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Author(s): Kohtamäki, Marko; Parida, Vinit; Rabetino, Rodrigo; Sjödin, David; Henneberg, Stephan

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FRAMING THE DIGITAL SERVICIZATION PATH TOWARDS AUTONOMOUS SOLUTIONS

Marko Kohtamäki, Vinit Parida, Rodrigo Rabetino, David Sjödin, Stephan Henneberg

ABSTRACT

Purpose: The present study intends to extend the discussion about transition towards autonomous systems by outlining and reviewing the existing literatures on ecosystems, product-service-software business models and related product-service-software technologies. We extend the existing discussions on transition towards autonomous systems by conducting the review by using a configurational research approach, identifying gaps between the relevant literatures, and suggesting avenues for future studies.

Design/Methodology/Approach: Systematic review

Findings: The study maps the digital servitization literature, generates a typology of five business model configurations, and an integrative digital servitization path towards autonomous solutions.

Originality/Value: We contribute to the discussion about the digital servitization by analysing the interplay between the ecosystem structure, business model configurations, and technological interfaces.

KEYWORDS: Digital servitization, business model configurations, Ecosystems and networks, Product-Service Systems (PSS), Business model innovation, Platforms and Sustainability

“ This recommended practice provides a taxonomy for motor vehicle driving automation systems that perform part or all of the dynamic driving task (DDT) on a sustained basis and that range in level from no driving automation (level 0) to full driving automation (level 5).”

1. Introduction

Variety of industry sectors are moving towards autonomous operation, such as the car industry, or transportation industry providing some of the prime examples. The direct quote comes from the SAE international's publication, which has published the six level-criteria for motor vehicles used on-road. The publication intends to guide manufacturers in developing autonomous vehicles, and indeed, some governance is needed in this macro-micro interplay between the environment and firms. The transition towards autonomous solutions can be coined as digital servitization, particularly when we mean the product-manufacturer's transition from pure products towards product-service-software systems. This transition involves large number of firms, public, and non-profit actors, their effective collaboration to enable the functionality of autonomous machines, e.g. vehicles. The transition has been recognized being far from easy, and much more difficult most could ever anticipate. Yet, the transition is ongoing, and some could claim, inevitable. Digital servitization covers both the institutional structures within industries, and ecosystems, but particularly at the micro-level of firms and their business models. For firms, this transition is critical and creates new market opportunities for business models and product-service-software technologies that can integrate to new business ecosystems. Regarding strategy and business theory, this transition is particularly interesting, as from the firms it requires capability to create micro-level processes to create and meet the standards at the macro-level. At the level of offerings, the transition requires effective integration between products, services, and software. For this integration, the present study uses the concept of digital servitization, which combines the perspectives around strategy and business model, service technologies, and ecosystems (Kohtamäki, Rabetino, Einola, Parida, & Patel, 2021; Thomson, Kamalaldin, Sjödin, & Parida, 2021).

The transition towards autonomous solutions is driven by the desire to develop the productivity and quality of product-service systems and their operation. The transition towards autonomous solutions critically changes the role of products, services, and software, changing the industry structures, and company business logics from product-logics to service-logics (Kowalkowski, Gebauer, Kamp, & Parry, 2017), eventually creating opportunities for improved sustainability of solutions, e.g. through variety of

