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Please cite the original article:

Sivula, A., Shamsuzzoha, A., Ndzibah, E., & Timilsina, B. (2022).  
End-to-end servitization model in industry 4.0. *Management and  
production engineering review*, 13(1), 89–98.



# End-to-End Servitization Model in Industry 4.0

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Received: 17 January 2021

Accepted: 10 February 2022

## Abstract

The purpose of servitization is to provide new business opportunities mainly to manufacturing companies. Companies strive to develop new services through utilizing servitization models, which are required to be applicable in several servitization scenarios. The main objective of this study is to propose a servitization model, known as “end-to-end servitization model” suitable for servitization purposes in companies. The model was developed based on several validated and commonly utilized service design models. Moreover, testing the validity of the model was implemented with the usability survey (usefulness, ease to use, easy of learning and satisfaction) with the Master’s level students, while they were developing new services by utilizing the proposed model. The results of this study indicate that the proposed servitization model can be utilized in different organizations to provide new services. Furthermore, the model can be concluded as useful, easy to use, easy to learn and it is at a satisfactory level based on the empirical evidence.

## Keywords

Servitization, service design, service innovation, industry 4.0.

## Introduction

Industry 4.0 plays a prime role due to the introduction of digital technologies, which acts as an impacting factor in improving the value chain and connectivity among manufacturing companies. Industry 4.0 offers greater operational efficiency and the development of new products, services, and business models (Kagermann et al., 2013). The integration between the manufacturing companies and service providers can initiate the processes of servitization and improves the market competitiveness by using the innovative technologies (De Propriis, 2016). Companies strive to provide service innovations to enhance the customer experience (Sanghavi et al., 2019). The recent development of innovative technologies has allowed companies to adopt new business by rapidly processing and utilizing real-time data that enables the companies to undertake efficient service deliveries and improves service-oriented strategies (Jasiulewicz-Kaczmarek et al., 2020; (Jiang et al., 2021). To introduce a servitization strategy, manufacturing companies need to

change their strategies, operations, and value chains (Bustinza et al., 2013). Such changes can be initiated by upgrading their business models with respect to improved products and services designs, production processes, deliveries and selling (Vendrell-Herrero et al., 2014).

Nowadays, global industries are emphasizing in smart initiatives such as automation, robotization that improves competitive business environment. To cope up with such changed environment, the manufacturing industries are shifting from traditional product-based business models towards developing and implementing product and service-based business models (Ferreira et al., 2016; Martin et al., 2018). Such shifting from the product-based model towards offering service solutions to consumers is defined as “Servitization” (Wise and Baumgartner, 1999; Kamal et al., 2020). In addition to added benefits for the companies, servitization has the potential to significantly impact on developing sustainable and eco-friendly environment. To improve competitiveness and initiate sustainable competitive advantage, the manufacturing companies must address the challenges of servitization (Myrthianos et al., 2014). Several leading multinational giants such as Wärtsilä, ABB, GE, IBM, and Rolls Royce are maintaining their business competitiveness through delivering their values by transforming their market shares from manufacturing towards product-service-oriented systems. This

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product-service business model is gradually becoming a fundamental business constituent for the manufacturing sector (Bigdeli et al., 2017; Kamal et al., 2020).

Although servitization offers great benefits for the companies by adding values to product offerings but there are inherent problems and challenges in employing the servitization strategy (Gebauer et al., 2016). Servitization requires large investments for the manufacturing companies that lead to an increasing service offerings and greater costs. Not only does that, adopting such strategy often not always produce the anticipated higher returns (Guo et al., 2015). It is also noticed that some manufacturing companies, offering product-service based solutions approach often experienced to make reduced profits in comparison to non-servitized manufacturing companies (Neely, 2008). There are several cases, where the manufacturing companies' face additional challenges such as to align business strategy and to ensuring the customer trust during the implementation of servitization strategy (Matschewsky et al., 2017; Lim et al., 2018).

