



Overarching servitization processes in industrial manufacturing – a scoping review

Bart Bluemink, Lianne Simonse, Sicco Santema, Odeke Lenior
r.g.h.bluemink@tudelft.nl

Delft University of Technology, Faculty Industrial Design Engineering,
Landbergstraat 15, 2628 CE Delft, Netherlands

Abstract

This paper summarises servitization research concerning product-service system design processes in the manufacturing industry, considering the overarching value chain. We used a methodological scoping framework to create a systematic overview of scientific papers in the context of the B2B manufacturing industry.

We identified five main topics: business models, organisational aspects, value creation, collaborative networks, and servitization strategies. Moreover, servitization research appeared to be concentrated in Europe, in particular in the United Kingdom and Nordic countries. We found only one paper that met all our selection criteria: service design and business model design within technology-intensive manufacturing firms, collaborating in networks and addressing end-customer needs. This research gap provides a direction for a further deep dive in what we call *overarching Servitization*; we will focus on designing product-service systems throughout customer supply networks.

Keywords: business model design, service design, overarching, end-customer, value creation, collaborative networks, servitization strategies

1. Introduction

Servitization is a useful strategy for technology-intensive manufacturers to extend their current product portfolio with linked services. In essence, Kohtamäki et al. (2018) defined Servitization as a transition process from selling products to selling product-service systems (PSS). Due to the increasing competition of newcomers disrupting current industries with data platform technologies offering different types of service propositions, technology-intensive manufacturers in the capital goods industry show a growing interest in servitization processes. Previous studies learned that manufacturers that adopted Servitization were able to increase their business profitability (Baines et al., 2010; Reim et al., 2013; Story et al., 2017)

Rolls Royce is an example of an industrial manufacturing firm that has gone through a servitization process. Visnjic et al. (2017) studied the Rolls Royce business case which provides a result-oriented PSS, called Power-by-the-Hour. Instead of selling engines to the aircraft industry, it sells operational up-time of the engines to airlines. In their study, Collier et al. (2018) identified Uber as an example of a newcomer that disrupts the business of taxi services by providing a data platform that enables mobility services in two ways. First, it provides on-demand taxi services for commuters, the so-called Mobility-as-a-Service (MaaS). Second, it offers taxi drivers the opportunity to become self-employed mobility providers.

However, servitization literature currently lacks a systematic overview of knowledge about designing product-services in the technology-intensive manufacturing industry, addressing customer needs throughout the value chain. Therefore, this study aims to explore the servitization research domain, to identify studies on topics related to our research question (see 2.1), to discover research gaps and to draw conclusions regarding research activities. We might find answers to our research question by studying processes and methods that manufacturers could apply in designing PSS to serve customers and stakeholders throughout a business-to-business-to-consumer supply network (B2B2C).

2. Method

In spring 2019, we reviewed scientific papers to examine servitization practices in business-to-business industries (B2B) and to identify researchers and research groups. We conducted a literature scoping study, using the methodological framework for scoping of Arksey & O'Malley (2005), which will be explained in the subparagraphs below. Although the first servitization studies appeared in the 1980s, we decided to limit our scoping study to a time frame of ten years since we want to focus on more recent and emerging research. For practical reasons, we used the digital search engine Scopus: according to Baines et al. (2009), most leading servitization scholars use Scopus as their source for scientific literature.

2.1. Identifying the research question

Arksey & O'Malley (2005) state that it is essential to find the key aspects of the research question, defining the initial search string in order to identify related studies. Considering too many aspects, translated in a search string with many keywords, can lead to a limited outcome, and may risk missing relevant articles. However, a search string definition on a limited number of aspects could lead to an unmanageable number of references.

We particularly wanted to study cases identifying processes and methods to design PSS in the B2B manufacturing industry. Therefore, we formulated the following research question, used as the subject of our scoping process: "How can technology-driven manufacturers of investment goods make a transition towards providers of PSS, creating user experiences and value propositions throughout the customer value chain?" (B. Bluemink et al., 2020)

2.2. Identifying relevant studies

In this phase of the scoping process, we performed a literature study. We composed a search string, based on keywords related to the research question, and applied it into a search engine. The initial search string resulted in 80 journal articles. It contained the words Servitization (or servitisation) and business model, searching in the article title, abstract and keywords, as well as the words transition and network in all fields of the database records. We limited our search to the English Language (see the first row of Table 1). A first refinement of the search result by excluding

conference papers, press articles and book chapters, limited the number to 61, as listed in the second row of Table 1.

2.3. Study Selection

In a second refinement, we selected papers that resonated with Servitization in technology-driven manufacturers of investment goods. Therefore, we decided to exclude all studies that did not relate to this part of our research question. We excluded articles describing studies of Servitization in healthcare, FMCG, business-to-consumer (B2C), governmental, NGO's and mathematical approaches of Servitization. The third row of Table 1 shows that these exclusion criteria reduced the relevant number of papers to 50.

