POLITECNICO DI TORINO
Repository ISTITUZIONALE

A worldwide survey on manufacturing servitization

Original
A worldwide survey on manufacturing servitization / Mastrogiacomo, L., Barravecchia, F., Franceschini, F.. - In: INTERNATIONAL JOURNAL, ADVANCED MANUFACTURING TECHNOLOGY. - ISSN 0268-3768. - STAMPA. - 103:9-12(2019), pp. 3927-3942. [10.1007/s00170-019-03740-z]

Availability:
This version is available at: 11583/2745073 since: 2019-07-31T17:33:04Z

Publisher:
Springer

Published
DOI:10.1007/s00170-019-03740-z

Terms of use:

This article is made available under terms and conditions as specified in the corresponding bibliographic description in the repository

Publisher copyright
Springer postprint/Author's Accepted Manuscript

This version of the article has been accepted for publication, after peer review (when applicable) and is subject to Springer Nature's AM terms of use, but is not the Version of Record and does not reflect post-acceptance improvements, or any corrections. The Version of Record is available online at: http://dx.doi.org/10.1007/s00170-019-03740-z

(Article begins on next page)

20 November 2026

A worldwide survey on manufacturing servitization

Luca Mastrogiacomo[a], Federico Barravecchia[a], Fiorenzo Franceschini[a*]

[a] *Department of Management and Production Engineering, Politecnico di Torino, Corso Duca degli Abruzzi 24, 10129 Torino, Italy*

** Corresponding author. E-mail address: fiorenzo.franceschini@polito.it*

Abstract

Manufacturing servitization is defined as the process of innovating companies' capabilities and procedures to support the shift from providing products to providing Product-Service Systems. Many studies have focused on this process, with particular regard to the potential benefits. Despite this general interest, a major void still concerns the quantification of its extent, e.g. in terms of involved companies and geographical diffusion. This study is based on the analysis of secondary data of a large sample of manufacturing companies from almost all over the world.

Keywords: *Manufacturing, Servitization, Product-Service Systems, Product-related services*

1. Introduction

The process of servitization involves a growing number of manufacturing companies that are strategically choosing to couple their traditional product offering with service components. They aim to renew and reorganize their business models to respond better to market demand and eventually gain market share while increasing their revenues. The typical offering of such companies – generally referred to as servitized companies – is a Product Service Systems (PSS), i.e. an integrated solution of products and services (Meier et al., 2010).

Quantitative studies on the extent and relevance of the servitization process are usually limited to specific manufacturing sectors or geographic markets, due to the scarcity of databases containing data of companies across multiple countries and industrial sectors (Bustinza et al., 2015). The most important works combining the analysis of a substantial number of companies distributed worldwide appear to be the preliminary quantification of the process proposed by Neely (Neely, 2007, 2009). Relying on the analysis of balance data of a sample of companies retrieved from the OSIRIS database, these analyses are mainly focused on the economic impact of the process. The author however points out to several limitations of his study: (i) sample heterogeneity in terms e.g. of size, core business, geographical location; (ii) the study concerns a small number of nations, some represented by a non-significant number of companies.

An analysis of the global extent of servitization process is herein proposed, aimed at overcoming these limits. According to the conceptual scheme suggested by Neely for the discrimination of servitized

companies, a worldwide sample of an unprecedented number of manufacturing companies from all over the world has been analysed to quantify the portion of servitized companies, also discriminating the services offered.

This paper provides three major contributions: (i) an updated picture of the extent of the servitization process in the world, by analysing secondary data related to more than 190.000 manufacturing companies in 114 countries; (ii) an investigation of the servitization process with respect to different factors, such as the geographical location, company dimension and commodity sector; (iii) the introduction of two indicators to perform an analysis of company positioning with respect to its competitors.

The rest of the paper is organised as follows. Section 2 contains a literature review concerning the servitization process. A taxonomy of product-related services is defined in Section 3, while the method of analysis is described in Section 4. Results are presented in Section 5, while Section 6 proposes an approach to analyse company positioning. The concluding section summarizes the main contributions focusing on the benefits, limitations and possible developments.

2. Literature review

The term servitization was first used by Vandermerwe and Rada in 1988 to describe the processes of adding value to product offerings through services (Vandermerwe and Rada, 1988). Over the past thirty years a growing body of literature has described the servitization process from a multitude of points of view (T. Baines et al., 2017). Existing research recognises the critical role played by services in the achievement of a sustainable competitive advantage and in the improvement of manufacturing companies' performance (Bustinza et al., 2015). The following sections focus on the results of previous studies concerning the service infusion process, opportunities and barriers arising from the shift towards service-oriented strategies and the measurement of the extent of the servitization process.

2.1 The service infusion process

Various studies addressed the transition from product-oriented to service-oriented strategies in manufacturing companies (Kowalkowski et al., 2017; Mastrogiacomo et al., 2018; Rapaccini et al., 2013). The term "service infusion" has been used by Kowalkowski et al. (2015) to define the process whereby the relative importance of the service offerings of a company increases (Kowalkowski et al., 2015; Eloranta and Turunen, 2015; Kowalkowski et al., 2012).

Peillon et al. (2015) proposed a conceptual framework to investigate a servitization path in industry, their study showed that the servitization path is typically not reversible. Brax and Visintin (2017) defined eight meta-models of servitized value constellation: (i) products with limited support; (ii) installed and supported products: (iii) complementary services; (iv) product-oriented solutions; (v) systems leasing; (vi) operating services; (vii) managed service solutions and (viii) total solutions.

