Digital Servitization in the Manufacturing Sector: Survey Preliminary Results

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Abstract. In the contention of the current industrial landscape, an increasing number of manufacturing firms are experimenting with the transition from product-centric offerings to service-based value concepts and product-service bundles as high-value integrated customer solutions to increase their revenues and build sustainable competitive advantages; a phenomenon known as the "servitization" of manufacturing. Nowadays, consistently with the Industry 4.0 paradigm, these companies have therefore started a process of integrating their traditional value offerings with digital services. This recent strategy is known as "Digital Servitization" and consists of developing new services and/or improving existing ones through digital technologies. However, this transformation is challenging, and companies often struggle to achieve their expectations. Thus, this study aims

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to shed light on the current state of Digital Servitization strategies in the manufacturing sector based on a survey addressed to the top and middle management. The results obtained by the analysis of the data collected from the survey show an increasing trend towards the adoption of digital technologies for enabling innovation and differentiation in service delivery processes.

Keywords: Digitalization · Servitization · Digital servitization · Industry 4.0 · Product-service systems · Survey

1 Introduction

Over the past 20 years, the term "servitization" has been used to describe the phenomenon of manufacturing firms increasingly moving toward offering integrated product-service solutions to achieve growth and competitive advantages [1] and reduce the environmental impact [2].

The phenomenon of *servitization* was initially identified by [3] in the late 80s. The recent debate on *Digital Servitization* highlights the increasing attention given to the convergence of two important research and business trends, namely "servitization" and "digitization" [4]. Recently, the growing interest in the *digital transformation* of manufacturing firms, particularly for those technologies that have seen significant growth driven by the Fourth Industrial Revolution (or Industry 4.0) has favoured manufacturing firms in their servitization process by accelerating the deployment and adoption of product-service offerings [5–7]. Today, traditional service offerings, although still preponderant, make it increasingly challenging to be highly competitive in an Industry 4.0 context and growing digital economy [8], leading companies to "digitalize" their value offerings increasingly and thus change their organizational, tactical, and strategic value creation and delivery processes [9]. This process, journey, and phenomenon of manufacturing firms increasingly moving towards offering integrated product-service solutions, using digital technologies to achieve growth and competitive advantages is defined as "Digital Servitization".

Although literature agrees that the emergence of new digital and analytical technologies such as the (Industrial) Internet of Things (IIoT), cloud computing, and big data analytics have fostered and it is still fostering the adoption of innovative services by manufacturing firms (e.g. digital services, smart services), to date, this process still poses multiple challenges to firms, such as financial ones, lack of competences and experiences, and difficulties in creating a collaborative ecosystem of partners and customers [10]. Moreover, there is little evidence on how companies implement *servitization* and more specifically *Digital Servitization* [11].

It is noticeable how many manufacturing firms have spotted the opportunity of exploiting a *servitization strategy in manufacturing,* from Alstom to Thales [12], to ABB to Ericson, and from IBM [13] to Xerox [14]. However, Neely et al. [15], while conducting an extensive analysis of 12,521 companies, found out that many have suffered poor revenues and scarce return on their investments moving towards "servitized business models". What is happening here? Companies that invest heavily in extending their service business, increase their service offerings and incur higher costs, but this

does not result in the expected correspondingly higher returns. Because of increasing costs and a lack of corresponding returns, the growth in service revenue fails to meet its intended objectives. This phenomenon is termed the *"service paradox in manufacturing firms"* [16, 17]. Instead of achieving a transition from products to servitized solutions, manufacturers leave the transition line and move into the *"service paradox"*.

Starting from these considerations and this paradox, the Special Interest Group (SIG) on "Service Systems Design, Engineering and Management" of the International Federation of Information Processing (IFIP), Working Group (WG) 5.7 on Advances in Production Management Systems (APMS) has launched a survey to answer the following research questions of academic and industrial interest:

- What is the actual service offering of manufacturing firms?
- How do companies envision the transformation of their service offerings?
- What digital technologies are mainly adopted by manufacturing firms in their service offerings?

The paper is structured as follows: Sect. 2 reports the methodology used to develop the survey and collect data, in Sect. 3 the main results related to the service offering and the adoption of digital technologies in service provision are described, while Sect. 4 concludes the paper summarizing the main lessons learned.