Table 1: Search String and Number of Search Results

Search Engine	Search String	Selection Criteria	Number of papers
<i>Scopus search results</i>	<i>"serviti*ation" AND "business model" AND "transition" AND "network" AND LIMIT-TO (LANGUAGE, "English")</i>	<i>Article Title/Abstract/Keywords All Fields All Fields</i>	80
<i>1st refinement of Scopus Results</i>		<i>Exclusion criteria: Conference papers Press articles Book chapters</i>	61
<i>2nd refinement of Scopus Results</i>		<i>Exclusion criteria: PSS related to healthcare PSS related to FMCG industry PSS related to government and NGO's PSS related to pure B2C Mathematical approach of PSS</i>	50

2.4. Charting the Data

After identification and selection, we collected and classified our search results in an Excel-file according to following criteria: Title, Abstract, First Author, Institute, Journal, Year of Publication, Citation Score, Type of Study, Originating Country, Research Subject, Originating Country of all Authors and the Overall Theme. We then analysed the data from different angles, as described in Chapter 3.

2.5. Summarising and Reporting the Scoping Results

The fifth stage of the scoping framework involves summarising and reporting the scoping results, which we included in Chapter 3.

3. Summarising and Reporting the Scoping Results

3.1. Centres of Servitization Research in Manufacturing

To determine in which part of the world servitization research in industrial manufacturing is located, we first analysed the originating countries of the authors and co-authors of the selected papers. Table 2 provides the number of authors with their originating countries in descending order. Second, we analysed the number of citations of all authors per country, listed in Table 3 in descending order. Based on Table 2 and 3, we concluded that research on Servitization concentrates in Europe. In particular, UK-based researchers are leading the way in Servitization in the manufacturing industry, closely followed by Finland, Sweden, Italy and Spain.

Table 2: Top-5 of Originating Country of Authors (we excluded countries with two or less first authors from the list)

<i>Originating Country of Authors</i>	<i>Number of Authors</i>
<i>United Kingdom</i>	<i>34</i>
<i>Finland</i>	<i>21</i>
<i>Sweden</i>	<i>19</i>
<i>Italy</i>	<i>17</i>
<i>Spain</i>	<i>11</i>

Table 3: Top-5 Number of Citations per Country

<i>Originating Country of Authors</i>	<i>Number of Citations</i>
<i>United Kingdom</i>	<i>1169</i>
<i>Sweden</i>	<i>342</i>
<i>Spain</i>	<i>247</i>
<i>Finland</i>	<i>140</i>
<i>Italy</i>	<i>66</i>

Moreover, we found that servitization research finds its domicile in universities that focus on research in the technical domain, described as industrial engineering, industrial manufacturing, manufacturing operations, information technology, technology management or industrial economics.

We also observed that the UK, Sweden and Spain score relatively high in the citations ranking of Table 3. An explanation might be that three universities in these countries stimulate and facilitate servitization research. First. The Aston University of Birmingham founded the

Advanced Services Group (ASG), specialising in research in advanced services and Servitization. The ASG organises the yearly Spring Servitization Conference, sharing knowledge about servitization processes. Second, the Business School of Deusto University, Bilbao, Spain hosts the annual International Conference on Business Servitization. Third, Linköping University carries out a research program called 'Value Creation in Innovative Service Systems', studying service transitions in industrial networks. The program, funded by the Bank of Sweden, has a spinoff of several publications, discussing value creation in industrial manufacturing networks.

3.2. Main Topics Addressed

By reading the abstract and keywords of each of the selected studies, we clustered them based on the central theme addressed. After this, we found five main topics, shown in Table 4, listed in descending order of the number of studies.

By reading the abstracts, we were able to map the specific subjects and themes of each paper. After clustering, we could identify five main topics, each of them dealing with a different issue: business models in Servitization, organisational aspects, value creation, collaborative networks, and servitization strategies.

Table 4: Number of Studies per Main Topic Addressed

Main Topic	Number of Studies	Short Description of Topic
<i>Business Models</i>	16	<i>Discussing Business Models in Servitization</i>
<i>Organisational Aspects</i>	11	<i>Discussing Organizational Aspects of Servitization</i>
<i>Value Creation</i>	9	<i>About Value Creation through Servitization</i>
<i>Collaborative Networks</i>	6	<i>Discussing Providing PSS's through Cooperation in a Network</i>
<i>Servitization Strategies</i>	8	<i>Discussing Strategic Frameworks and practices for Servitization</i>

In the next subchapters, we will highlight each topic, discussing the papers that cover our interest most.

3.3. Studies Related to Business Models in Servitization

Table 5 shows 16 studies about business models in Servitization in descending order of citation scores. Reim et al. (2015), Lulea University of Technology, Sweden, contributed with their systematic literature review 'Product-Service-Systems Business Models and Tactics' to the understanding of applying business models in PSS. The paper provides a valuable overview of studies, discussing business models implemented in the servitization practice. Tongur & Engwall (2014) examined the difficulties manufacturing industries face in innovation processes. He concluded that technological innovation should go hand in hand with service innovation to create a viable business model.