platform-business models, e.g. a car manufacturing company moving from production of vehicles as its main business towards provision of a platform that enables car-sharing services. As the transition towards the autonomous cars is still in its early stages, we have relatively little research nor theorizing on the interplay between business models, technologies and ecosystems during this transition (Thomson et al., 2021). Thus, this transition is particularly challenging, as it does not touch only the firm-level activities, but requires, like many technological changes, an effective interplay between environment (ecosystem), strategy (business model) and structure (product-service-software technology). Thus, it is the business model configuration that has to be fitted with the opportunities provided by the technological development, and the contingencies of the business environment, the institutional macro-environment and structures interplay with the business model configurations and within firm micro-activities. The research around these topics is scattered to different topical areas, and very little integrative efforts have been conducted regarding the transition towards autonomous solutions. This lack of integrative efforts is a particularly important drawback, considering the gravity of integration needs in this field of autonomous solutions. For the need of integration, when transitioning towards autonomous solutions, the centre point of analysis is the product-service system (PSS), or in other words, product-service-software systems, as underline by many highlighting the increasing role of software a part of the firm's offering (Coreynen, Matthyssens, & Van Bockhaven, 2017; Kohtamäki, Parida, Oghazi, Gebauer, & Baines, 2019). Product-service-software systems are part of *digital servitization, which is the transition from pure standalone products towards autonomous product-service-software system*. The concept of digital servitization business model builds on the servitization literature, which originally denoted the transition from product-logic to service-logic, a conceptualization relevant today when we consider the business models in autonomous solutions. While the literature has been expanding regarding the servitization and digital servitization literatures, very few works have been done to stretch the theorizing until autonomous solutions (Thomson et al., 2021; Tsvetkova, Hellström, & Ringbom, 2021). Therefore, a call exist to build understanding on the transition towards autonomous solutions, to integrate the perspectives from ecosystems, business models and technologies.

The present study concentrates on scrutinizing the digital servitization literature, providing an overview about the journey towards autonomous solutions to answer the following research question: *What are the characteristics of business model configurations, technologies and ecosystems in the path towards autonomous solutions?* Building on the previous literature, we intend to outline the characteristics of business model configurations, technologies and ecosystems based on the existing literature on digital servitization, complemented by specific literature on autonomous solutions, and ecosystems. We intend to contribute to the discussion about the digital servitization business model, by searching and reviewing the digital servitization literature, to scrutinize the concept of digital servitization, and discuss the interplay between the two constructs. We review the business model concepts in digital servitization to define a typology and unfold the various business model configurations. We take a critical perspective on the existing knowledge base and present suggestions for future research.

2. Review methodology and description of data

For the study, we conducted a search of articles based on two search strings, servitization and digitalization, digitalization covering terms related to autonomous solution. We used the following two strings of servitization and digital, with servitization keywords including "service infusion*", "servitization*", "servitisation*", "service transition*", "service transformation*", and digitalization including "digital", "internet-of-things", "internet of things", "IOT", "remote", "industry 4.0", "smart solution", "smart product", "autonomous solution*". The search produced 221 hits, which we used for further analysis, as these papers put significant attention to digitalization in the context of servitization of manufacturing companies. We complement the discussion about the digital servitization studies by adding

some seminal papers on servitization, as the classic servitization and Product-Service Systems can provide significant depth to the discussion about business models and the transformation process.

3. The conceptual evolution of the digital servitization towards autonomous solutions

3.1. Evolution of the digital servitization concept towards autonomous solutions

The roots of the digital servitization concept can be seen in the servitization literature, which got initiated at 1988 when the concept was first used by Vandermerwe and Rada (1988). Since then, multiple related concepts have been created, such as the product-service systems (PSS), integrated solutions, and customer solutions, amongst others (Rabetino, Kohtamäki, Brax, & Sihvonen, 2021). Digital servitization, and PSS literatures begin from the offerings, and value creation logics, as the starting point for the literature was the transition from product-logic (emphasis on the product) to service-logic (emphasis on the value). Product-service-software adds the software element to emphasize its role as a core component of the offerings, in the digital era. The role of data has been part of the servitization literature since its infancy, but recently, scholars have begun reclaiming the emphasis on digitalization and software, to reflect the rapid change in manufacturing companies towards digital solutions and architectures (Kohtamäki, Parida, et al., 2019). Figure 1 illustrates the evolution of the digital servitization literature starting from the servitization and PSS literatures, and the interplay between digitalization and servitization – At the upper left side, the figure depicts the digital-related concepts, while the lower right side illustrates the servitization concepts – these equal to digital servitization. The figure illustrates the emergence of digital servitization.