To implement servitization strategy, the companies need to question themselves, to what extent they can manage the transition from product manufacturing to service-centric manufacturing, especially in terms of effectiveness and efficiency of transition. This transition process therefore needs deeper understanding associated to the types of servitization strategies such as customer types, their needs and type of product-service systems (Haber et al., 2018). The scope and applicability of servitization phenomenon highlight to effective transition from only product centric to product-service centric (Dimache and Roche, 2013). This phenomenon contributes towards establishing an understanding about the efficient and effective decision-making processes within the manufacturing companies.

Various studies have been conducted so far on servitization in relation to operations management, reversed servitization paths, change management and interdependent trends in servitization (Antioco, 2006; Finne et al., 2013; Smith et al., 2014; Bigdeli et al., 2017a; Raddats et al., 2019; Presti et al., 2020; Grandinetti et al., 2020). These studies provided greater understanding on some aspects of servitization area; however, there seems to be lack of a comprehensive and methodological approach to understand the phenomenon of servitization. This research study, therefore, attempts to broaden the scope of the methodological aspects by investigating and assessing a service model to promote servitization strategies in the manufacturing industries. It is predominantly descriptive to understand the servitization concept and it demands practical approaches towards the manu-

facturing companies. It is expected that the proposed servitization model will motivate manufacturing companies to search for customized solutions through servitization, which is also considered as a useful task in the context of Industry 4.0.

To provide detailed methodological insights into servitization process, this research study proposed a servitization model that might help companies' managers to adopt this strategy in their corresponding companies. Therefore, the objectives of this study can be identified as follows:

1. To propose the end-to-end servitization model to implement servitization in the manufacturing companies.
2. To verify and validate the presented model's ability to support servitization strategy in the companies.

The remainder of this paper is structured as follows: Section 2 provides a theoretical framework in the servitization area. Thereafter, Section 3 presents the proposed end-to-end servitization model. Then, in Section 4, research methodology is presented, highlighting the overall research conducted in this paper. Results of the empirical study are stated in Section 5. Next, the theoretical and practical implications are provided in Section 6. Finally, conclusions, limitations and potential future research avenues are offered in Section 7.

## Theoretical framework

Vandermerwe and Rada (1988) first introduced "Servitization" term within the business domain. The term is meant to integrate business-to-business manufacturers to design and develop new service models and to promote their traditional product-based offerings (Palo et al., 2019). Servitization is the ability of a firm to incorporate service, as an add-on be it bundled, auxiliary or supplementary. In some scenarios, servitization can be considered as an added value component that aims at enriching product delivery as a bundled package, or as an auxiliary component, consumed alongside a specific product for which a modest recurring fee is paid (Neely, 2009; Frank et al., 2019). For instance, the purchase of an internet service can come directly or indirectly with a physical product: modem, router, and any other related peripherals. Nevertheless, when it comes to functionality, for instance a family could opt for added security features including internet security from phishing, malware and cyberattack.

Servitization supports enhanced product functionality and offers competitive advantage through in-

creasing sales and profitability (Martinez et al., 2010). In literature, the term can have similar notions such as service infusion (De Keyser et al., 2019), service transition (Chiu et al., 2019), service growth (Kowalkowski et al., 2017) and service orientation (Zghid & Zaiem, 2017). To promote servitization in the companies, it is essential to change business strategy from product-based to service-based (Bellos & Ferguson, 2017; Adrodegari & Saccani, 2020). This strategical shift motivates the companies to adopt innovative and flexible business model to secure stable revenue flow, improved customer relationships and market differentiation (Oliva and Kallenberg, 2003; Kohtamäki et al., 2020).

