the final decision to proceed or not to proceed. Each meeting was accompanied by at least three researchers who documented the results and information provided. The information gathered was presented to the company representatives to generate as much objectivity as possible.

3 Case Study Results: Methods for a Shared Framework

Table 1 summarises the methods, the business model dimensions are detailed with its advantages, and disadvantages as well as the derived impact on enabling a shared framework. In addition, the co-creation is summarised i.e., customer (CCC) or supplier (SCC) co-creation. Brackets indicate optional involvement of customer or suppliers.

Table 1 Applied methods and descriptions

Pro (P)	Contra (C)	Shared frame	CCC/SCC
(1) Shadowing (value offering) Shadowings or observations are used to gain more insights to the customers' work. With the "shadowing" method, the observer follows the customer like a "shadow", while the customer does his or her work as usual. It supports the concretization of the value proposition relevant for the customer			
P: Observation in natural environment	C: Time consuming	• Development of a joint customer understanding (Mr. Maintenance) • Provides an example which every team member can refer to	CCC
(2) Interview (challenges and needs, value offering, pricing) The interview is suitable for areas of application in which possible knowledge is missing, i.e., concretisation of value proposition, pricing. The interviewer can respond flexibly, individually, and in-depth to the answers of the interviewee			
P: In-depth discussions about challenges and needs; possibilities of "digging deeper"	C: customer wishes may not be mirrored in willingness to pay	• Multiple interviews provide the justification for decisions of relevance of the value proposition	CCC
(3) Quantitative Survey (value offering, pricing) Quantitative surveys provide access to a broader set of responses with respect to challenges, value proposition and pricing. Prior qualitative findings are made measurable and can be confirmed or rejected			
P: Larger sample provides a better understanding	C: Openness of interviewees to answer questions (i.e., pricing) rather low; access to a larger sample challenging	• Insights of customer needs from a larger sample supports decision making • Understanding of correlations (i.e., shifts, inhouse maintenance, …) • Insights for pricing decisions	CCC
(4) Service Theatre (value offering, value chain, connectivity) Within a service theatre the processes for providing a service are played (i.e. on-boarding, sales talk). This allows deriving of argumentation, reviewing processes and required documentation. It provides insight for value propositions, internal processes and customer interactions, revenue mechanism and connectivity (how to gain access to customer data)			

(continued)

Table 1 (continued)

Pro (P)	Contra (C)	Shared frame	CCC/SCC
P: Preparation of sales argumentation; interaction with customers strengthens story line; preparation of sales documentation and prototype; reveals argumentation gaps in the sales pitch	C: Time intensive; customer willingness to participate in service theater	• Development of a common wording to "sell" the value proposition • Shared understanding of shortcomings of the value proposition • Insights into cost/benefit-analysis and price settings • Insights into the connectivity requirements and associated risks	CCC
(5) Prototyping (value offering) Development of an initial or preliminary version of the service, e.g., a dashboard that visualize the relevant indicators for measuring the state of a machine. The prototype can be combined with the service theatre			
P: Service content (i.e., dashboard) becomes "touchable"; enables direct customer feedback	C: Derivation of future output (i.e., of Dashboard) difficult	• Prototype (i.e., dashboard) makes service "visible" and enables understanding of service content • Enables precise customer feedback	CCC
(6) FRAM (value chain) The Functional Resonance Analysis Method (FRAM) is a methodology to analyse and describe the nature of daily labour activities. Holistic capture of the cooperation to fulfil a task			
P: Not only processes but knowledge is analysed	C: Experience with methodology is needed; result is not intuitive	• Visualisation of processes and needed knowledge enables an understanding of relevant processes and interactions • Understanding of necessary changes in collaboration • Highlights the challenges of knowledge transfer to fulfil the required tasks	–
(7) Service Blueprint and Customer Journey (value chain, I4.0 enabler, connectivity) The service blueprint and the customer journey show the changes in the process in connection with the customer regarding the customer touchpoints and the technology used. In addition, the service blueprint shows where (new) collaboration is needed internally and who is involved in the process with the new offering			