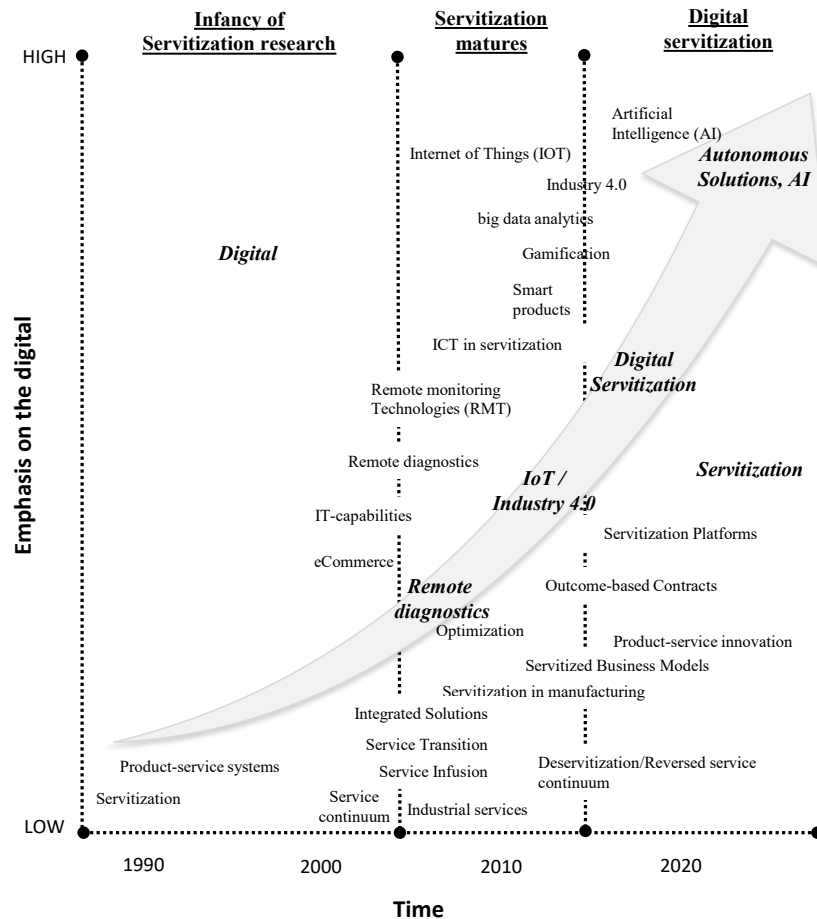


Figure 1. Evolution of the digital servitization concept.

3.2. Defining digital servitization and autonomous solutions

The concept of digital servitization has been evolving in an interplay between digitalization and servitization. It is the interaction between digital technology and servitization that enables an increase in sales and profits. While digitalization provides a critical technological enabler for new types of smart solutions, services provide the means of capturing the value from digital technologies.

As suggested in previous studies, conceptual richness is vast. There are many concepts in this conceptual sphere known as digital servitization, which denote product technologies, software and data, and servitization and services. The roots of the digital servitization discussion are in servitization research, where the studies have previously approached the role of software through the concepts of remote monitoring technology, and remote diagnostics (Brax & Jonsson, 2009; Grubic, 2018). Porter and Heppelmann (2015) used the concept of smart products, and some have suggested the concept of smart solutions, to integrate better the product-service-software system (Kohtamäki, Parida, et al., 2019). The figure 1 suggest autonomous solutions as a one kind of future state of solution automation – how autonomous some solutions may become, is another question, as discussed by SAE International (2013: 26). As a term, autonomous refers to e.g. solutions *“that have the ability and authority to make decisions independently and self-sufficiently. Over time, this usage was casually broadened to not only encompass decision making, but to represent the entire system functionality, thereby becoming synonymous with automated. This usage obscures the question of whether a so-called “autonomous vehicle” depends on communication and/or cooperation with outside entities for important functionality (such as data acquisition and collection). Some driving automation systems may indeed be autonomous if they perform all of their functions independently and self-sufficiently, but if they depend on communication and/or cooperation with outside entities, they should be considered cooperative rather than autonomous.”* This notion is important, when we consider the usage of the term autonomous, since in many occasions, the solution is not fully independent on the interaction with other outside systems, but is interacting with other systems, and systems of systems. **Scrutinizing the content digital servitization business models**

3.3. Understanding the digital servitization business models

Table 3 demonstrates business model typologies from servitization and digital servitization research, from which we selected a few examples. When we analyzed the already published articles on digital servitization, we counted 58 of those 221 studies using business model as a central concept in title, abstract or keyword, which provides is some quantitative ground to understand the gravity of the business model concept in the digital servitization literature. To understand the variety of use in the business model concept within the literature, we decided to map the studies for the business model dimensions they use, idea typical business models they suggest, and the primary findings they have. The concept of ideal typical we draw from Max Weber, who used the concept of ideal typical to denote a concept, in this case business model, to describe something that is an ideal description of a specific type in an empirical reality, to create a series of types, which is coined as a typology.