The overall servitization business model provides an integrating view of key business dimension, which can be used to commercialize new offerings after overcoming associated challenges. It allows the companies to measure the servitization process through examining their network structures, transactions, interaction between revenue models and incentives, and access to capabilities (Spring and Araujo, 2009). In addition, the servitization business model allows the companies to not only examine its acceptance process, but also from its business ecosystem and market (Ferreira et al., 2013; Palo and Tähtinen, 2013). In general, such a business model is considered as a bunch of practices itself that supports the business ecosystem including customers and other stakeholders. A company might have single or multiple business models to implement servitization, which may depend on co-existing product and service orientations (Lenka et al., 2018).

In the era of digitalization in service, companies may follow parallel servitization, where companies can adopt specific business models for different customer segments (Paiola et al., 2013; Kindström and Kowalkowski, 2014). This form of servitization is known as project-based servitization that focuses on mapping business processes, actions, and practices for different customer segments in different types of companies (Rabetino et al., 2017). Companies need mapping the servitization strategy for describing the strategic logic, while identifying critical sources of synergy and value creation. Exchange of services can increase the value for the customers who benefit them from customized offerings, customer intimacy, product availability, risk reduction, and system performance (Visnjic & Looy, 2013). Such exchanges can improve companies balance between the service and manufacturing oriented values.

Servitization contributes towards cross-functional and intra-organizational integration and coordination to overcome the reductions of sales, production, and service operations (Storbacka et al., 2013). It requires

fostering a service-oriented culture within the companies to implement a service-base business model (Baines et al., 2013). This service-oriented culture promotes organizational innovation more precisely and shift from manufacturing-oriented mind-set towards a service-oriented mind-set. Companies' cognitive and psychological dimensions are changed towards service culture, where cultural transformation is created and fostered. The challenge of servitization is how to blend services into the overall strategies of a company. To overcome such challenge, it is important to integrate into companies' competitive analysis and strategy design. Several questions may arise such as what services to offer, how to make service decision, and how far to go. These questions need to be answered by the companies' top management before making any changes to servitization strategy.

In the contemporary business scenario, servitization can be a hit or miss, in achieving competitive advantage in any given industry (Kaplan and Norton, 2006; Rabetino et al., 2017), especially, if a company does not have a clear strategic convergence, which is based on the implementation logic and process. Strategic convergence is the ability to understand and to utilize skills needed to deliver the product and service, which meet the long-term needs of existing customers leading to a greater product differentiation. For a successful end-to-end service design for servitization of the fourth industrial revolution, the following should hold true: the leverage of knowledge and realignment of the current resources of any given organization (Huikkola et al., 2016). Furthermore, there should be synergy creation with the aim of improving asset utilization across production line to enable the improvement in cost savings and promote a clear competitive advantage as well as differentiation in product delivery (Fang et al., 2016).

## Proposed end-to-end servitization model

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Service innovations involve several stakeholders in service design and servitization process. Service development and servitization should be holistic and customer centric to maximize the customer value. The model is providing an end-to-end approach to service development from theoretical perspectives. The model is based on several common and well-known service design models (e.g. design thinking), which are utilized in several ways in the companies. Services are part of the company's activities and, therefore, the service itself should relate to other activities of a com-