Recently, Mastrogiacomo et al. (2018) defined a servitization scale with the aim of providing a conventional tool to assess the servitization level of different manufacturing companies. The shift towards service-oriented business models in manufacturing companies resulted to be associated with internal changes that mainly affect five servitization dimensions: *revenue strategy* (i.e. how revenues are generated); *design* (i.e. the objectives and objects of the design activities); *corporate organization* (i.e. the integration of different organizational functions and business units); *quality control and management* (i.e. the focus of quality activities) and *customer relationship* (i.e. the extent of interactions between a company and customers).

2.2 Opportunities and barriers for the transition to services

Existing research recognises several factors as drivers and barriers for the implementation the servitization strategies (Shi et al., 2017; Alghisi and Saccani, 2015; Krucken and Meroni, 2006).

Many reasons may explain why manufacturing company are going to undertake a transition towards service provision: (i) services are found to increase the degree of differentiation from competitors (Bustinza et al., 2015; Durugbo, 2014), setting barriers to competition (Oliva and Kallenberg, 2003) and improving product reliability (Lingegård and Lindahl, 2015); (ii) the establishment of long lasting relationship with customers is positively associated with the level of customer loyalty (Beuren et al., 2013; Visnjic Kastalli and Van Looy, 2013; Gaiardelli et al., 2014); (iii) the offering of network of services may positively influence the overall perception of quality (Barravecchia et al., 2018). Moreover, services are usually more profitable than products for manufacturing companies (Juehling et al., 2010; Fang et al., 2008; Eggert et al., 2014).

However, the implementation of service strategies creates not only opportunities, but also barriers for manufacturing companies (T. S. Baines et al., 2007; Vezzoli et al., 2015). In this regards, Martinez *et al.* (2010) identified five categories of challenges: (i) the need for a product-service culture for traditional manufacturing companies; (ii) the ability to manage the delivery of integrated offering through a plurality of touch-points; (iii) the acquisition of the internal processes and capabilities in order to compete in new service markets; (iv) the alignment of mindset and understanding towards service provision and (v) the ability to build new supplier relationships and to cooperate in innovative service ecosystems.

2.3 Previous studies on the extent of the servitization process

There is a relatively small body of literature that is concerned with the assessment of the servitization extent. To date, some of the most relevant works addressing this issue have been carried out by Neely and colleagues (Neely, 2007, 2009; Neely et al., 2011). The secondary data analysis is based on the information of a sample of 12,500 publicly listed manufacturing companies drawn from the OSIRIS database (Bureau Van Dijk, 2018). The major outcome of these studies is a comparison of the servitization extent in 27

countries, with a view on the evolution trend from 2007 to 2011 (see Fig. 1). The number of analysed companies per country ranges from 62 (Greece) to 2590 (United States of America).

Neely et al. (2011) also provide insights on: (i) the different product-related services offered by manufacturing companies; (ii) the relationship between the servitization process and company size (number of employees) and (iii) the impact of the servitization process on economic and financial performance indicators.

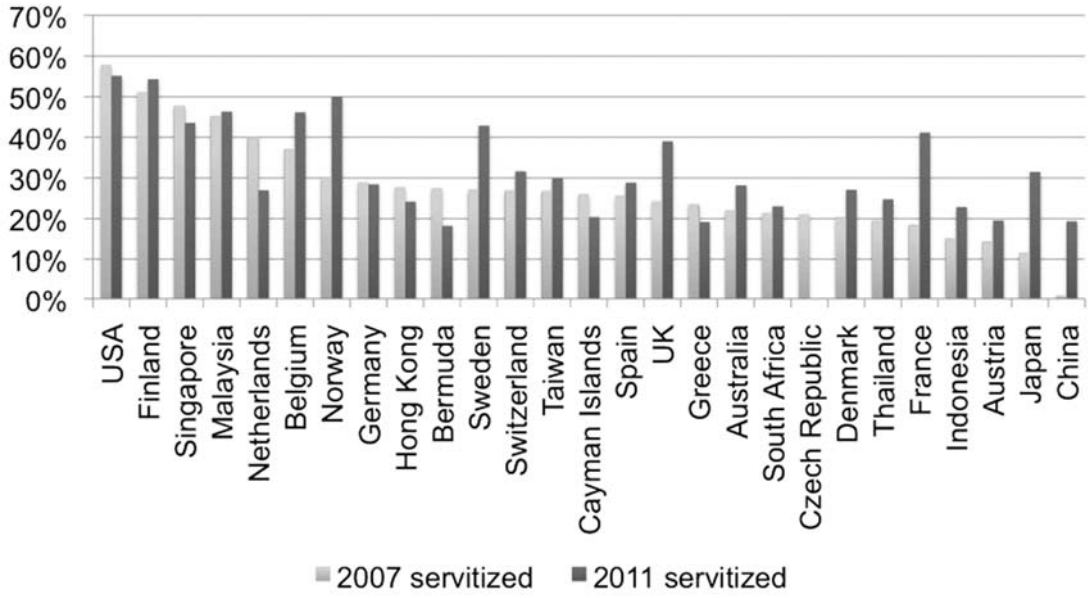


Fig. 1. Analysis of servitization extent in 27 countries of the world (Neely, Benedettini et al. 2011). Per each country, the graph shows the percentage of servitized companies.

Another important analysis of the servitization process has been carried out by Dachs et al. (2014) who focussed their attention on European manufacturing companies. Their quantitative study is based on the data contained in the European Manufacturing Survey, a firm-level primary database collected through a questionnaire, which contains, among others, information on company business model and portfolio of product-related services (Fraunhofer-ISI, 2011). Their results evidence that around 86% of the 3693 examined companies offer at least a service (see Table 1 for the data concerning the different European countries). It is noteworthy how their results differ greatly from the ones proposed by Neely et al. (2011). The differences can be partially explained by the different samples of analysed companies (only publicly listed companies in Neely et al. (2011)) and by the different data collection method (primary vs. secondary data).