2 Survey Methodology

An exploratory survey was conducted to understand the current state of manufacturing firms in implementing a *Digital Servitization transformation.* Data was collected through the dissemination of a questionnaire, specifically designed for the research, and spread at the European level among the network of manufacturing firms.

The questionnaire itself was designed by a group of international experts involved in *Digital Servitization research* to provide a clear picture of the actual service offering and an understanding of how companies are implementing *Digital Servitization strategies* starting from the main research trends highlighted in the literature. The survey is made of two main sections:

- Section I is dedicated to the collection of data about the respondent (position, business function), the company (name, industry, number of employees, gross annual turnover, market, and sales), the service offering structure, and the level of utilization of digital technologies in service delivery processes, and
- Section II is dedicated to a deeper evaluation of actions at strategic, tactical, and operational levels that companies adopt to comply with their *Digital Servitization transformation process.* Five main areas of investigation, namely: (i) Product-Service System (PSS) design, (ii) Digital Servitization strategy, (iii) Assessing tool for PSS decisions, (iv) Knowledge management along the lifecycle, and (v) Sustainable business models, are analysed based on the primary research trends in "Digital Servitization" as identified by Pirola et al. [11].

The questionnaire was developed in English, translated into Italian, German and Spanish languages, and then disseminated to manufacturing firms by e-mailing lists and social media. It was disseminated at the end of January 2022 and, as a result, it has collected 142 responses until June of the same year. The answers collected were gathered into a comprehensive database to perform the analysis. This study is focused on providing a preliminary description of the current state of *Digital Servitization* in the manufacturing industry. Therefore, only the first part of the survey results is reported and discussed in this paper.

3 Main Findings

The respondents are mainly directors, managers and staff, with 20 years of experience on average and with very heterogeneous business functions (see Table 1).

Table 1. Number of respondents divided into business functions.

Business function	N° of respondents	Business function	N° of respondents
Service/After sales	35 (25%)	Sales	11 (8%)
General Management	20 (14%)	R&D/Engineering	10 (7%)
Production & Quality	19 (13%)	Supply Chain	2 (1%)
IT	11 (8%)	Other	26 (18%)

Tables 2 and 3 summarize the main characteristics of the sample. The sample is characterized by a more significant share of medium- and large-sized enterprises compared with the European Union population, where SMEs are mainly predominant. This may be due to large companies' greater awareness and interest in the "servitization" phenomenon, while SMEs are expected to have a lower degree of maturity in service-related aspects.

Table 2. Classification of the respondents based on companies' industry sectors.

Industry	N° of respondents
Capital goods (Aerospace and Defense, Construction, Machinery, Medical, Electronics)	42 (30%)
Oil and Gas, Energy, Chemicals and Materials (Plastics, Metals, Mining, Paper)	24 (17%)
Consumer (non-durable) goods (food, beverage, tobacco, household products)	14 (10%)
Consumer (durable) goods (consumer electronics, domestic appliances)	11 (8%)
Other	51 (36%)

Table 3. Classification of the respondents based on companies' size.

Company's size	N° of respondents
Large	31 (22%)
Medium	78 (55%)
Small	33 (23%)

The main findings resulting from the analysis of the data collected have been described in this order: firstly, focusing on the service offers provided by the responding companies to identify the current state and future trends; then, focusing on the digitalization of these services, to understand the level of adoption of digital technologies in the service delivery processes.

3.1 Service Offering: Current State and Future Trends

More and more manufacturing firms are interested in new business solutions-oriented to services. In particular, from the data analysis, it emerged that traditional product-oriented services [18], such as Spare parts delivery, are already in the portfolio of 68% of the respondents, as well as Repairs, Warranties, Maintenance, Retrofit, and Upgrading. These are followed by Training, Consultancy, and Engineering, which are present in 64% of the companies, and Maintenance long-term contracts, Pay-per-use, Full-Service contracts, and Outcome-based contracts in 55%. To a lesser extent, use-oriented services such as Leasing, Renting, Sharing, and Pooling are active only in 28% of the companies (see Fig. 1).

