Transformation of Manufacturing Firms: Towards Digital Servitization

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Abstract. Digital technologies are disrupting servitization in manufacturing firms. In the last decade, manufacturing firms transform their business models from traditional offers of physical goods to digital solutions for their customers. In this paper, we investigate the transformation of digital servitization in manufacturing firms. We challenge relations between traditional and digital service portfolio offered by applying linear regression on the data obtained from 690 manufacturing firms from the Republic of Serbia from 2015 to 2020. The results show that firms significantly increase the offer of traditional services from 2015 to 2018. Moreover, results demonstrate a rapid growth of digital services in the period from 2018 to 2020. The application of traditional and digital services in manufacturing firms increased by 30% in five years.

Keywords: Servitization · Digital transformation · Product-related services · Digital services

1 Introduction

The growing *Service Economy* has changed the way manufacturing firms do their business [1], driving the implementation of *service business models*, as clearly evidenced by a growth of about 20% in the last decade [2, 3]. Also, the implementation of *digital technologies* in manufacturing firms has rapidly expanded due to the beginning of the Industry 4.0 era [4]. The combination of these two paradigms has transformed the traditional service business models into the *digitalized service business models* [5, 6]. Traditional product-related services such as maintenance, installation, revamping are often used by firms with low technology levels [7] while manufacturing firms with more research activities have more opportunity to get involved in the development of new digital services [8]. From this perspective, the literature provides an overview that *digital servitization* represents the implementation of digital technologies in the offer of product-related services [9]. In such a context, digital technologies such as Big Data

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Analysis, Virtual Reality, the Internet of Things, influence the characteristics of new "smart services" [10]. However, the influence of traditional product-related services on the implementation of digital services is still neglected [8]. This gap in the literature makes a misunderstanding in the transformation process from "traditional" to "digital service" [10]. Although the literature presents digital technologies as triggers for digital servitization, the role of traditional services needs to be illuminated [10]. Accordingly, this paper aims to shed the light on how manufacturing firms transform their business from the offer of traditional services to the offer of digital services, and which traditional services influence the use of digital services. Hence, this led to the following research questions:

RQ1: *What is the implementation trend of traditional and digital services in manufacturing firms?*
RQ2: *To what extend traditional services influence the use of digital services?*

In line with the proposed research questions, Fig. 1 depicts the research framework.

Fig. 1. Research framework

To answer the two research questions, we used data from the European Manufacturing Survey (EMS) obtained from 690 firms from the Republic of Serbia. The results show that firms significantly increase the offer of traditional services from 2015 to 2018. Moreover, results demonstrate the rapid growth of digital services in the period from 2018 to 2020.

2 Literature Review

Through time, the application of traditional services has included a variety of technologies, which have contributed to a more comprehensive range of services [11]. The increased application of digital technologies in manufacturing firms influenced the implementation of digital services [12]. For instance, *product-oriented firms* are introducing digital technologies to increase product-service efficiency and value while changing processes and business models [13]. Industrial cases such as IBM, Piaggio, Canon, and Kone have shown how new business models and smart services can be delivered with high efficiency and effectiveness [14]. A precondition for the use of digital services is the existence of a *service ecosystem* in the firms, which plan to deliver these types of services [10]. The ecosystem must strive for the firms to provide systemic, dynamic, and contextual interaction between firms that offer digital services and their customer [15]. A *service ecosystem* includes both internal and external resources of the firm. *Internal organisational aspects* possess the ability to use internal resources to achieve a delivery strategy of traditional and digital services [10]. For instance, *internal*

resources for digital servitization are digital technologies, organisation structures, or knowledge [1]. Previous studies show that along with digital technologies traditional product-related services could be drivers for digital servitization [8]. According to the previous research which investigates the role of product-related services in manufacturing firms, this research involves eight product-related services [7, 16]. The product-related services presented in this study could be divided into two groups. The first group consists of services that are closely related to product characteristics such as installation, maintenance and repair, design, consultation and planning, and take-back services [7, 16]. The second group includes services that are not closely related to the product such as training, remote support for clients, software development, and revamping and modernization [7, 16]. Gebauer [18] presented the *innovation potential* of product-related services, which could be drivers for the transformation of manufacturing firms. The first type of transformation is from product to service-oriented firms, and the second is from product-service systems to digitalized-service systems [13]. According to the digitalized service business models, this research involves digital services which are proposed from the Cambridge Service Alliance, EMS, and previous research that investigates digital servitization [18, 19]. *Digital services,* which are shown in this research, are examples of the application of digital technologies into traditional services [21]. Digital services are different from traditional since the marginal cost of digital services is smaller than that of traditional, and they are substitutes for traditional products [9]. The relationship between traditional and digital services is only presented in a way how they affect the financial performance of firms [20, 21]. However, the relationship of the transformation process from product-related to digital services remains neglected [8]. In such a context, this study examines the influence of product-related traditional services on the use of digital services.