Countries	Austria	Croatia	Denmark	Finland	France	Germany	Netherlands	Spain	Switzerland	Total
Share of manufacturers offering at least one service	85%	80%	86%	79%	88%	83%	83%	82%	90%	86%

Tab. 1. Analysis of servitization extent in 9 European Countries (Dachs et al. 2014)

Dachs et al. (2014) also concluded that: (i) national differences in servitization play a minor role; (ii) firm size is relevant and (iii) the degree of servitization is not linearly linked to firm size, they found a U-shape distribution.

Léo and Philippe (2001) conducted a similar study focusing their attention on the association between services and products among French exporters. Their analysis found that around 30% of French exporters couple their product offering with at least one service. 70% of them offer more than one single type of service.

Huxtable and Schaefer (2016) analysed the extent of the servitization process in UK, concluding that 61% are offering a product-service mix and 39% generate revenue only from goods. Their analysis highlights that in 75% of the firms, services generate less than 40% of the revenues.

Other studies attempted to quantify the extent of the servitization process and its dynamics applying empirical approaches based on limited number of real cases (T. S. Baines et al., 2010; Neely, 2013; Ahamed et al., 2013; Li et al., 2015; Arnold et al., 2016; Raja and Frandsen, 2017; Zhu et al., 2011). The main weakness of these works is the relatively limited size of the sample of companies. Also, a previous work by the same authors of this paper analysed secondary data from AIDA database (Bureau van Dijk, 2017) with the purpose of presenting a picture of the extent of the servitization process limited to Italian manufacturing companies (Mastrogiacomo et al., 2017).

The majorities of the studies regarding the extent of the servitization process are focused on European countries, but it is clear that all the world economies are interested. Many evidences show that also emergent economies in Africa, Asia and South America are following the route taken by other countries (Visnjic Kastalli and Van Looy, 2013; Fleury and Fleury, 2014).

Three elements emerge from the reviewed studies:

(i) the analysis of the servitization extent is available for a limited number of countries and often based on the study of a small sample of companies. This limitation is due to the method of analysis adopted, which often uses surveys, questionnaires or interviews. Clearly, these approaches can be applied to the study of a limited set of companies, often located in specific geographical contexts.

(ii) there is a high variance between results presented by the different studies; this is due to the heterogeneous nature of the aforementioned studies both from a methodological and chronological point of view;

(iii) there is no agree on the role and interaction of the structural enablers (company size, geographical location, commodity sector) in the implementation of servitization strategies.

The aim of the study hereafter presented is to address and overcome the aforementioned limitations.

3. Product-related Services

The scientific literature proposes a number of different classifications of product-related services, depending on the type of service, the nature of the company, the time of the offer, its purpose, the nature of the interaction between customer and provider, etc. (Gebauer et al., 2006). Summarizing the different proposals, product-related services can be clustered in the following macro typologies (Mastrogiacomo et al., 2017):

- *Consultancy services*: the manufacturing company shares his practical experience in the field to advise and assist customers.
- *Design and development services*: the company customizes the design and development of the product for third parties so as to meet the specific needs of their customers.
- *Retail and distribution services*: the manufacturing company directly promotes and distributes its products to the end customers, exports it to foreign countries and sells it. These services do not include those of the simple sale of goods produced without an articulated organization to support the customer service.
- *Financial services*: the company directly manages long-term credits related to its products, deferring their payment or proposing rental or leasing contracts.
- *Logistic services*: the company provides delivery, transport and/or storage services for its or customer's products, components or raw materials.
- *Installation and setup services*: the company installs and tests its products, also training the personnel in charge of their use.
- *Management and operating services*: the company operates its products throughout their life cycle, the customer receives only the benefits of the use of the product without having to run it.
- *Maintenance and support services*: the company offers the necessary support services to solve potential operational problems during the life cycle of the product, offering spare parts and skilled labour capable of repairing or updating the product features. Possible support services are also those that allow the regular functioning of the product.
- *Disposal and conversion services*: at the end of the life cycle of the product, the manufacturing company deals with the demolition, conversion or recycling of the product materials.

As shown in Table 2, this taxonomy can be related to a selection of the most significant ones available in the literature (Mathieu, 2001, Tukker, 2004, Gebauer et al., 2012, Oliva and Kallenberg, 2003). Mathieu (2001) distinguished between three types of services: customer services, product service and service as a product. Customer service facilitates the interaction between customer and seller (e.g. on-line tutorial). Product services directly support the product (e.g. technical assistance). Services as a product are

independent from the product (e.g. consulting services). Oliva and Kallenberg (2003) proposed to classify product-related services into four categories: (a) basic installed base services; (b) maintenance services; (c) professional services (d) operational services. Tukker (2004) provided a classification into three classes: (i) product-oriented services, including services that are needed during the usage phase of the product and advice and consultancy service; (ii) use-oriented services, including services where the ownership of the product is not transferred to the customer that pays for the use of the product; (iii) result-oriented services, in which the provider maintains product ownership, manages the asset and distributes product results. Gebauer et al. (2012) proposed a classification where nine categories of product-related services are selected considering the whole value chain of the product (see Table 2).

	(Mathieu, 2001)			(Oliva and Kallenberg, 2003)				(Tukker, 2004)			(Gebauer et al., 2012)								
Type of product related service	Customer service	Product service	Service as a product	Basic installed base services	Maintenance services	Professional services	Operational services	Product-oriented services	Use oriented services	Result oriented services	Consulting services	Product sale support	R&D / Product design	Supplier management	Production and System integration	Product delivery	Installation, commissioning and training	Product support service	Managed services
Consultancy services			x			x		x			x								
Design and development services	x					x		x					x		x				
Retail and distribution services		x		x				x				x		x					
Financial services			x	x				x	x			x							
Logistic services		x		x				x								x			
Installation and setup services		x		x				x									x		
Management and operating services		x			x		x		x	x									x
Maintenance and support services		x			x		x	x										x	
Disposal and conversion services	x				x			x										x	

Tab. 2. Relationship between the proposed and other taxonomies concerning product-related services (Mathieu, 2001; Oliva and Kallenberg, 2003; Tukker, 2004; Gebauer et al., 2012).