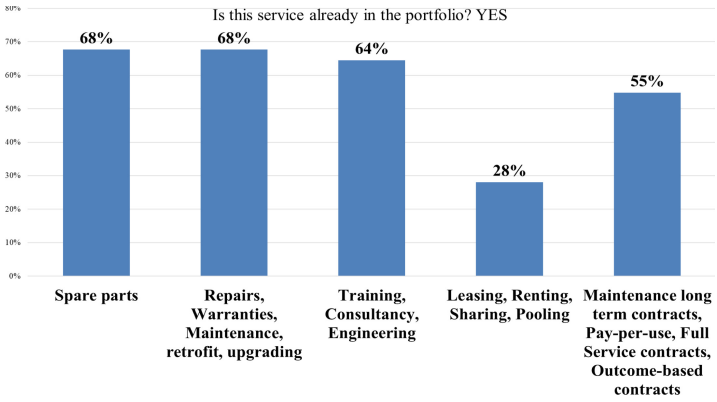

Fig. 1. Current service provision of the responding companies.

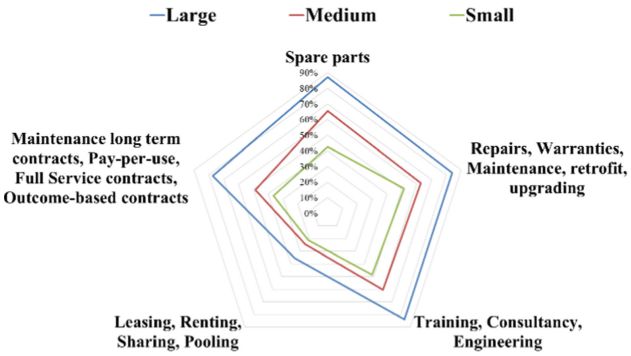

Fig. 2. Adoption of services by company size.

As shown in Fig. 2, almost all large companies provide a broad and multifaceted service offering that includes, on average, many services that have been developed to meet different end-customer needs. On average, the service portfolio of SMEs is more limited in terms of service quantity and type. Nevertheless, the study highlights an increasing interest, even among small companies, to offer more advanced services by expanding the traditional transactional service offerings based on the provision of spare parts, maintenance, and repair.

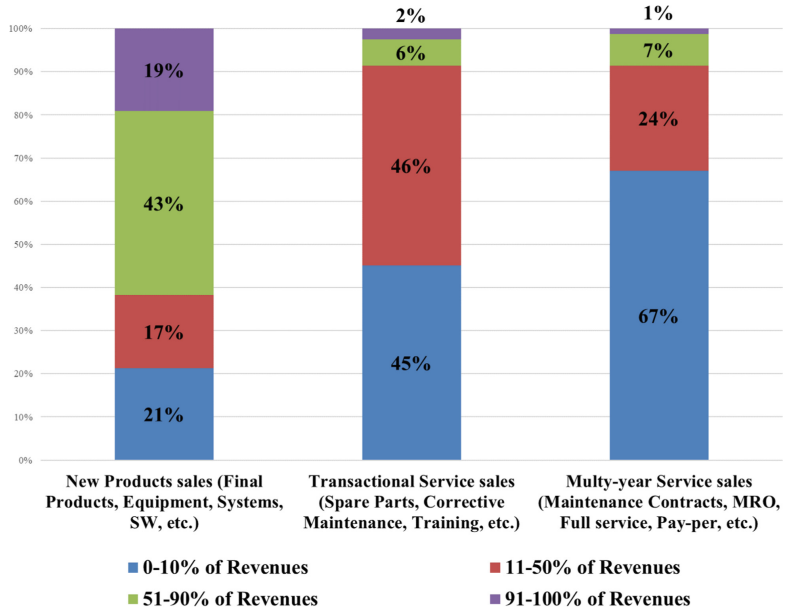

Fig. 3. Revenues share among new products, transactional service and multi-year service sales.

As expected, the highest source of revenue in the sample still corresponds to the sale of new products (see Fig. 3). Indeed, in most responding companies, the revenues deriving from the sales of service-related offers are no more than half of the total revenue. It has been observed that "transactional" services account for 0–10% of the total revenues in 45% of the responding companies, 11–50% of the revenues in 46% of the respondents, while 51–90% of the revenues in only 6% of them, and 91–100% in the 2%. Similar results have been obtained for multi-year services, in which sales still generate low revenues, which is not surprising, given that they are not fully present in companies' portfolios and even when they are present they are not yet particularly pervasive among customers. However, revenue from the sale of both "transactional" and "relational" services has grown for a large part of the sample in the past two years, and firms companies also expect revenue from service sales to increase in the coming years as they are becoming increasingly interested in providing more advanced services than standard services (see Fig. 4).