Table 5: Studies Related to Business Models in Servitization

<i>ID*</i>	<i>Title</i>	<i>Originating Country</i>	<i>Citation Score</i>	<i>Type of Study</i>	<i>Journal</i>
34	Product-Service-Systems (PSS) Business Models and Tactics - A Systematic Literature Review (Reim et al., 2015)	Sweden	183	Literature review	Journal of Cleaner Production
36	The Business Model Dilemma of Technology Shifts (Tongur & Engwall, 2014)	Sweden	52	Case Study	Technovation
5	Meta-Model of Servitization: The Integrative Profiling Approach (Brax & Visintin, 2017)	Finland	35	Literature Review	Industrial Marketing Management
32	Strategy Map of Servitization (Rabetino et al., 2017)	Finland	30	Case Studies (3)	International Journal of Production Economics
15	A Decision Methodology to Support Servitisation of Manufacturing (Dimache & Roche, 2013)	Ireland	24	Framework	International Journal of Operations and Production Management
29	Constructing A Sustainable Service Business Model: An S-D Logic-Based Integrated Product Service System (IPSS) (Liu et al., 2014)	Taiwan	15	Literature Review	International Journal of Physical Distribution and Logistics Management
39	What Brings The Value to Outcome-Based Contract Providers? Value Drivers in Outcome Business Models (Visnjic et al., 2017)	Spain	10	Case Studies (4)	International Journal of Production Economics
4	The Digitalization and Servitization of Manufacturing: A Review on Digital Business Models (Luz Martin-Peña et al., 2018)	Spain	9	Literature Review	Strategic Change
9	PSS Business Model Conceptualization and Application (Adrodegari & Sacconi, 2017)	Italy	9	Framework	Production Planning and Control
10	Business Models for the Service Transformation of Industrial Firms (Adrodegari et al., 2017)	Italy	9	Literature Review	Service Industries Journal
38	The Path to Outcome Delivery: Interplay of Service Market Strategy and Open Business Models (Visnjic et al., 2018)	Spain	8	Case Studies (12)	Technovation
20	Do Outcome-Based Contracts Exist? The investigation of Power-by-the-Hour and Similar Result-Oriented Cases (Grubic & Jennions, 2018)	United Kingdom	5	Case Study	International Journal of Production Economics
1	The Transition towards Service-Oriented Business Models: a European Survey on Capital Goods Manufacturers (Adrodegari et al., 2018)	Italy	3	Quantitative Survey	International Journal of Engineering Business Management
13	A Design-Thinking Perspective on Capability Development: The Case of New Product Development for Service Business Model (Beltagui, 2018)	United Kingdom	2	Case Study	International Journal of Operations and Production Management
30	Lessons Learned from a Successful Industrial Product-Service System Business Model: Emphasis on Financial Aspects (Oliveira et al., 2018)	Brazil	2	Case Study	Journal of Business and Industrial Marketing
31	Servitization as Business Model Contestation: A Practice Approach (Palo et al., 2018)	United Kingdom	1	Case Study	Journal of Business Research

*) *ID* refers to the identification number of the paper

In general, we primarily focused on papers with a high citation score. However, we acknowledge that recent studies reflect emerging research more. Despite a low citation index, these papers might be of more interest in answering our research question. For example, Adrodegari et al. (2018) identified different servitization business models used in the capital goods industry. With their framework to create their future business, they support industrial companies to make a manageable shift from products to services (Adrodegari & Saccani, 2017). In their paper, Visnjic et al. (2017) explained how the Power-by-the-Hour PSS changed the business model of Rolls Royce, creating *user values* and *experiences* throughout a B2B2C network. Rolls Royce used to supply engines to the aircraft industry, such as Boeing and Airbus, but changed its strategy by addressing the new needs of the customer-of-customer. Rolls Royce now offers maintenance and up-time services during the operational lifetime of aeroplane engines. As a result, airlines have changed from buying aeroplanes from the aircraft industry to purchasing aeroplane up-time services at Rolls Royce, covering a more significant part of the supply chain. It evolved from B2B to B2B2C.

In general, all papers show that in a servitization process, a change in business model is inevitable. When developing services, companies should pay particular attention to the redesign of their business model, related to the changed interactions with customers and stakeholders.

3.4. Studies Related to Organizational Aspects of Servitization

Table 6 shows 11 studies about organisational aspects of Servitization in descending order of citation scores. With his review, Baines et al. (2017) created a clear overview of studies that highlight the impact of Servitization on organisational processes. Kindström & Kowalkowski (2014) discussed specific organisational resources and capabilities needed across the eight different dimensions of his proposed service business model. His model can be used to visualise changes, associated with new service opportunities, to create better understanding and awareness in the internal organisation. The more recent papers of Crowley et al. (2018), Amboise et al. (2018) and Hasselblatt et al. (2018) discussed the required conditions and the organisational 'mind-set' which are beneficial for a successful product-service transition. Overall, all papers acknowledge the vital role that the organisation is playing in product-service innovation processes and give directions to optimise them.