4. Method of analysis

Data used for the proposed analysis were retrieved in September 2018 from the ORBIS database which contains personal, commercial and financial data of about 275 million companies across the globe (Bureau

Van Dijk, 2018). Only manufacturing companies with more than 50 employees were considered, thus resulting in a sample of 190407 companies. In detail, the analysed sample contains companies located in 114 different countries: 35% are large companies (number of employees greater than 250), while the remaining 65% are medium-sized enterprises (number of employees between 50 and 250). Small companies were excluded from the study due to the limited availability of reported information. In order to select manufacturing companies only, the ORBIS query was limited to companies belonging to NACE (Nomenclature statistique des Activités économiques dans la Communauté Européenne) sectors classified with codes from 10 to 32 (see Table 3).

NACE rev. 2 Code	Description
10	Manufacture of food products
11	Manufacture of beverages
12	Manufacture of tobacco products
13	Manufacture of textiles
14	Manufacture of wearing apparel
15	Manufacture of leather and related products
16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
17	Manufacture of paper and paper products
18	Printing and reproduction of recorded media
19	Manufacture of coke and refined petroleum products
20	Manufacture of chemicals and chemical products
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
22	Manufacture of rubber and plastic products
23	Manufacture of other non-metallic mineral products
24	Manufacture of basic metals
25	Manufacture of fabricated metal products, except machinery and equipment
26	Manufacture of computer, electronic and optical products
27	Manufacture of electrical equipment
28	Manufacture of machinery and equipment n.e.c.
29	Manufacture of motor vehicles, trailers and semi-trailers
30	Manufacture of other transport equipment
31	Manufacture of furniture
32	Other manufacturing

Tab. 3. Detail of NACE rev. 2 sectors from 10 to 32 (European Community, 2002).

Among other information, the ORBIS database provides a textual overview of the main activities and trades characterizing each company. In accordance with the method proposed by Neely (2009), this information has been processed for discriminating between servitized, pure manufacturing and pure service companies. In detail, an automatic keyword research within the textual overview has been implemented. To this end, two different sets of keywords have been defined to describe manufacturing and service activities (see ANNEX C). To build the keyword list, the authors analysed a preliminary sample of 250 overviews randomly drawn from the set of analysed companies. An iterative procedure was then used to enrich the list of keywords: in each iteration, an additional sample of 100 company overviews was analysed and the result of the automatic categorization was compared with information retrieved from other sources (white

papers, corporate web sites and public databases). The iterative procedure was stopped when the addition of an overview sample did not result in any change in the list of keywords. The list of keywords was then extended with variants and synonyms to get the final set. In this sense, this approach is similar to the one proposed in a previous work of the same authors (Mastrogiacomo et al., 2017). The keywords related to service activities were further clustered into the product-related services discussed in Section 3 (see ANNEX C).

The defined sets of keywords were then used to scan the textual overview of the complete sample of companies. Analysed companies were classified as pure manufacturing, or pure service when respectively containing keywords belonging to the relevant keyword set only. Those companies including keywords belonging to both the sets were classified as servitized. Fig. 2 provides a schematization of the method, also showing the distinction between product related service typologies. See Annex B for a detailed example of the application of the method.

The results of the automatic classification were validated by comparing the assigned category of a randomly selected sample composed of 200 companies with a manual category assignment. The manual category assignments were performed using information retrieved also from other resources (white papers, corporate web sites and public databases). The validation showed that the automatic process produced a category assignment which did not differ significantly from the results obtained by a manual categorization: from the sample of 200 companies, we found 1 false positive (categorising a company as servitised when it is not) and 2 false negatives (categorising a company as not servitised when it is) only.