Table 1. Business model typologies from servitization to digital servitization research.

Study	Business model dimensions	Ideal typical business models	Findings
Gebauer, Edvardsson, Gustafsson, & Witell (2010)	1) Organizational design factors 2) Human resource management 3) Organizational structures	1) after sales service provider, 2) customer support service provider, 3) customer service strategy, 4) development partner, 5) outsourcing partner	Strategy-structure configuration enables succession

Kowalkowski, Windahl, Kindström, & Gebauer, (2015)	1) Business growth, customer loyalty, stable revenues 2) Customer demand, differentiation, partnership potential, customer lock-in 3) Scale economies, in-house resources, potential to address larger customer base	1) availability provider, 2) performance provider 3) industrializer	Firms need to balance growth and standardization Firms should also manage the co-existence of different roles
Kohtamäki, Parida, et al., (2019)	1) Digitalization 2) Pricing logic 3) Level of solution customization	1) Product provider, 2) Industrializer, 3) Customized integrated solution provider, 4) Outcome provider, 5) Platform provider	Paper depicts how digital servitization business models within ecosystems vary regarding strategic positioning, strategic identity, strategic capabilities, and transaction costs.
Paiola and Gebauer (2020)	1) Services type 2) Service orientation towards technology	1) Product, 2) Process, 3) Outcome	Paper identifies opportunities and challenges of process and outcome-oriented business models in digital servitization
Frank et al., (2019)	1) Servitization levels 2) Digitalization levels	1) Customer-oriented, 2) Process-oriented	The paper identifies nine service offering types and provides illustrative examples
Parida, Sjödin and Reim (2019)	1) Value creation, 2) value delivery and 3) value capture	1) Add on services, 2) optimization service, 3) digital platforms 4) outcome based services	The paper identifies current knowledge and future research directions for digitalization enabled business model innovation

Based on previous research, the ideal types identified by the previous studies exist in the empirical world and are hence viable. This situation suggests that the equifinality assumption holds in servitization as well as in digital servitization, that is various configurations can lead to optimal outcomes – there is no one path or trajectory to success (Fiss, 2007; Forkmann, Ramos, Henneberg, & Naudé, 2017; Sjödin, Parida, & Kohtamäki, 2016), or failure, suggesting that a company can succeed or fail in so many ways. Thus, when building a business model, a company should not only fit the customer need, strategy and structure, but also the business environment (Kohtamäki, Henneberg, Martinez, Kimita, & Gebauer, 2019). One of the challenges of the existing business model theorizing has been, that it tends to neglect the business environment.

Based on the literature, we can identify five business model configurations, which we coin, aligned with Kohtamäki et al. (2019) as 1) product provider, 2) industrializer, 3) customized integrated solution provider, 4) outcome provider, and 5) platform provider (Table 3). Product provider references to a typical product business model (+ add-on services), where a company offers relatively standardized products and only add-on basic services. Industrializer refers to a business model, where the manufacturer has standardized its 'too often customized offerings', often offering also maintenance agreements. Customized integrated solutions provider refers to a manufacturer providing large, customized solutions