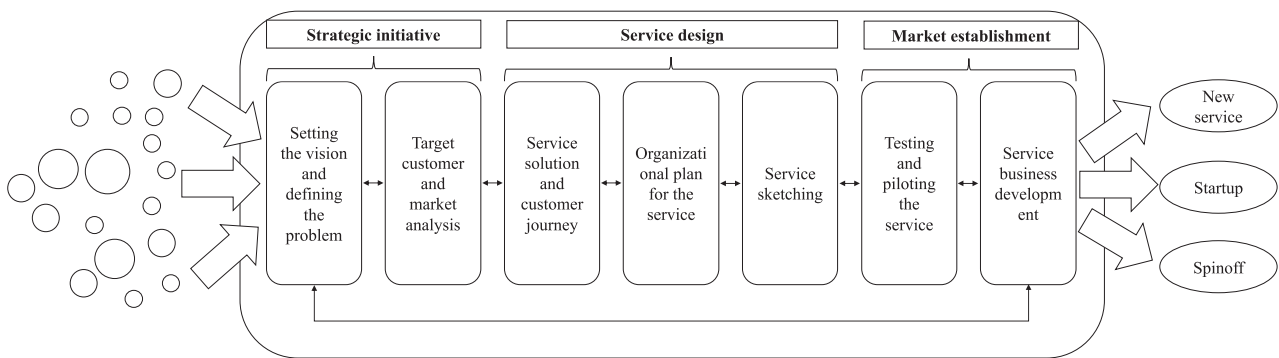


Fig. 1. Proposed End-to-End Servitization Model

pany and it should be analyzed from the multiple points of view during servitization process. The end-to-end servitization model is presented in Figure 1.

Servitization begins with innovative ideas, which need to be analyzed carefully and concluded, which of the idea provides maximum value for a company and its customers. Ideas can be harvested through various ways. Some modern examples are innovation contest platforms, crowdsourcing and customer workshops (Sivula & Kantola, 2014; Sivula & Kantola, 2016; Özyaygen & Balagué, 2018; Yachin, 2018; Segev, 2019). Idea-harvesting methods rely on the diversity of the participants and, thus, the innovativeness of the group (Acar, 2019). A company can strength its view to service and its development with these methods.

A company should create a strategic initiative of the selected idea, which can be concluded a profitable one. Only the ideas, which might generate a profit or some other values for a company should be processed. Strategic initiatives provide strategic advantage for a company when implemented in an appropriate way in the business area, where a company is acting on (Canales & Caldart, 2017). Selecting a target customer and analyzing the market is required to gather better understanding about a service consumer. This can be implemented several ways, for instance, with personas tool, customer experience and competitive analysis (Carey et al., 2019; Cesar et al., 2019).

Service development can be initiated when the market and customers are well-known with different analyses. First, the service solution should be developed with the support of several tools, like the customer journey and different canvases. The customer journey is a tool strives to tell a story of a customer's experience which can be complex in digital environments (Vakulenko et al., 2019). After the customer journey is designed the organizational plan should be developed, which is provided with blueprint design of a service. The service blueprint is an operational

tool, which provides a strategy, how service is delivered for the customers (Pöppel et al., 2018). The service blueprint provides guidelines, for instance, machinery required, staff actions and possible support systems. Service sketching is an activity, where the service sketched with the mockup tools, and can be digital or traditional ones. Sketching supports the service launch and supports piloting and testing of a service.

Testing and piloting of a service is implemented commonly in a controlled environment, and it is important part of the modern businesses because most services are complex. Moreover, people who are testing and piloting the services, are commonly potential customers of a new service. Testing and piloting a service helps to avoid mistakes and supports customer understanding (Freitag & Schiller, 2017). Thus, the aim is to develop the minimum viable product (MVP), which satisfied the earlier customer needs or even more (Ries, 2011).

A company can improve its service before the launch because of piloting and testing if mistakes or other development ideas are found in the early stage. The final stage is a business model development for a service. Business model development is an activity, where the business (e.g. revenue logic) is crystalized for the service. Service business models vary based on the markets and there is no standard service business model to use (Ode & Wadin, 2019). Tools what a company can utilize in this stage are, for example, business model canvas and servitization canvas.

New services should lead to new businesses, which can as well emerge within a company. This means that a company can add new service as a part of its current service or product portfolio. On the other hand, new service can create totally new companies as startups or spinoffs or something else. Moreover, some services are not necessarily provided for the customers because they are for the internal use only of a company.