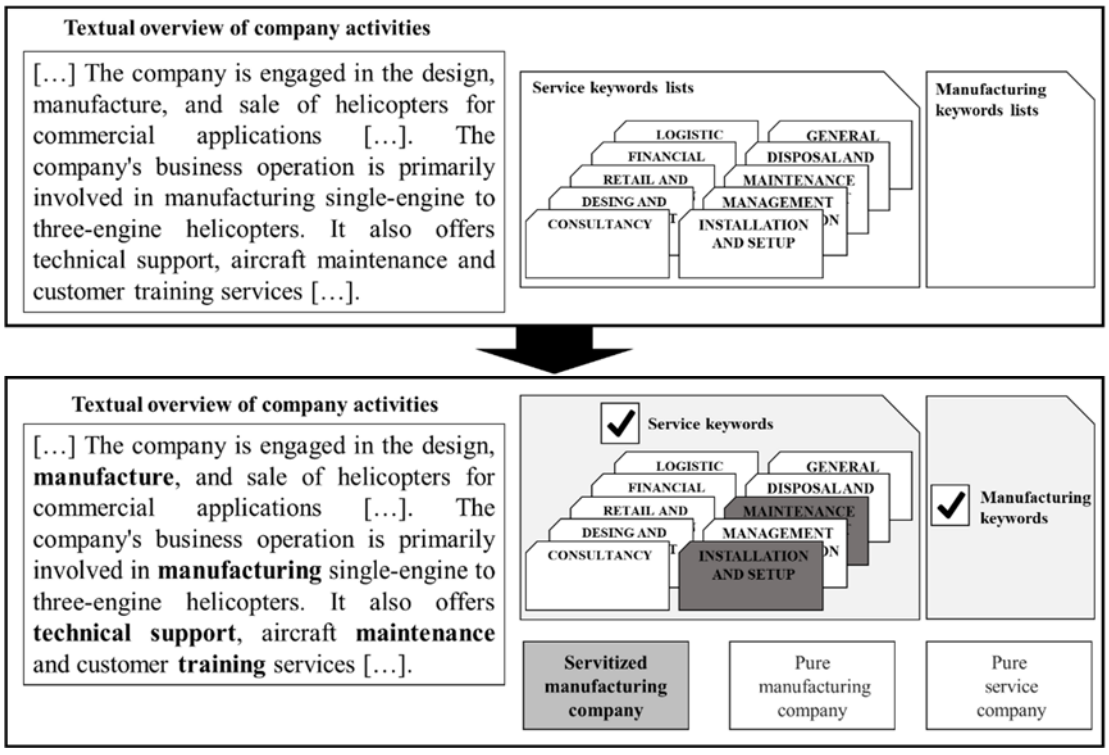


Fig. 2. Schematization of the classification method. Inputs of the method are (1) the textual overview of the company activities and (2) two set of keywords characterizing service and manufacturing activities (see Annex C). A keywords

research within the textual overview allowed to distinguish between manufacturing, pure service and servitized companies.

5. Results

The sample analysis shows an interesting aggregate result: 72790 out of 190407 (38%) are servitized companies; 113861 (60%) are pure manufacturing companies and 3756 (2%) are pure service companies. Typically, companies in this latter category are originally from the manufacturing sector and eventually changing business model, deciding to limit their activities to the provision of services.

5.1. The worldwide extent of servitization

Fig. 3 presents a qualitative overview of the achieved result in the analysed countries: darkest areas of the map correspond to countries presenting the highest percentage of servitized companies. Note that the map only considers countries with at least 100 analysed companies. For a detail of the results per country, we refer the reader to Table A.1 in the Appendix.

European countries, North America and Oceania are the most servitized geographical areas. Focusing on the single country, China shows a significant percentage of servitized companies (38%), with a radical increase from the result reported by Neely (2009) in 2011 (19%) and 2007 (1%). Not surprisingly, United Kingdom and United States of America are among the most servitized countries, presenting a percentage of servitized companies respectively of 56% and 53%.

Many different reasons may be used to explain this behavioural diversity, including the specificity of local markets, the heterogeneous management culture, the diverse aversion to risk, the customer proximity, the availability of specialized skills and the diffusion of key enabling technologies, among others. Further studies are surely needed to test these hypotheses.

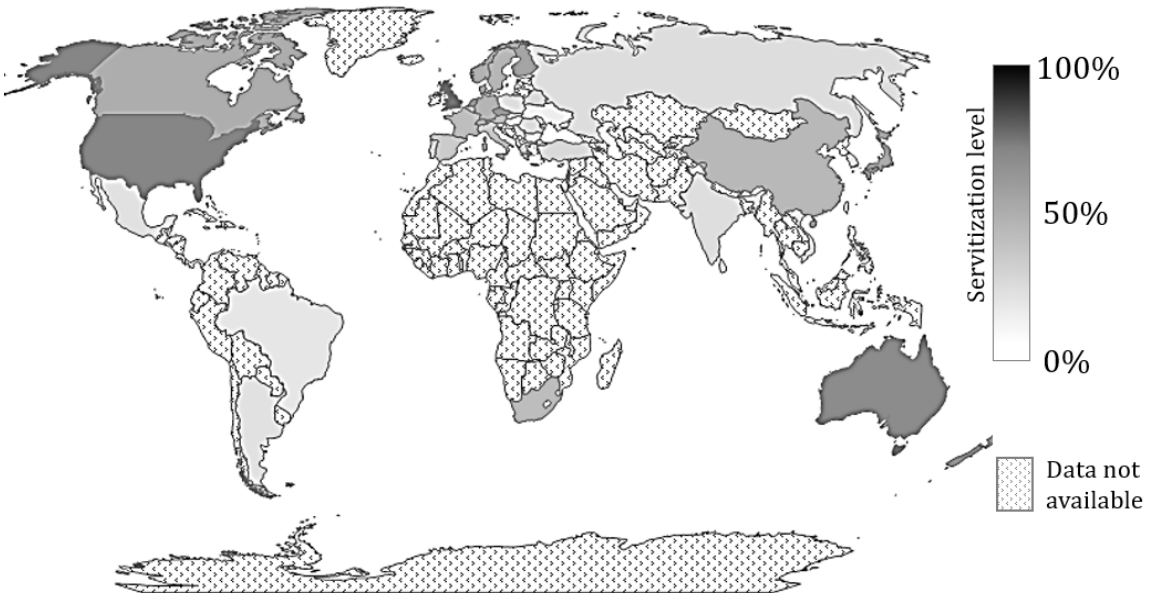


Fig. 3. World map of servitization. Dotted areas distinguish countries not covered by the study. Only countries with at least 100 manufacturing companies are considered.

These outcomes support the relevance of the servitization process in manufacturing companies. The servitization extent of European manufacturing companies in this investigation are far below those observed by Dachs et al. (2014). Results are in general in line with those observed by Neely et al. (2011). However, the servitization extent of some countries (such as China and Czech Republic) resulted significantly different.

5.2. Product-related services, company size and commodity sector

Changing perspective, the servitization process can be observed considering the different types of product-related services offered by the companies. Fig. 4 reports the distribution of these services. Note that maintenance and support activities, and retail and distribution are the most common product-related services. These services are offered by 34% and 19% of the manufacturing companies respectively. On the other hand, disposal and conversion, and transportation and logistics services are offered by a minority of the analysed manufacturing companies (around 5%).