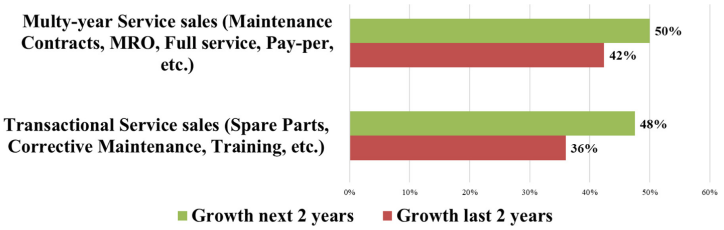

Fig. 4. Growing business trends among transactional service and multi-year service sales in the next two years and the last two years.

3.2 Technology Adoption in the Service Offering

Since the survey has been disseminated to understand the current state of *Digital Servitization,* the following analysis properly focuses on the digital technologies that companies are adopting to offer their service solutions. Firstly, the authors have explored the level of utilization of technology (no/partially/yes) for service delivery (see Fig. 5). It has been observed that digital technologies are mainly utilized for (i) Spare parts provision (in 53% of the companies), (ii) Repairs, Warranties, Maintenance, Retrofit, and Upgrading (52%), and (iii) Training, Consultancy, and Engineering (52%). These are followed by (iv) Maintenance long-term contracts, Pay-per-use, Full-Service contracts, and Outcome-based contracts (46%), and finally, (v) Leasing, Renting, Sharing, and Pooling (only 20%).

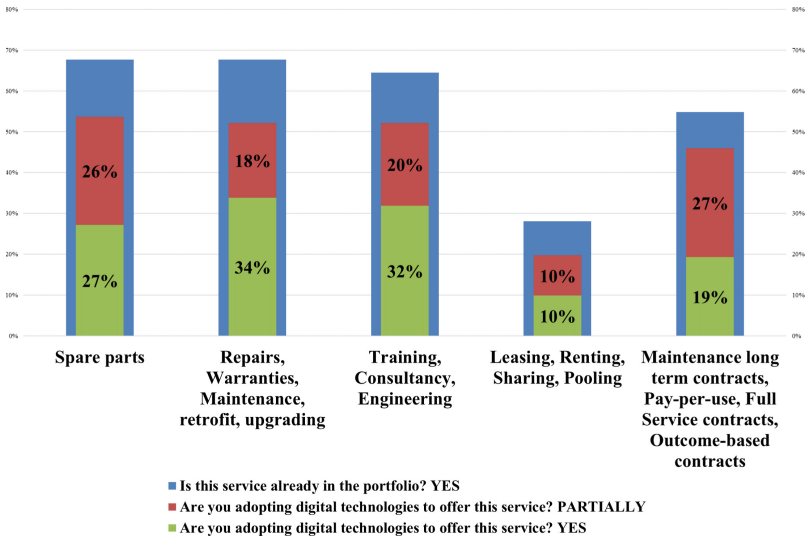

Fig. 5. Level of utilization (yes and partially) of digital technologies for providing related service offers.

Among the digital technologies [7, 19] that companies are currently adopting in their service offerings (see Fig. 6), the (Industrial) Internet of Things (IIoT) is the most utilized, followed by Cyber Security and Cloud Computing. Instead, Big Data Analytics, Simulation of Connected Machines (e.g., Digital Twin), and Mixed Reality (Virtual and Augmented Reality) are still characterized by a low utilization level, but they are expected to be further adopted in service delivery, meaning they are very attractive for manufacturing firms. Artificial Intelligence (AI)/Machine Learning (ML), Advanced