3 Methodology

Data for this empirical study derive from the European Manufacturing Survey [24]. The objective of this regular, triennial questionnaire is to systematically monitor the innovation behaviour of European manufacturers at the firm level. The final sample comprises 690 manufacturing firms from the Republic of Serbia, operating during the period 2015–2020. Concerning the descriptive statistics, the sampled firms report, on average, a company size of 230 employees (SD = 90.2). In total, 266 companies are small firms (less than 50 employees), 318 companies are medium-sized (between 100 and 249 employees), and 106 firms are large enterprises (more than 250 employees). The largest industry in the sample is the Manufacture of Food Production (NACE 10) with 17.1%, followed by the Manufacture of Electrical Equipment (NACE 27) and Manufacture of Machinery and Equipment n.e.c. (NACE 27) with 8.2%. In third place are the Manufacture of Rubber and Plastic products (NACE 22), Manufacture of Basic Metals (NACE 24), Manufacture of Motor Vehicles, Trailers and Semi-trailers (NACE 29), and

Manufacture of Furniture (NACE 31) with 5.3%. The remaining manufacturing sectors together have 45.3% of the total sample. According to the classification of UNIDO for developing countries [25], the sample can be divided into three groups of technology intensity: low technology intensity firms constitute 47.1%% of the total sample, while 20.6%% and 32.4%% of the sample consist of medium- and high-technology-intensive companies respectively. To analyse the impact of product-related services on the use of digital services, the authors adopt linear regression. The dependent variable is the use of digital services, and the independent variables are product-related services shown in the research framework depicted in Fig. 1. The dependent variable is presented as a latent variable of the average values from digital services used per firm. According to the previous research on digital servitization, the industry sector is used as the control variable [26]. To prevent the effect of the external factors on the relationships between traditional and digital services The NACE Rev 2.2 classification was used to define the firm's sector.

4 Results and Discussion

Figure 2 and Fig. 3 present the usage trend of traditional and digital services in the manufacturing sector of the Republic of Serbia in the period from 2015 to 2020. In particular, in Fig. 2, eight product-related services are presented: Installation (PR1), Maintenance and Repair (PR2), Training (PR3), Remote Support for Clients (PR4), Design, Consulting, Project Planning (PR5), Software Development (PR6), Revamping (PR7), and Take-back Services (PR8).

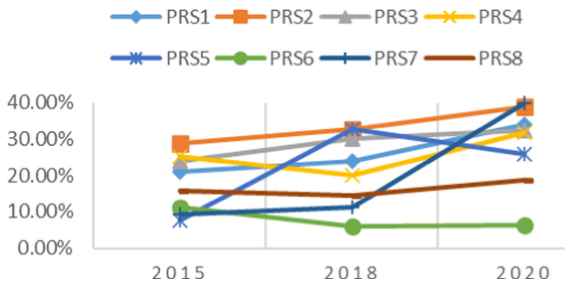

Fig. 2. Use of product-related services in manufacturing firms

Figure 3 depicts the trends of the application of digital services – Digital Services for Product Utilization (DS1), Digital Services for Customized Product Configuration or Product Design (DS2), Digital Monitoring of Operating Status (DS3), Mobile Devices for Diagnosis, Repair or Consultancy (DS4), and Data-based Services based on Big Data Analytics (DS5).

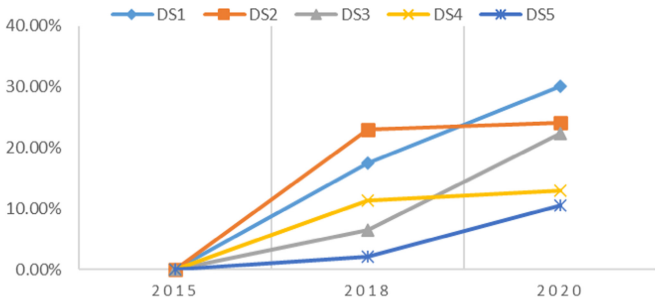

Fig. 3. Use of digital services in manufacturing firms

Table 1 depicts the use of traditional and digital services in the manufacturing firms according to the technology level of the firm.