Table 6: Studies Related to Organisational Aspects of Servitization

<i>ID*</i>	<i>Title</i>	<i>Originating Country</i>	<i>Citation Score</i>	<i>Type of Study</i>	<i>Journal</i>
62	Servitization: Revisiting State-of-the-Art and Research Priorities (T. Baines et al., 2017)	United Kingdom	119	Literature Review	International Journal of Operations and Production Management
25	Service Innovation in Product-Centric Firms: a Multidimensional Business Model Perspective (Kindström & Kowalkowski, 2014)	Sweden	106	Qualitative Study	Journal of Business and Industrial Marketing
14	Servitization and Competitive Advantage: the Importance of Organizational Structure and Value Chain Position (Bustinza et al., 2015)	Spain	37	Qualitative Study	Research Technology Management
22	Resource Realignment in Servitization: a Study of Successful Service Providers Explores How Manufacturers Modify their Organisational Structures (Huikkola et al., 2016)	Finland	16	Case Studies (9)	Research Technology Management
18	Organizational Capabilities for Pay-Per-Use Services in Product-Oriented Companies (Gebauer et al., 2017)	Switzerland	13	Case Study	International Journal of Production Economics
6	Challenges of Servitization: a Systematic Literature Review (Zhang & Banerji, 2017)	United Kingdom	10	Literature Review	Industrial Marketing Management
43	Organisational Change towards Servitization: A Theoretical Framework (Ziaee Bigdeli et al., 2017)	United Kingdom	6	Literature Review	Competitiveness Review
21	Modelling Manufacturer's Capabilities for the Internet of Things (Hasselblatt et al., 2018)	Finland	2	Qualitative Study	Journal of Business and Industrial Marketing
11	Financial Performance of Servitized Manufacturing Firms: A Configuration Issue between Servitization Strategies and Customer-Oriented Organizational Design (Ambroise et al., 2018)	France	1	Quantitative Study	Industrial Marketing Management
24	Exploring the Dynamic Capabilities Required for Servitization (Kanninen et al., 2017)	Finland	1	Case Studies (14)	Business Process Management Journal
44	Servitization Intent as a Factor in the Servitization Process (Crowley et al., 2018)	United Kingdom	1	Qualitative Study	Journal of Business and Industrial Marketing

**) ID refers to the identification number of the paper*

3.5. Studies Related to Value Creation

Table 7 shows nine studies about value creation through Servitization in descending order of citation scores. Visnjic et al. (2013) of the ESADE Business School, Barcelona, Spain, is heading the citation scores with her paper 'Servitization, disentangling the impact of service business models innovation on manufacturing firm performance'. This scholar pinpointed

that implementation hurdles potentially lead to lower profitability. Although she discussed business models, her paper merely addresses value creation through Servitization. In her survey among manufacturing industries, she reported an increased turnover of those companies that successfully managed to provide additional services, inherently connected to their products. She also found that investments to create an economy of scale of their services contributed positively to higher profitability. However, companies offering services separated from their products are less successful and suffer a decline in profitability over time. The more recent studies of Lindhult et al. (2018), Resta et al. (2017) and Ayala et al. (2017) address the importance of identifying value flows (both upstream and downstream) between the different stakeholders in cooperation networks.

Table 7: Studies Related to Value Creation

<i>ID*</i>	<i>Title</i>	<i>Originating Country</i>	<i>Citation Score</i>	<i>Type of Study</i>	<i>Journal</i>
40	Servitization: Disentangling The Impact of Service Business Models Innovation on Manufacturing Firm Performance (Visnjic Kastalli & van Looy, 2013)	Spain	191	Quantitative Study (44)	Journal of Operations Management
60	Servitized Manufacture: Practical Challenges of Delivering Integrated Product and Services (Baines, Lightfoot, & Kay, 2009)	United Kingdom	52	Case Study	Journal of Engineering Manufacture
16	Seeking Competitive Advantage with Service Infusion: A Systematic Literature Review (Eloranta & Turunen, 2015)	Finland	46	Literature Review	Journal of Service Management
26	Industrial Services - The Solution Provider's Stairway to Heaven or Highway to Hell? (Kohtamäki & Helo, 2015)	Finland	13	Literature Review	Benchmarking: An International Journal
17	Driver Configurations for Successful Service Infusion (Forkmann et al., 2017)	USA	9	Quantitative Study	Journal of Service Research
12	Knowledge Sharing Dynamics in Service Suppliers' Involvement for Servitization of Manufacturing Companies (Ayala et al., 2017)	Brazil	6	Case Studies (9)	International Journal of Production Economics
28	Value Logics for Service Innovation: Practice-Driven Implications for Service-Dominant Logic (Lindhult et al., 2018)	Sweden	1	Literature Review	Service Business
35	Enhancing The Design And Management of Product-Service Supply Chain: An Application to The Automotive Sector (Resta et al., 2017)	Italy	1	Qualitative Study	Service Science
37	Servitization in Contract Manufacturing - Evidence from Polar Business Cases (Viitamo et al., 2016)	Finland	1	Qualitative Study	Strategic Outsourcing

**) ID refers to the identification number of the paper*

3.6. Studies Related to Collaborative Networks

Table 8 shows six recent papers relating to collaboration in networks. With their qualitative study, Story et al. (2017) focused on identifying capabilities that actors (manufacturers, customers and intermediaries) in a collaborative network need, to develop and maintain advanced services successfully. Moreover, Jamie et al. (2016) discussed types and sources of tensions that may occur between actors in a collaboration. Ziaee Bigdeli et al. (2018) discuss the risks associated with implementing strategic partnerships with network partners. At the same time, he concludes that a strategic alliance improves its competitiveness and arms against newcomers to the market. The main takeaway of the listed papers is that cooperation in collaborative networks increases the resilience of individual companies.