(continued)

Table 1 (continued)

Pro (P)	Contra (C)	Shared frame	CCC/SCC
P: Enables insights into technology, processes and customer interaction; provides a customer centric perspective	C: Needs to be sharpened with additional insights from customer and internal or external partners	• Visualisation of processes, interactions and technologies strengthens understanding of business model • Enables the inclusion of employees from different functions to strengthens understanding of business model content	(SCC, CCC)
(8) Technology and Skills Roadmap (I4.0 enabler, connectivity) Mapping of relevant technologies and skills to fulfil value proposition. Determination of the technologies needed for data gathering, storage, transfer, analysis, and visualisation			
P: Enables understanding of relevant technologies as it is discussed from a data gathering perspective	C: Interviewees need knowledge of technologies	• Provides a common understanding about needed investments in technologies and skills as well as dependencies between them • Allows integrating technology suppliers to get a better understanding	(SCC)

4 Discussion and Conclusion

The presented research results indicate that a shared servitization framework supports companies within their servitization process or more precisely to overcome the tipping point between exploration and engagement. The concretisation of the business model dimensions (value proposition, value chain, revenue mechanism, technologies/capabilities and connectivity) enabled the respective management to get an understanding of the market potential as well as the related investments to achieve the change (i.e. in technology). The results support Kohtamäki et al. (2019) and Martinez et al. (2017), stating that the process is neither smooth nor straightforward.

The methods applied may support companies in their struggle to overcome the digital paradox as it reduces barriers in management cognition and supports companies in the modification of the key business model components (Gebauer et al., 2020). A particularly central result is that the integration of customers and suppliers during the concretization phase of the idea by means of the applied methods promotes the development of a common understanding within the companies involved, here provider, supplier and customer. First, the involvement of customers leads to stories of needs and challenges, which support the development of sound and evidence-based value propositions. This is preventing companies from taking an approach which is only the justification of internal believes and is not suitable for their markets. Additionally, the service is tested with the customer prior to launch, which can save the company time and money as they receive feedback from the customer early in the process. Second, the involvement of suppliers within the exploration phase allows an initial understanding of the technological changes needed as well as its possibilities. The cases reveal that involving suppliers supports the development of a shared servitization framework, as the technologies are often new to the respective companies and difficult to understand how to implement them in their operations. To summarise, the decision to move on to the engagement phase or not, was, within both companies, easy as the project team and top management had a good understanding of the business model content and the investments needed (i.e., technology, skills, processes and collaboration). Thus, the research at hand ads to literature as it discusses how a business model analysis, and the applied methods support the development of a shared understanding and with this, support the servitization process.

5 Recommendation

From a managerial perspective, the analysis shows that to understand the changes related to servitization, a good understanding of the business model is needed. There are different methods that can be applied to improve the shared understanding. The methods are based on customer- and supplier-co-creation. Although co-creation is widely applied within the engagement phase, the exploration phase profits as well.

Often, the business model is only discussed at the beginning of an idea and is not further developed during the course of the project. The idea of a service is constantly evolving as new information is gathered, e.g., by applying the methods above, so the business model should also be continuously adapted to the latest state of knowledge.

A successful servitization needs the reduction of the digital paradox. Although the methods may be time-consuming, the research suggests that the potential to support the development of a shared servitization framework leads to bigger benefits.

The methods support each other and can be applied jointly or separately. Each method enables to build up a better understanding of the business model and with this strengthens the likelihood of a successful transformation in the servitization process and a smoother implementation of the service.