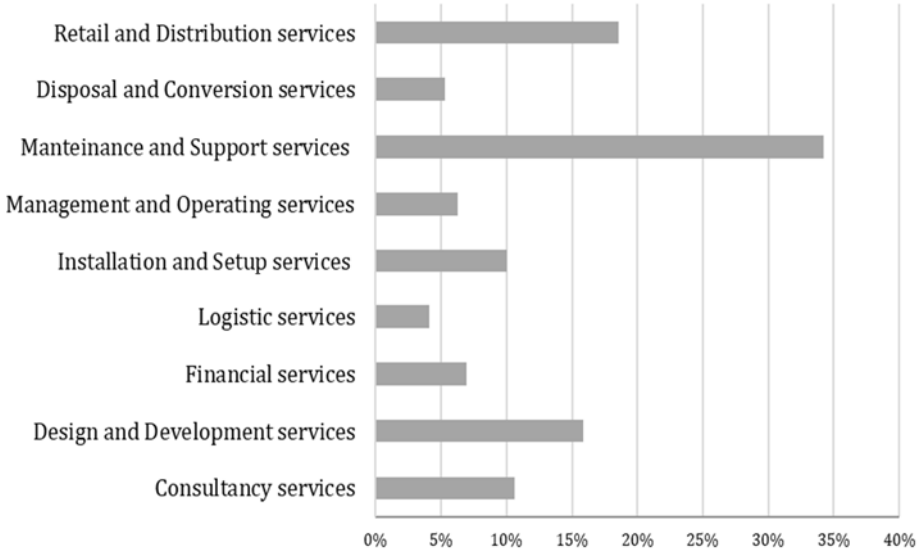


Fig. 4. Distribution of product-related services among servitized companies (72797 companies).

The distributions of product-related services typologies per country are generally comparable, with some significant differences. For instance, Canada and United States of America have a considerably high percentage of companies providing design and development services (around 30%); in the United Kingdom, Netherland and Australia, the percentage of servitized companies that provide financial services is higher than the average, ranging from 16% to 22%.

Different commodity sectors show dissimilar behaviours in the provision of different types of services. Table 4 reports the percentage of servitized companies providing a specific typology of product-related service for each NACE sector. As we can see, the distribution of service typologies per NACE sector can

be rather different, for example the 85% of NACE 15 companies (Manufacture of leather and related products) offer retail and distribution services; this percentage drops to 17% if we consider NACE 26 (Manufacture of computer, electronic and optical products).

	Service offering									
NACE sector	**Consultancy services**	**Design and development services**	**Financial services**	**Logistic services**	**Installation and setup services**	**Management and operating services**	**Maintenance and support services**	**Disposal and conversion services**	**Retail e distribution services**	**General services**
NACE 10	8%	4%	9%	6%	3%	2%	8%	0%	51%	19%
NACE 11	4%	0%	7%	11%	4%	0%	7%	0%	74%	11%
NACE 13	8%	6%	6%	6%	1%	7%	16%	2%	35%	24%
NACE 14	4%	11%	5%	0%	2%	3%	9%	1%	71%	7%
NACE 15	1%	5%	1%	2%	4%	1%	10%	0%	85%	1%
NACE 16	26%	17%	0%	12%	10%	2%	19%	2%	17%	7%
NACE 17	8%	20%	4%	6%	3%	4%	10%	4%	39%	14%
NACE 18	9%	11%	9%	4%	4%	0%	15%	1%	33%	41%
NACE 19	9%	9%	0%	45%	0%	0%	14%	0%	32%	9%
NACE 20	9%	10%	6%	8%	7%	3%	25%	1%	34%	13%
NACE 21	5%	13%	5%	0%	4%	2%	18%	1%	55%	16%
NACE 22	12%	19%	4%	9%	4%	5%	31%	4%	22%	5%
NACE 23	16%	4%	5%	13%	9%	5%	22%	8%	26%	10%
NACE 24	21%	9%	7%	9%	5%	4%	24%	5%	15%	18%
NACE 25	14%	16%	4%	10%	9%	5%	28%	3%	17%	18%
NACE 26	16%	16%	5%	16%	16%	3%	33%	3%	17%	14%
NACE 27	14%	14%	1%	12%	13%	4%	31%	3%	20%	9%
NACE 28	12%	10%	3%	11%	17%	3%	43%	8%	13%	13%
NACE 29	7%	8%	9%	5%	4%	4%	58%	5%	22%	10%
NACE 30	11%	11%	6%	11%	10%	2%	62%	17%	13%	7%
NACE 31	9%	13%	3%	23%	4%	4%	15%	2%	45%	4%
NACE 32	5%	10%	4%	8%	3%	5%	23%	1%	44%	11%

Tab. 4. Distributions of product-related services typologies per NACE Sector (NACE 12 data are not present due to the low number of companies included in the ORBIS database)

The servitization variety – intended as the number of different typologies of services offered by each company – is another interesting viewpoint of the servitization process. Fig. 5 shows the servitization variety per country: United Kingdom, Australia, Netherlands and United States of America are countries with a high servitization variety. It is noteworthy that countries with a high percentage of servitized companies are also characterized by a high servitization variety.