## Methodology

The aim of the empirical part of this study was to validate and test the usability of the proposed end-to-end servitization model. The validation of the model was implemented in the Master's level service design course, where multiple student groups were utilized to model the design services at different industries. Students were working at different industries. Students developed different types of services during the course using this model in the industry which they know well. In total 35 new services were developed between the year 2019 to 2020. The services were designed by the different team of students during the course. The questionnaire survey was sent to the students after completing their service design course, where they had the possibility to estimate the usability and comments on the proposed model in overall. Both datasets were combined to get the wider understanding in the usability of the model. Figure 2 illustrating the research process.

This study adapted Lund's (2001) usability survey, which strives to explain the usability in different areas. The usability survey is generic and can be utilized in various cases. The questions were answered with Likert-scale 1 to 7. The total amount of responses was 124 in total. The survey was sent to 72 participants in 2019 and 93 participants in 2020. Total population is, therefore, 165 and respondent rate was 75.15%.

## Usability of the proposed model

The proposed model was tested with the students in the service design course. The results were analyzed after receiving the answers from the respondents. The dimensions were created from the usability survey (usefulness, ease to use, easy of learning and satisfaction) in total and scoring of the usability was implemented per dimension by averaging the dimension scores. Missing data was imputed by averaging the values during the analysis procedure. The data pre-processing was implemented with Python scripts and data analysis was implemented with R front-end software.

## Descriptive analysis

Each dimension of the usability survey was analyzed by its own during the analysis process. The model was concluded highly positive in overall because the average of all four dimensions is more than 5. The standard deviation of the data is around 1, which is moderately low. Moreover, the data is moderately skewed in all dimensions and Kurtosis is acceptable. Table 1 is illustrated the descriptive statistics for each dimension.

Table 1  
Descriptive statistics of usability dimensions

	Avg	SD	Min	Max	Skew	Kurt
Usefulness	5.24	1.09	1.5	7	-1.02	1.06
Ease of use	5.22	0.995	1	7	-0.891	1.69
Easy of learning	5.3	1.01	1	7	-0.81	1.7
Satisfaction	5.16	1.17	1	7	-0.747	0.585

Skewness describes the degree of asymmetry between a distribution and kurtosis refers to the nature of distribution tails (Bono et al., 2020). The proposed model can be concluded useful, because of high average of different dimensions. Moreover, standard deviation is relatively low. The students were able to implement new services successfully with the proposed model, which is one reason why respondents see the model positive in overall.

## Correlation of dimensions

Pearson's correlation coefficient was adapted during the analysis process to analyze the correlation between four dimensions. Dimensions are positively correlated as expected. Especially easy of learning is correlating positively with ease of use and easy of learning is correlating positively with satisfaction. Table 2 is illustrating the correlation table of different dimensions.

The correlation table indicates that different areas are correlating moderately. Thus, variables move the same direction based on the data. This was expected

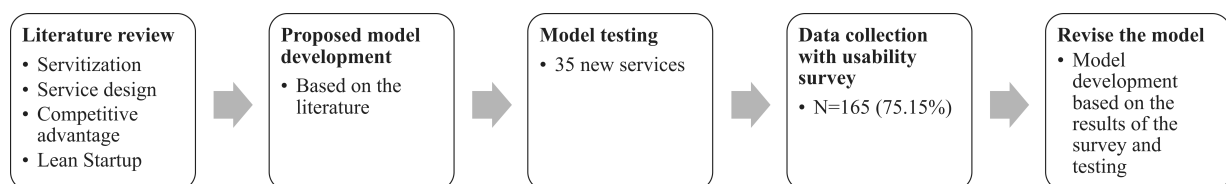


Fig. 2. Summary of the research process

Table 2  
Correlation table of usability dimensions

	Usefulness	Ease of use	Easy of learning	Satisfaction
Usefulness	1	0.6623	0.6588	0.6123
Ease of use	0.6623	1	0.7893	0.6968
Easy of learning	0.6588	0.7893	1	0.7309
Satisfaction	0.6123	0.6968	0.7309	1

because of the usability survey and its adaption in the selected domain. Moreover, moderate positive correlation as well describes the overall usability of the model.