Table 8: Studies Related to Collaborative Networks

<i>ID*</i>	<i>Title</i>	<i>Originating Country</i>	<i>Citation Score</i>	<i>Type of Study</i>	<i>Journal</i>
58	Capabilities for Advanced Services: a Multi-Actor Perspective (Story et al., 2017)	United Kingdom	8	Literature Review	Industrial Marketing Management
23	Identifying Tensions in the Servitized Value Chain (Jamie et al., 2016)	United Kingdom	7	Qualitative Study	Research Technology Management
42	Network Positioning and Risk Perception in Servitization: Evidence from the UK Road Transport Industry (Ziaee Bigdeli et al., 2018)	United Kingdom	7	Qualitative Study	International Journal of Production Research
19	Two Strands of Servitization: a Thematic Analysis of Traditional and Customer Co-Created Servitization and Future Research Directions (Green et al., 2017)	United Kingdom	6	Literature Review	International Journal of Production Economics
8	Conceptual Approach for Value Driven Performance in Servitising Companies (Adel & Wiesner, 2015)	Egypt	1	Literature Review	International Journal of Services and Operations Management
27	Cost-efficient Co-Creation of Knowledge Intensive Business Services (Kuula et al., 2018)	Finland	1	Literature Review	Service Business

*) *ID* refers to the identification number of the paper

3.7. Studies Related to Servitization Strategies

Table 9 shows eight studies we found regarding servitization strategies in the manufacturing industry. Although not quite recent, we consider Baines' literature review as valuable for further research due to its citation score (see Table 9). He found a wide range of servitization strategies in the

manufacturing industry (Baines et al., 2009). After his survey among industrial firms in the UK, he reported increased turnovers and revenues at those manufacturers that successfully added services to their product offerings. He also noticed that these manufacturers were able to create a clear customer focus, rather than solely having a technology focus. Finally, he concluded that after an initial decline due to the change to another business model, the profitability of product-service propositions turns into growth. A recent study of Ryu et al. (2018) raised our interest in discussing the application of UX design and collaborations in manufacturing industries as a strategy to mitigate risks and overcome implementation issues.

Table 9: Studies Related to Servitization Strategies

<i>ID*</i>	<i>Title</i>	<i>Originating Country</i>	<i>Citation Score</i>	<i>Type of Study</i>	<i>Journal</i>
59	The Servitization of Manufacturing: A Review of Literature and Reflection on Future Challenges (Baines et al., 2009)	United Kingdom	667	Literature Review	Journal of Manufacturing Technology Management
63	Towards an Operations Strategy for Product-Centric Servitization (Baines et al., 2005)	United Kingdom	227	Literature Review	International Journal of Operations and Production Management
3	Product Service System: a Conceptual Framework from a Systematic Review (Annarelli et al., 2016)	Italy	44	Literature Review	Journal of Cleaner Production
61	The Adoption of Servitization Strategies by UK-Based Manufacturers (Baines et al., 2010)	United Kingdom	36	Survey	Journal of Engineering Manufacture
33	Motivations for Servitization: The Impact of Product Complexity (Raddats et al., 2016)	United Kingdom	23	Qualitative Study	International Journal of Operations and Production Management
41	The Development of a Generic Servitization Systems Framework (Weeks & Benade, 2015)	South Africa	2	Case Study	Technology in Society
2	Servicizing Solutions for Manufacturing Firms: Categorizing Service Ideas from Product-Service Integrated Examples (Ryu et al., 2018)	South Korea	1	Literature Review	Design Journal
7	Uncovering the Topic Landscape of Product-Service-System Research: From Sustainability to Value Creation (Lee et al., 2018)	South Korea	1	Literature Review	Sustainability

**) ID refers to the identification number of the paper*

4. Conclusions

4.1. Theoretical Contribution

The scoping process provided us with useful insights into the servitization research field, related to our research question. First, research concentrates in Europe (especially in the UK), where three universities in the manufacturing domain play an initiating role by organising conferences and research programs. Second, we saw five main research themes discussed: business models, organisational aspects, value creation, collaborative networks and servitization strategies. Third, technological innovation in manufacturing industries has to go hand in hand with service innovation to create viable business models since servitization processes inevitably entail a change in business models. Fourth, all papers acknowledge the vital role that organisations play in the successful transition to product-service solutions. Fifth, recent studies show an increasing interest in the identification of upstream and downstream value flows in collaborating networks. Sixth, collaboration increases the competitiveness and resilience of networking industrial manufacturers. Seventh, companies adopting servitization strategies show an increase in turnover and revenues. Finally, we see an emerging interest to adopt UX-design as a product-service innovation strategy in the manufacturing industry. However, as of yet, we have not found servitization research in the industrial design or service design domain, targeting manufacturing industries.