Table 1. The use of services according to the technology level of the firm

Services	Technology intensity		
Tradition/Digital	Low-tech firms (%)	Med-tech firms (%)	High-tech firms (%)
Installation, start-up	31	71	47
Maintenance and repair	33	74	51
Training	26	60	40
Remote support for clients	15	34	24
Design, consulting, project planning	20	46	31
Software development	6	14	9
Revamping	25	57	36
Take-back services	1	3	2
Digital services for product utilization	20	46	29
Digital services for customized product configuration or product design	13	29	22
Digital monitoring of operating status	20	46	29
Mobile devices for diagnosis, repair or consultancy	6	14	9
Data-based services based on big data analytics	5	11	7

Result analysis reveals that manufacturing firms increase the use of traditional services over the years (Fig. 2). In particular, Installation (PR1), Maintenance and Repair (PR2), Training (PR3), and Revamping (PR7) progressive increase their use in all three research rounds. Furthermore, Remote Support for Clients (PR4), Design, Consulting, Project Planning (PR5), and Take-back Services (PR8) have progressed with some oscillation in 2018, while Software Development (PR6) is the only service that has declined over the years. Moreover, the results show that manufacturing firms increase the use of

digital services over the years, especially in the period from 2018 to 2020: DS1, DS3, and DS5 have the highest level of usage increase in the manufacturing sector, while DS2 and DS4 are increased in the period from 2015 to 2018 but stays on a similar level in 2020. Finally, as shown in Table 1, the same trend of the use of services is observed in the firms with low, medium, and high technological intensity, despite their percentage difference. In other words, the achieved results underline that the same types of services have the largest share regardless of the percentage of use and type of technological intensity.

In conclusion, referring to RQ1 (*What is the implementation trend of the traditional and digital services in manufacturing firms?*) it can be stated that the process of servitisation had two significant phases. After a first phase during which firms have significantly increased their offer of traditional product-related services (from 2015 to 2018), an expansion of digital services began (from 2018 to 2020). Moreover, regardless of their origin, the application of traditional and digital services in manufacturing firms increased by 30% in the period from 2015 to 2020.

Table 2 reports the main effects of the linear regression model, used to test RQ2 and where the regression coefficients for the independent variables reflect the influence on the dependent.

Table 2. Results of the linear regression

Product-related services	Model parameters
Industry sector	.258
Installation, start-up	.087
Maintenance and repair	−.029
Training	.304***
Remote support for clients	.121*
Design, consulting, project planning	.057
Software development	.278**
Revamping	.158*
Take-back services	.070
R	.610
R^2	.370
Sig.	.000

In the regression model, the overall model is significant, $R^2 = .370$, $p < .001$. Four predictors had significant coefficients – training ($B = .304$, $p < 0.001$), software development ($B = .278$, $p < 0.01$), revamping ($B = .158$, $p < 0.1$), and remote support for clients ($B = .121$, $p < 0.1$), thus supporting the idea to include these product-related services in the service portfolio to increase the use of digital services. Nevertheless, installation, maintenance and repair, design, consulting and project planning, and take-back services show no statistically significant effect on the use of digital services. Moreover, results show that the control variable does not make a significant effect on model construction.

Outcomes of the linear regression depict the results for the RQ2: *To what extend traditional services influence the use of digital services*. The four from eight product-related services show a positive effect on the use of digital services, providing support for RQ2.

5 Conclusions

This research investigates what is the trend in the implementation of *digital services* and how traditional services influence the use of digital services in manufacturing firms. Therefore, this study provides theoretical and practical implications for how manufacturing firms could employ digital services. The empirical results show that traditional services, which are not closely related to product characteristics significantly, influence the use of digital services. These findings fill the gaps in the literature in the transformation process from traditional product-service systems to digitalized product-service systems. Moreover, these results show that product-related services are drivers of digital servitization along with digital technologies. Additionally, results show what is a trend in the implementation of traditional and digital services and how managers of manufacturing firms could combine traditional with digital services. Findings show that from the practical side manufacturing firms have two ways to involve servitization in their firms. One side is like a traditional servitization with services that are closely related to products (e.g., installation, maintenance). On the other side, they could involve digital technologies with traditional services that are not related to the product to involve digital servitization in manufacturing firms.

This study adds to the understanding of the implementation of service business models and transformation towards digital servitization. We take an initial step toward formulating a model that simultaneously analyses the impact of product-related services on a business model based on digital services. As such, we extend the empirical work of Sklyar et al. [10] and find that product-related services that are not closely related to product characteristics influence the use of digital services. Our findings advise manufacturing firms to provide training, software development, revamping or modernization, and remote support for clients to increase the use of digital services and catch up with the current trend [2, 3]. Additionally, research results show that services that are closely related to products, such as installation, maintenance and repair, design, consulting and project planning, and take-back services are inhibitors of the implementation of digital services in the processing sector. The results of the research complement the existing research that examines the drivers of digital servitization [1, 8].

This study is limited only to datasets considers in the Republic of Serbia. In such a context, further research could consider datasets from the other members of the EMS consortium to show the wider framework of digital servitization. For further research, authors could involve interviews with experts from practice to finds more drivers for digital servitization, which are not based on digital technologies or product-related services. Additionally, further research is necessary to estimate the challenges of firms over the years. With this information production managers could find how firms change their offer of digital services. The development of these ideas could be especially useful for manufacturing firms facing the challenges of “digital servitization”.

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