### Cronbach's alpha

Cronbach's alpha is a measurement of the internal consistency of reliability of the data. Overall Cronbach's alpha of the data was 0.897. Moreover, all dimensions were analyzed separately. The values are presented in Table 3.

Table 3  
Cronbach's alphas of usability dimensions

	Cronbach's $\alpha$
Usefulness	0.890
Ease of Use	0.855
Easy of Learning	0.849
Satisfaction	0.875

From Table 3, it is seen that in each dimension alphas are higher than 0.84. Many items on the usability survey are quite similar in the meaning, which have an affection for the high reliability (Lewis, 2002). This is the common case when utilizing the usability survey in the research.

### Implications

This study provides both theoretical and practical implications. The research proposed the theoretical model for servitization, which can be concluded the main theoretical and practical implications of the study. This model was implemented integrating several points of view from earlier research. Moreover, several practical tools were proposed the utilization of the theoretical model. The usefulness of the model

was tested with Master's level students, who developed several services for multiple industries utilizing the model. The model is useful based on the empirical evidence in service development and testing.

The model is useful as well in practice and can be adapted several ways in many industries. The model simplifies the servitization process for the companies and it provides practical tools for developing services and stresses the main points of the process. Therefore, the utilization of the model provides a new way for companies to create different types of services including the digital ones. However, the model was not tested directly by the companies during this study even though some students were working in the companies during the course, where new services were developed.

### Conclusions

The term "servitization" can be refers as an understanding of increasing the value by adding services to an organization's offering. It is considered as an innovative capability for an organization in a sense that, rather than merely offering only products, the organization provides customers with the complete product-service systems. Servitization changes the customer's value proposition, where the organization creates value. Considering today's competitive business environment, it has become one of the major challenges for manufacturing companies to remain competitive. On the contrary, the shift from only product-based delivery to a service-based system has the potential benefits, not only in developing sustainable and eco-friendly environment but also in gaining and sustaining competitive advantage in the long run. To provide a greater insight into the servitization phenomenon, this paper presents a comprehensive end-to-end servitization model, which is suitable for implementing in various organizations.

The basic objective of the proposed service model is to better satisfy the customers by providing an optimized combination of products and services. This model provides detailed methodological insights into servitization process that might help companies' managers to adopt this strategy in their corresponding companies. The first objective of this study is fulfilled by proposing an innovative and novel end-to-end servitization model, which demonstrates each step of service offering from start to end. The second objective was also met by verifying and validating the proposed service model by considering its implementation in developing 35 new services during a Master's

level course called “Service Design” in the years 2019 to 2020.

The outcomes from this research study can guide the company managers to define their servitization strategies and business models. Specifically, this study provides a novel service model that supports to companies’ managers by outlining relevant practices, which should be considered during developing service strategies. The benefit of the model is that it supports developing of new services, which provides new business opportunities for companies. In addition, the proposed model provides information about relevant practices to enable the implementation of the servitization strategies. The proposed model and its validation result also support the recognition of the servitization need. It is believed that the model’s outcomes may serve companies that are undergoing various phases of servitization. It provides great help to the companies in the initial phases of the servitization and promotes to design and develop the strategy map to facilitate long-term value creation and appropriation. The proposed service model may offer guidelines for re-inventing servitization strategies in the companies.

This study has limitations, which are worthwhile to mention. Firstly, the study focuses on project-based servitization, however, the companies may execute parallel servitization paths, which involves specific business models, suitable for different customer segments. It is, therefore, can be a way out for future studies that focus on categorized practices for different service strategies in different types of companies and their customer segments. Secondly, the developed model can be upgraded by integrating with resource-based views, where the companies use various service-related processes to generate value via resources and competencies. Finally, the model might be integrated with other processes such as performance management systems, information technology systems and organizational cultures to create higher customer value and assessment purposes.

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