Moreover, we concluded that most studies mainly discussed the impact of servitization on the manufacturer's business. In many cases, the companies reorganised their value creation process or changed their business models. Generally speaking, manufacturing industries usually operate in a B2B market, with a strong focus on the needs of their direct customers. Most studies we found mainly focused on this one-to-one relationship between the manufacturer and its customer, creating PSS within its current B2B context. This fact may explain why we found only one paper discussing PSS design and business model design within technology-intensive manufacturing firms Visnjic et al. (2017). In this Rolls Royce case, surprisingly, we recognised a different design approach. We argue that Rolls Royce designed a PSS, considering its new B2B2C supply network. Although it bypassed the aircraft industry, it also addressed the needs of airlines. Here, Rolls Royce collaborated with

airlines and the aircraft industry and co-created a PSS in a network. We call this *overarching servitization*.

4.2. Limitations and Further Research

Of course, a quantitative overview, such as this scoping study, does not evaluate the quality of the research. Although we found numerous studies, the search was limited to journal articles in the Scopus database. Due to this, there is a chance that we may have missed related articles in design journals, such as the *Journal of Design Issues* and *Design Science* since Scopus does not index design journals.

We found that when starting a servitization innovation process, B2B manufacturers lacked knowledge and practices for PSS design. Many questions remain about the capabilities and methods that R&D organisations need to become successful servitizers, changing their product portfolio from bare products to PSS. We therefore conclude that further servitization research should focus on designing PSS, including their related business models. We recommend exploring the service design domain more deeply, to understand how to apply service design methods for servitization in the B2B industry. Moreover, to better understand PSS design in collaborative networks, future research should focus on serving customers throughout the B2B2C value chain. In a forthcoming paper, we will create an *overarching servitization* framework that the manufacturing industry can use to design PSS in complex network collaborations.

References

- Adel, R., & Wiesner, S. A. (2015). Conceptual approach for value driven performance in servitising companies. *International Journal of Services and Operations Management*, 21(4), 504–531.
<https://doi.org/10.1504/IJSOM.2015.070258>
- Adrodegari, F., Bacchetti, A., Sacconi, N., Arnaiz, A., & Meiren, T. (2018). The transition towards service-oriented business models: A European survey on capital goods manufacturers. *International Journal of Engineering Business Management*, 10.
<https://doi.org/10.1177/1847979018754469>

- Adrodegari, F., & Saccani, N. (2017). Business models for the service transformation of industrial firms. *Service Industries Journal*, 37(1), 57–83. <https://doi.org/10.1080/02642069.2017.1289514>
- Adrodegari, F., Saccani, N., Kowalkowski, C., & Vilo, J. (2017). PSS business model conceptualization and application*. *Production Planning and Control*, 28(15), 1251–1263. <https://doi.org/10.1080/09537287.2017.1363924>
- Ambroise, L., Prim-Allaz, I., & Teyssier, C. (2018). Financial performance of servitized manufacturing firms: A configuration issue between servitization strategies and customer-oriented organizational design. *Industrial Marketing Management*, 71, 54–68. <https://doi.org/10.1016/j.indmarman.2017.11.007>
- Annarelli, A., Battistella, C., & Nonino, F. (2016). Product service system: A conceptual framework from a systematic review. *Journal of Cleaner Production*, 139, 1011–1032. <https://doi.org/10.1016/j.jclepro.2016.08.061>
- Arksey, H., & O'Malley, L. (2005). Scoping studies: Towards a methodological framework. *International Journal of Social Research Methodology: Theory and Practice*, 8(1), 19–32. <https://doi.org/10.1080/1364557032000119616>
- Ayala, N. F., Paslauski, C. A., Ghezzi, A., & Frank, A. G. (2017). Knowledge sharing dynamics in service suppliers' involvement for servitization of manufacturing companies. *International Journal of Production Economics*, 193, 538–553. <https://doi.org/10.1016/j.ijpe.2017.08.019>
- Baines, T. S., Asch, R., Hadfield, L., Mason, J. P., Fletcher, S., & Kay, J. M. (2005). Towards a theoretical framework for human performance modelling within manufacturing systems design. *Simulation Modelling Practice and Theory*, 13(6), 486–504. <https://doi.org/10.1016/j.simpat.2005.01.003>
- Baines, T. S., Lightfoot, H., Benedettini, O., Whitney, D., & Kay, J. M. (2010). The adoption of servitization strategies by UK-based manufacturers. *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture*, 224(5), 815–829. <https://doi.org/10.1243/09544054JEM1567>