combined with maintenance agreement and some availability offering (e.g., performance guarantees). Outcome provider sells performance instead of products, offering the performance or outcome produced by the machinery, e.g., Power-by-the-hour. Platform provider refers to an Über-type of business model, where a manufacturer takes a platform operator role, starting to offer a multid-sided exchange platform instead of only products and services, e.g., Alibaba in industrial goods. Figure 2 integrates the components of business configurations, technologies, and business ecosystems to the path towards autonomous solutions. To extend the maturity framework previously introduced (Thomson et al., 2021), we address the integrative development, where the transition is suggested to require integration between the components of the business model, related technologies and ecosystem – in the figure we intend to address the integration by the primary arrows, which close in and meet in the future (wishful thinking). As such, the figure intends not to be conclusive, but suggestive serving as a proposition and a method to frame the integrative digital service transition towards autonomous solutions. The figure X below provides an overly simplified depiction of the potential configurations including characteristics of the business model, PSSS technologies, and the ecosystems. Potential configurations are many, and they are likely to mix characteristics from different layers in practice. Then again, this conceptualization may provide some starting point for theorizing about the digital servitization towards autonomous solutions.

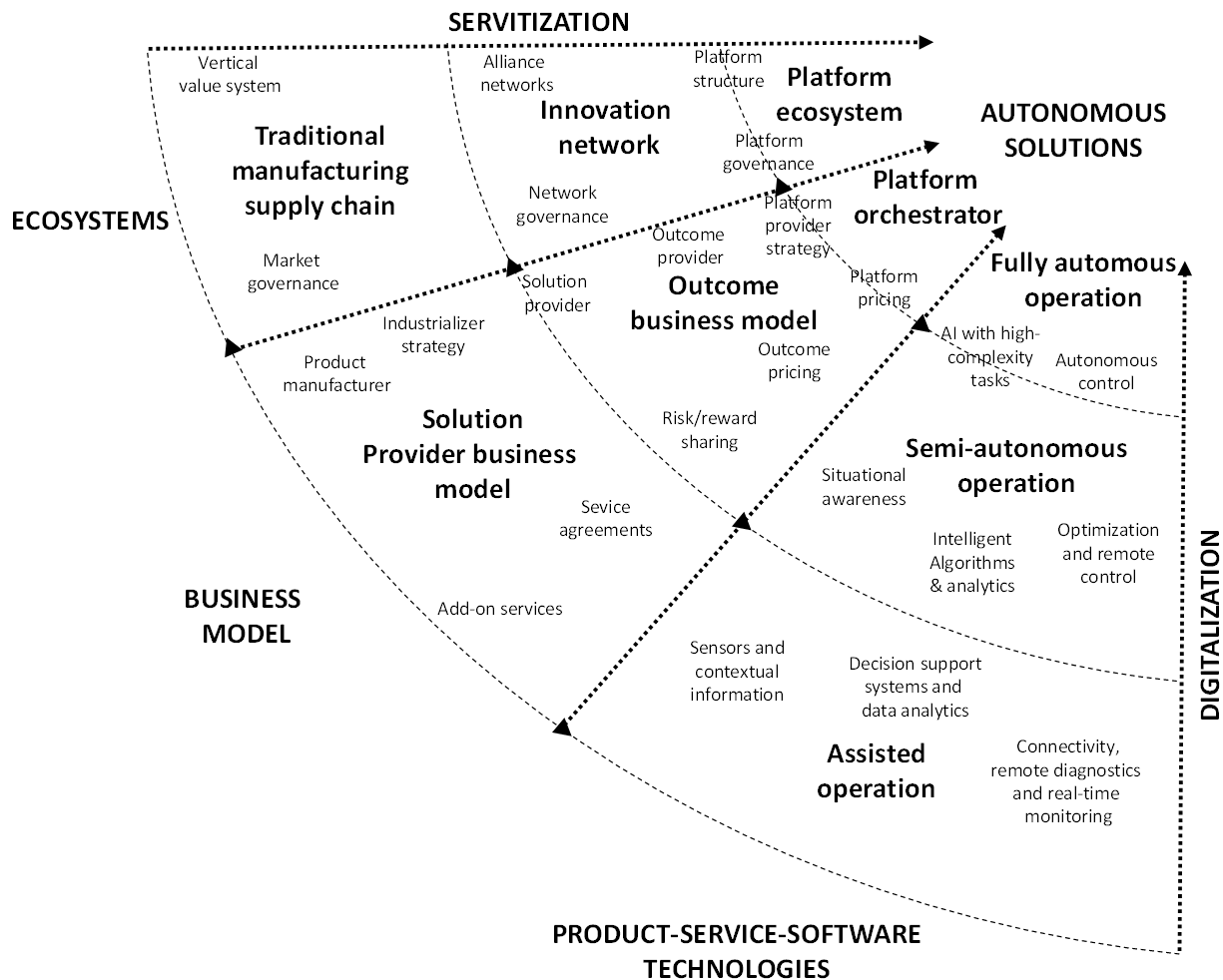


Figure 2. Integrative digital servitization path towards autonomous solutions.