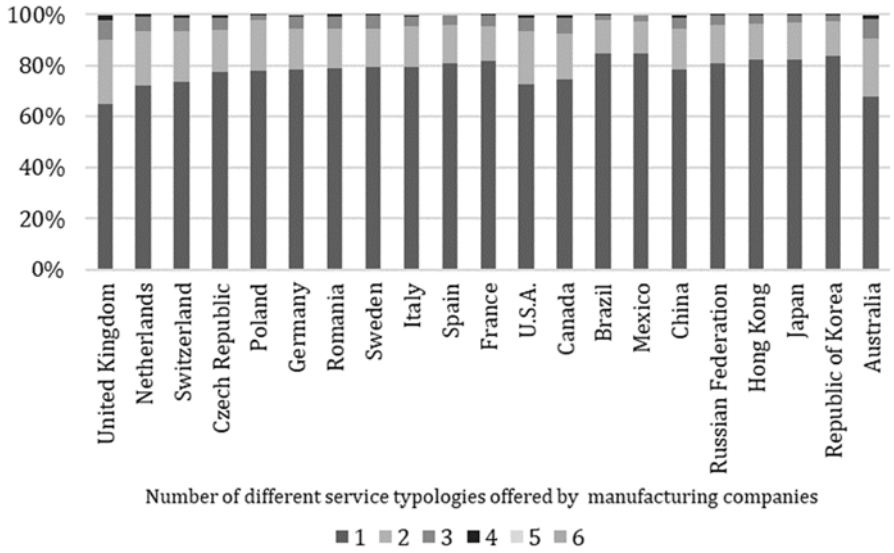


Fig. 5. Distribution of the servitization variety per country. Only countries with at least 500 servitized companies are herein considered.

Both the percentage of servitized companies and service variety show a correlation with the dimension of the company. Fig. 6.A shows how the percentage of servitized companies tends to increase with the size of the company in terms of number of employees.

Similar considerations hold for service variety: larger manufacturing companies tend to offer a wider range of services (see Fig. 6.B). The reasons behind these two evidences can be probably found in the greater availability of financial and human resources which allows and enhance the diversification of each company's offering while reducing the reluctance to face and overcome servitization barriers (T. S. Baines et al., 2009).

Also, the percentage of servitized companies and the variety of offered services are markedly related to the commodity sector in which a company operates (see Fig. 7). For instance, companies in NACE sectors 10 (food production) and 13 (textiles production) have a low percentage (less than 27%) of servitized companies. Companies in these sectors also offer a low service variety: less than 15% provide more than one service typology. On the other hand, companies producing computer, electronic and optical products (NACE 26) and machinery of equipment (NACE 28) have a higher propensity to servitization: nearly half of the companies (49%) are servitized and the proportion of companies offering more than a service is close to 30%. This finding can be related to the intrinsic features of the products offered by different commodity sectors, but also to the specificity of the market segment (Lay, 2014).

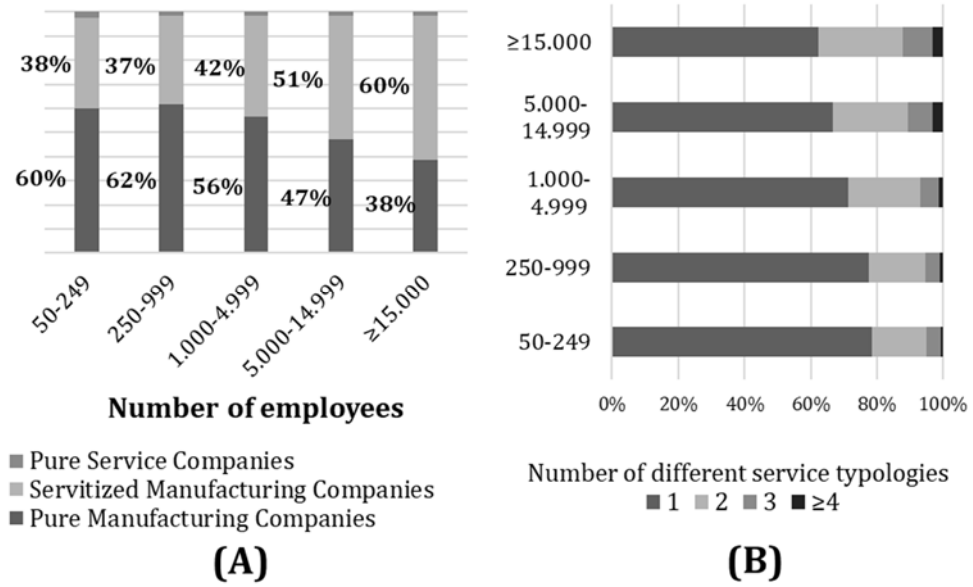


Fig. 6. Company dimension versus (A) percentage of servitized company (190407 companies) and (B) service variety (72797 companies).

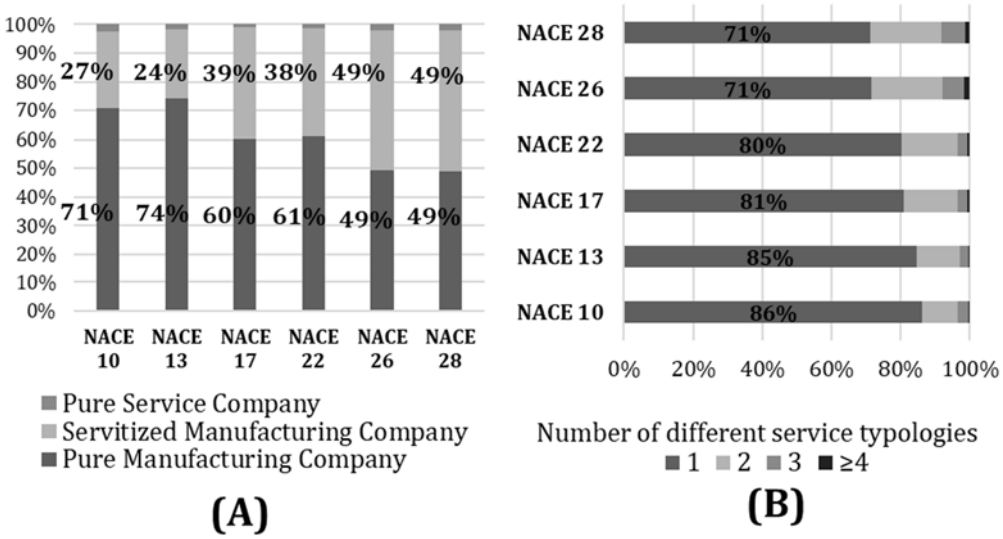


Fig. 7. Commodity sector versus (A) percentage of servitized companies and (B) service variety (NACE 10 - 20300 companies; NACE 13 - 5622 companies; NACE 17 - 5549 companies; NACE 22 - 12131 companies; NACE 26 - 13790 companies).