- 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>
- Baines, T. S., Lightfoot, H. W., & Kay, J. M. (2009). Servitized manufacture: Practical challenges of delivering integrated products and services. *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture*, 223(9), 1207–1215.
<https://doi.org/10.1243/09544054JEM1552>
- 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. *International Journal of Operations and Production Management*, 37(2), 256–278.
<https://doi.org/10.1108/IJOPM-06-2015-0312>
- Beltagui, A. (2018). A design-thinking perspective on capability development: The case of new product development for a service business model. *International Journal of Operations and Production Management*, 38(4), 1041–1060. <https://doi.org/10.1108/IJOPM-11-2016-0661>
- Bluemink, B., Simonse, L., Santema, S., & Lenior, O. (2020). Overarching Servitization Processes in Industrial Manufacturing - a Scoping Review. *Internal Report Delft University of Technology*
- Brax, S. A., & Visintin, F. (2017). Meta-model of servitization: The integrative profiling approach. *Industrial Marketing Management*, 60, 17–32. <https://doi.org/10.1016/j.indmarman.2016.04.014>
- Bustinza, O. F., Bigdeli, A. Z., Baines, T., & Elliot, C. (2015). Servitization and competitive advantage : The importance of organizational structure and value chain position. *Research Technology Management*, 58(5), 53–60.
<https://doi.org/10.5437/08956308X5805354>
- Collier, R. B., Dubal, V. B., & Carter, C. L. (2018). Disrupting regulation, regulating disruption: The politics of uber in the United States. *Perspectives on Politics*, 16(4), 919–937.
<https://doi.org/10.1017/S1537592718001093>

- Crowley, E., Burton, J., & Zolkiewski, J. (2018). Servitization intent as a factor in the servitization process. *Journal of Business and Industrial Marketing*, 33(8), 1125–1140. <https://doi.org/10.1108/JBIM-08-2016-0199>
- Dimache, A., & Roche, T. (2013). A decision methodology to support servitisation of manufacturing. *International Journal of Operations and Production Management*, 33(11), 1435–1457. <https://doi.org/10.1108/IJOPM-07-2010-0186>
- Eloranta, V., & Turunen, T. (2015). Seeking competitive advantage with service infusion: A systematic literature review. *Journal of Service Management*, 26(3), 394–425. <https://doi.org/10.1108/JOSM-12-2013-0359>
- Forkmann, S., Henneberg, S. C., Witell, L., & Kindström, D. (2017). Driver Configurations for Successful Service Infusion. *Journal of Service Research*, 20(3), 275–291. <https://doi.org/10.1177/1094670517706160>
- 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>
- Green, M. H., Davies, P., & Ng, I. C. L. (2017). Two strands of servitization: A thematic analysis of traditional and customer co-created servitization and future research directions. *International Journal of Production Economics*, 192, 40–53. <https://doi.org/10.1016/j.ijpe.2017.01.009>
- 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>
- Hasselblatt, M., Huikkola, T., Kohtamäki, M., & Nickell, D. (2018). Modeling manufacturer's capabilities for the Internet of Things. *Journal of Business and Industrial Marketing*, 33(6), 822–836. <https://doi.org/10.1108/JBIM-11-2015-0225>

- Huikkola, T., Kohtamäki, M., & Rabetino, R. (2016). Resource realignment in servitization: A study of successful service providers explores how manufacturers modify their. *Research Technology Management*, 59(4), 30–39. <https://doi.org/10.1080/08956308.2016.1185341>
- Jamie, J. B., Story, V., Zolkiewski, J., Raddats, C., Baines, T. S., & Medway, D. (2016). Identifying tensions in the servitized value chain. *Research Technology Management*, 59(5), 38–47. <https://doi.org/10.1080/08956308.2016.1208042>
- Kanninen, T., Penttinen, E., Tinnilä, M., & Kaario, K. (2017). Exploring the dynamic capabilities required for servitization: The case process industry. *Business Process Management Journal*, 23(2), 226–247. <https://doi.org/10.1108/BPMJ-03-2015-0036>
- Kindström, D., & Kowalkowski, C. (2014). Service innovation in product-centric firms: A multidimensional business model perspective. *Journal of Business and Industrial Marketing*, 29(2), 96–111. <https://doi.org/10.1108/JBIM-08-2013-0165>
- Kohtamäki, M., Baines, T., Rabetino, R., & Bigdeli, A. Z. (2018). Practices and tools for servitization: Managing service transition. In *Practices and Tools for Servitization: Managing Service Transition*. <https://doi.org/10.1007/978-3-319-76517-4>
- Kohtamäki, M., & Helo, P. (2015). Guest editorial: Industrial services – The solution provider's stairway to heaven or highway to hell? *Benchmarking*, 22(2), 170–185. <https://doi.org/10.1108/BIJ-01-2015-0002>
- Kuula, S., Haapasalo, H., & Tolonen, A. (2018). Cost-efficient co-creation of knowledge intensive business services. *Service Business*, 12(4), 779–808. <https://doi.org/10.1007/s11628-018-0380-y>
- Lee, H., Seo, H., & Geum, Y. (2018). Uncovering the topic landscape of product-service system research: From sustainability to value creation. *Sustainability (Switzerland)*, 10(4). <https://doi.org/10.3390/su10040911>
- Lindhult, E., Chirumalla, K., Oghazi, P., & Parida, V. (2018). Value logics for service innovation: practice-driven implications for service-