4. Research directions

Based on the review on the digital servitization literature, some shortcomings in the literature can be identified, to suggest future research. A business model should find an optimal fit not between strategy and strategy and structure, but also between business environment and strategy, and business environment and structure. While the business model literature seems to neglect the business environment in times, it should not be acknowledged by the digital servitization literature. The interplay between the macro and micro-dimensions of business can be approached from either perspective. The institutional theory approaches the interplay from macro –perspective, the macro environment affecting to micro-behaviors, whereas the practice theory approaches the interplay from the micro-perspective, the micro shaping the macro. When advancing the digital servitization literature, both angles deserve attention. For example, what are the challenges, resistances, and how does firms, business units, and individuals cope with these (Lenka, Parida, Sjödin and Wincent, 2018).

Research direction 1. Macro-level understanding is needed about the institutional challenges faced by the manufacturers when moving towards autonomous systems.

Future digital servitization research should tap into process research to unfold the activities and processes related to digital servitization. In its core, digital servitization is a transformation process for provider and customers (Kamalaldin et al., 2020) and it may require a radically different innovation process ensuring agility and customer co-creation while stimulating internal capability development (Sjödin et al., 2020).

Research direction 2. Process research is needed to understand the evolvement of digital servitization in manufacturing companies.

We need theories and models to understand the behavioural micro-issues regarding digital servitization towards autonomous solutions. The micro-approaches (See Kohtamäki, Whittington, Vaara, & Rabetino, 2022) to analyse the transition may involve studies and approaches from behavioural economics, e.g. micro-foundations movement or practice theoretical implications (Kohtamäki, Parida, et al., 2019).

Research direction 3. Micro-level Conceptual tools are needed for the study of servitization business model innovations

In transition towards autonomous solution, we should carefully understand the interplay between the micro and the macro. This understanding has meaningful implications to the progress of the digital servitization journey, which we do not know well enough, currently.

Research direction 4. Micro-macro interaction in digital servitization towards autonomous solutions.

5. Discussion and conclusions

Theoretical conclusions

This paper was set out to become an introduction to the special issue on autonomous solutions. Hence, the paper will continue evolve during the coming year to a full paper, intending to shed light on the business model configurations from servitization to digital servitization, with emphasis on digitalization of servitization business models. Our perspective is configurational highlighting the equifinality of various business models – there is more than one potential configuration that can lead to optimal outcomes. As argued by the configurational literature, this perspective enables researchers to appreciate the complexity of empirical business world. The research journey towards autonomous solutions, or automatically operating solutions, is on its way, but there is much work ahead. The present study suggests digital servitization as one of the core literature in this journey, which can combine the requires perspectives from business model configurations, technologies, and ecosystems to understand the systemic entities related to autonomous operation of on-road vehicles, off-road vehicles, ships or other types of product-service-software systems, or smart solutions.

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AUTHORS

Marko Kohtamäki, Professor, School of Management, University of Vaasa, Finland
USN Business School, Norway, LTU, Sweden
marko.kohtamaki@uva.fi.

Rodrigo Rabetino, Professor, School of Management, University of Vaasa, Finland
rodrigo.rabetino@uva.fi

Stephan Henneberg, Professor, Queen Mary University of London, School of Business and Management, United Kingdom
s.henneberg@qmul.ac.uk.

Vinit Parida, Professor, Entrepreneurship and Innovation, Luleå University of Technology, Sweden
vinit.parida@ltu.se.

David Sjödin, Associate Professor, Entrepreneurship and Innovation, Luleå University of Technology, Sweden
david.sjodin@ltu.se