References

Baines, T., Ziaee Bigdeli, A., Bustinza, O. F., Shi, V. G., Baldwin, J., & Ridgway, K. (2017). Servitization: Revisiting the state-of-the-art and research priorities. *IJOPM, 37*(2), 256–278. https://doi.org/10.1108/IJOPM-06-2015-0312

Baines, T., Ziaee Bigdeli, A., Sousa, R., & Schroeder, A. (2020). Framing the servitization transformation process: A model to understand and facilitate the servitization journey. *International Journal of Production Economics, 221*, 107463.https://doi.org/10.1016/j.ijpe.2019.07.036

Coughlan, P., & Coghlan, D. (2002). Action research for operations management. *IJOPM*.
Deflorin, P., Scherrer-Rathje, M., Ziltener, A. (Hg.) (2017). Business model innovation: unravelling the potential of technologies enabling digital transformation. 24th Annual EurOMA Conference, Edinburgh, UK, 1–5 July 2017: European Operations Management Association.
Gebauer, H., Arzt, A., Kohtamäki, M., Lamprecht, C., Parida, V., Witell, L., & Wortmann, F. (2020). How to convert digital offerings into revenue enhancement—Conceptualizing business model dynamics through explorative case studies. *Industrial Marketing Management, 91*, 429–441. https://doi.org/10.1016/j.indmarman.2020.10.006
Gebauer, H., Saul, C. J., Haldimann, M., & Gustafsson, A. (2017). Organizational capabilities for pay-per-use services in product-oriented companies. *International Journal of Production Economics, 192*, 157–168. https://doi.org/10.1016/j.ijpe.2016.12.007
Hey, H. Jonothan, G., Joyce, C. K., & Beckman, S. L. (2007). Framing innovation: negotiating shared frames during early design phases. *Journal of Design Research, 6*(Nos. 1–2).
Hollnagel, E. (2017). *FRAM: The functional resonance analysis method: modelling complex socio-technical systems.* CRC Press.
Imenda, S. (2014). Is there a conceptual difference between theoretical and conceptual frameworks? *Journal of Social Sciences, 38*(2), 185–195. https://doi.org/10.1080/09718923.2014.11893249
Kohtamäki, M., Parida, V., Oghazi, P., Gebauer, H., & Baines, T. (2019). Digital servitization business models in ecosystems: A theory of the firm. *Journal of Business Research, 104*, 380–392. https://doi.org/10.1016/j.jbusres.2019.06.027
Kowalkowski, C., Gebauer, H., Kamp, B., & Parry, G. (2017). Servitization and deservitization: Overview, concepts, and definitions. *Industrial Marketing Management, 60*, 4–10. https://doi.org/10.1016/j.indmarman.2016.12.007
Lee, S. M., Olson, D. L., Trimi, S. (2012). Co-innovation: Convergenomics, collaboration, and co-creation for organizational values. *Management Decision, 50*(5), 817–831. https://doi.org/10.1108/00251741211227528
Martinez, V., Neely, A., Velu, C., Leinster-Evans, S., & Bisessar, D. (2017). Exploring the journey to services. *International Journal of Production Economics, 192*, 66–80. https://doi.org/10.1016/j.ijpe.2016.12.030
Mason, K., Spring, M (2011). The sites and practices of business models. *Industrial Marketing Management 40*(6), 1032–1041.
Palo, T., Åkesson, M., & Löfberg, N. (2019). Servitization as business model contestation: A practice approach. *Journal of Business Research, 104*, 486–496. https://doi.org/10.1016/j.jbusres.2018.10.037
Polova, O., & Thomas, C. (2020). How to perform collaborative servitization innovation projects: The role of servitization maturity. *Industrial Marketing Management, 90*, 231–251. https://doi.org/10.1016/j.indmarman.2020.06.005
Schön, D. A. (1994). *Frame reflection.* Basic Books.
Sjödin, D., Parida, V., Jovanovic, M., & Visnjic, I. (2020a). Value creation and value capture alignment in business model innovation: A process view on outcome-based business models. *Journal of Product Innovation Managemaent, 37*(2), 158–183. https://doi.org/10.1111/jpim.12516
Sjödin, D., Parida, V., Kohtamäki, M., & Wincent, J. (2020b). An agile co-creation process for digital servitization: A micro-service innovation approach. *Journal of Business Research, 112*, 478–491. https://doi.org/10.1016/j.jbusres.2020.01.009
Zhang, W., & Banerji, S. (2017). Challenges of servitization: A systematic literature review. *Industrial Marketing Management, 65*, 217–227. https://doi.org/10.1016/j.indmarman.2017.06.003

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