- dominant logic. *Service Business*, 12(3), 457–481.
<https://doi.org/10.1007/s11628-018-0361-1>
- Liu, C. H., Chen, M.-C., Tu, Y.-H., & Wang, C.-C. (2014). Constructing a sustainable service business model: An S-D logic-based integrated product-service system (IPSS). *International Journal of Physical Distribution and Logistics Management*, 44(1), 80–97.
<https://doi.org/10.1108/IJPDLM-02-2013-0039>
- Luz Martín-Peña, M., Díaz-Garrido, E., & Sánchez-López, J. M. (2018). The digitalization and servitization of manufacturing: A review on digital business models. *Strategic Change*, 27(2), 91–99.
<https://doi.org/10.1002/jsc.2184>
- Oliveira, M. G., Mendes, G. H. S., Albuquerque, A. A., & Rozenfeld, H. (2018). Lessons learned from a successful industrial product service system business model: emphasis on financial aspects. *Journal of Business and Industrial Marketing*, 33(3), 365–376.
<https://doi.org/10.1108/JBIM-07-2016-0147>
- Palo, T., Åkesson, M., & Löfberg, N. (2018). Servitization as business model contestation: A practice approach. *Journal of Business Research*. <https://doi.org/10.1016/j.jbusres.2018.10.037>
- Rabetino, R., Kohtamäki, M., & Gebauer, H. (2017). Strategy map of servitization. *International Journal of Production Economics*, 192, 144–156. <https://doi.org/10.1016/j.ijpe.2016.11.004>
- Raddats, C., Baines, T., Burton, J., Story, V. M., & Zolkiewski, J. (2016). Motivations for servitization: the impact of product complexity. *International Journal of Operations and Production Management*, 36(5), 572–591. <https://doi.org/10.1108/IJOPM-09-2014-0447>
- Reim, W., Parida, V., & Örtqvist, D. (2013). Strategy, business models or tactics -what is product-service systems (PSS) literature talking about? *Proceedings of the International Conference on Engineering Design, ICED, 4 DS75-04*, 309–318.
- Reim, W., Parida, V., & Örtqvist, D. (2015). Product-Service Systems (PSS) business models and tactics - A systematic literature review. *Journal of Cleaner Production*, 97, 61–75.
<https://doi.org/10.1016/j.jclepro.2014.07.003>

- Resta, B., Gaiardelli, P., Cavalieri, S., & Dotti, S. (2017). Enhancing the design and management of the product-service system supply chain: An application to the automotive sector. *Service Science*, 9(4), 302–314. <https://doi.org/10.1287/serv.2017.0193>
- Ryu, H., Song, H., Seo, K., & Kim, J. (2018). Servicizing Solutions for Manufacturing Firms: Categorizing Service Ideas from Product-Service Integrated Examples. *Design Journal*, 21(2), 267–302. <https://doi.org/10.1080/14606925.2018.1431456>
- Story, V. M., Raddats, C., Burton, J., Zolkiewski, J., & Baines, T. (2017). Capabilities for advanced services: A multi-actor perspective. *Industrial Marketing Management*, 60, 54–68. <https://doi.org/10.1016/j.indmarman.2016.04.015>
- Tongur, S., & Engwall, M. (2014). The business model dilemma of technology shifts. *Technovation*, 34(9), 525–535. <https://doi.org/10.1016/j.technovation.2014.02.006>
- Viitamo, E., Luoto, S., & Seppälä, T. (2016). Servitization in contract manufacturing – evidence from Polar business cases. *Strategic Outsourcing*, 9(3), 246–270. <https://doi.org/10.1108/SO-04-2016-0014>
- Visnjic, I., Jovanovic, M., Neely, A., & Engwall, M. (2017). What brings the value to outcome-based contract providers? Value drivers in outcome business models. *International Journal of Production Economics*, 192, 169–181. <https://doi.org/10.1016/j.ijpe.2016.12.008>
- Visnjic, I., Neely, A., & Jovanovic, M. (2018). The path to outcome delivery: Interplay of service market strategy and open business models. *Technovation*, 72–73, 46–59. <https://doi.org/10.1016/j.technovation.2018.02.003>
- Visnjic Kastalli, I., & van Looy, B. (2013). Servitization: Disentangling the impact of service business model innovation on manufacturing firm performance. *Journal of Operations Management*, 31(4), 169–180. <https://doi.org/10.1016/j.jom.2013.02.001>
- Weeks, R., & Benade, S. (2015). The development of a generic servitization systems framework. *Technology in Society*, 43, 97–104. <https://doi.org/10.1016/j.techsoc.2015.09.003>

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>

Ziaee Bigdeli, A., Baines, T., Bustinza, O. F., & Guang Shi, V. (2017). Organisational change towards servitization: a theoretical framework. *Competitiveness Review*, 27(1), 12–39. <https://doi.org/10.1108/CR-03-2015-0015>

Ziaee Bigdeli, A., Bustinza, O. F., Vendrell-Herrero, F., & Baines, T. (2018). Network positioning and risk perception in servitization: evidence from the UK road transport industry. *International Journal of Production Research*, 56(6), 2169–2183. <https://doi.org/10.1080/00207543.2017.1341063>