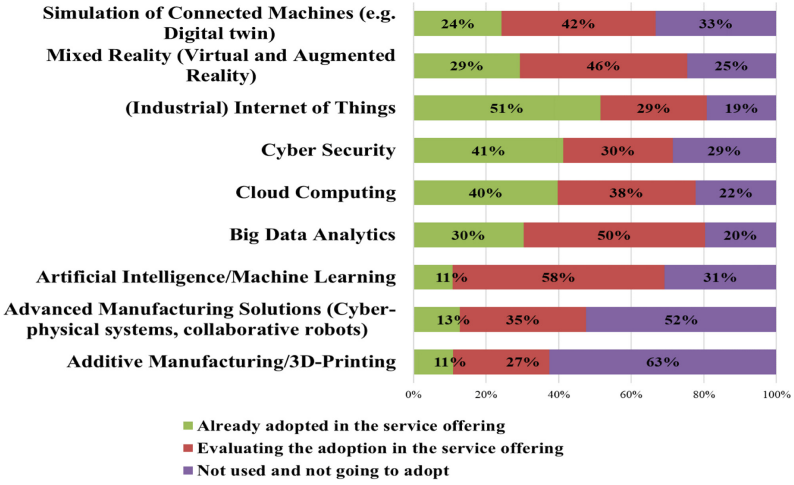

Fig. 6. Level of adoption of digital technologies.

Manufacturing Solutions (Cyber-Physical Systems, Collaborative Robots), and Additive Manufacturing/3D-Printing are not currently utilized by the companies. However, it is interesting to notice that AR/ML represents the digital solution with more potential of being adopted, with a higher percentage of companies evaluating its implementation for service delivery (58%).

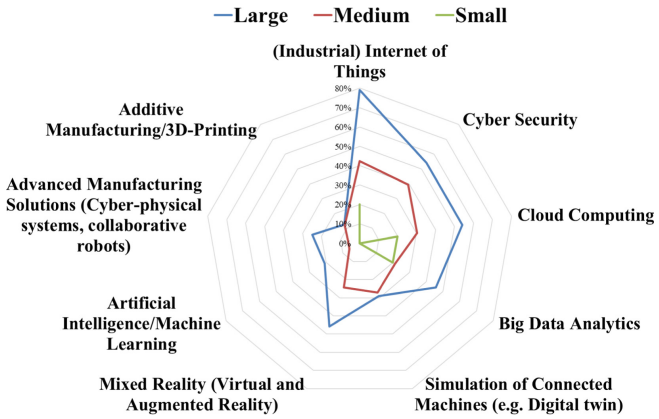

Fig. 7. Digital technologies adopted about the companies' size.

In addition, it has been observed that the companies already adopting these digital technologies are mainly large-sized enterprises (see Fig. 7), although medium-sized enterprises also appear to have a good level of implementation of the same technologies. On the contrary, small-sized enterprises have a low adoption level of such technologies, which may be explained by the limited financial resources, a lack of digital skills and resources, and the challenges of networking with other companies. Only IIoT, cloud computing, and big data analytics are present in the small companies of the sample, probably because they are less complex to implement and manage.

4 Conclusions and Future Work

From the results reported in the previous section, the service business of manufacturing firms is substantial and the future growth of their service offerings is estimated to keep growing. Yet, the word "potential" is used here because there remains a very product-centric view of the offering, although an increasing number of companies are offering "transactional services". Multi-year services, in particular the ones related to maintenance, are emerging mainly in the form of contacts. While, unfortunately, business models such as leasing, renting, etc., are not yet widely spread. However, these services generate still low revenues for manufacturing firms that have already introduced them in their portfolio. Thus, the data shows that although the service offering is there, it is not yet possible for most companies to achieve enough revenues to enable a paradigm shift.

Digital technologies, although more slowly than the literature often points out, are pushing companies toward a "service-oriented offering". Technologies turn out to be an effective enabler: they have already become an indispensable element characterizing the offering and are helping companies propose an increasingly broad and articulated service offering. The most adopted technologies to date are related to IIoT, followed by Cyber Security and Cloud computing, which are increasingly interesting when linked to XaaS (Everything-as-a-Service) service offerings. Finally, a high interest emerges, although still exploratory, in technologies such as Mixed Reality and AI/ML, technologies undoubtedly more complex to implement and manage, where the need for in-house expertise becomes a distinguishing factor. Moreover, it emerges that SMEs are focusing only on a few technologies such as IIoT, cloud computing, and big data analytics.

Future work should address the extension of the responding sample. Then, it would be particularly interesting to investigate the actions taken by manufacturing firms at operational, tactical, and strategic levels to implement a *Digital Servitization transition,* as well as to study their impacts on the entire supply chain ecosystem.

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