6. Company positioning

These insights have significant implications for the development of service strategies in manufacturing companies, in particular for the definition of the service portfolio variety. As reported in Section 5, some factors, such as company dimension, geographical location and commodity sectors, may influence the tendency to offer services. However, there is no general evidence of a direct relationship between a company servitization variety and its success: companies need to identify the service strategy that best fits the competitive environment (Gebauer, 2008).

The position of the analysed company can be compared with other competitors in the marketplace. To this end, it is firstly necessary to determine the number of different product-related services offered by the company (service variety) and an indication on its overall profitability (e.g. ROI). Having these data, all the positions (service variety vs. profitability) of the competitor companies can be represented in a chart. As an example, Fig. 8 plots the data referred to service variety vs. profitability for an explanatory set of companies (sample of Italian manufacturing companies in the optical products sector, NACE 26). Each point on the graph indicates the position of a specific company. The distribution of companies on this chart provides a picture of an industrial sub-sector in terms of its variety of offered services and its profitability with respect to the investments made (ROI).

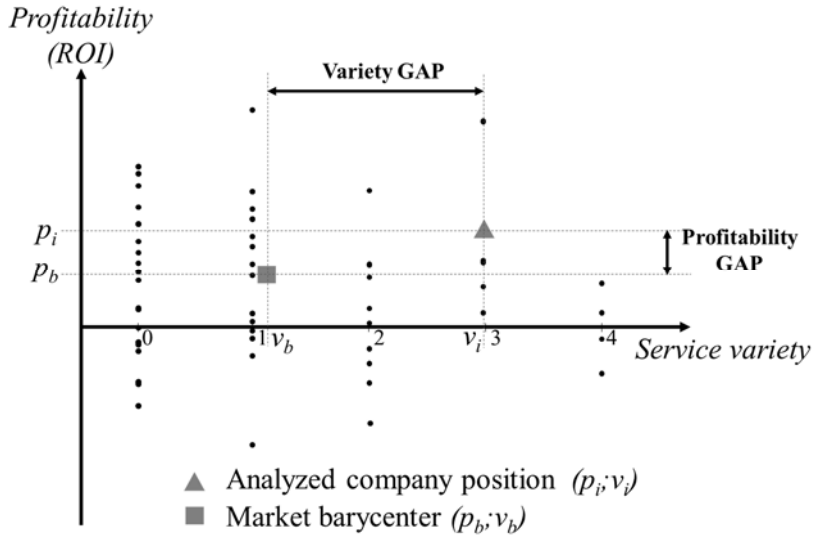


Fig. 8. Service variety vs. profitability. This example refers to a subset of Italian companies in the Optical products sector (NACE 26).

The position of a company can be related to that of the others, or, in general, to the position of the market barycentre. The market barycentre $(p_b; v_b)$ is intended as the point representing the average behaviour of the analysed companies in term of variety of product-related services and profitability:

$$p_b = \frac{\sum_{i=1}^{N}(n_i \cdot p_i)}{\sum_{i=1}^{N}(n_i)} \quad (1)$$

$$v_b = \frac{\sum_{i=1}^{M}(m_i \cdot v_i)}{\sum_{i=1}^{M}(m_i)} \quad (2)$$

Being n_i and m_i respectively the number of companies with profitability (p_i) and variety (v_i), N and M the number of groups with a specific profitability and variety in the sub-sector considered. The market barycentre can be interpreted as the position of the "average" company in the sector, so that comparisons between the position of a specific company and that of the barycentre can be used to support the strategic choices of the company management. To this aim, two indicators can be defined:

$$Profitability\ GAP = (p_i - p_b) \quad (3)$$

$$Variety\ GAP = (v_i - v_b) \quad (4)$$

These two indicators respectively indicate whether the company has a profitability and a service variety that differ from the market average.

The joint information of these two GAPs could provide insights on the possible strategies to undertake (see Table 5). Four different types of position can be defined according to the values of the identified indicators:

- *Dominant position*: both the profitability and variety gaps are positive. While being more profitable than its competitors, the company provides a higher number of product-related services to its customers. This type of position must be managed and defended.
- *Specialized position*: companies that fall into this category offer fewer services than the market barycentre, but they achieve above-average profitability. Specialisation in a niche of services allowed these companies to optimise their service delivery processes and improve their economic performance. This position must be defended and managed, also considering the possibility of expanding the provision of services.
- *Ineffective position*: while being less profitable than competitors, these companies offer a higher variability of services. Companies that fall into this category may decide to reconsider their strategy of service provision in order to enhance their profitability.
- *Subordinate position*: companies that fall into this category couple a limited service offering with a profitability that is lower than competition ones. Substantial changes in strategies are necessary to align the company to market. The option of providing of a wider range of services could improve the long-term competitiveness of the company.

	Variety GAP < 0	Variety GAP > 0
Profitability GAP > 0	**SPECIALIZED POSITION**	**DOMINANT POSITION**
Profitability GAP < 0	**SUBORDINATE POSITION**	**INEFFECTIVE POSITION**

Tab. 5. Classification of company positioning according to the profitability and variety gaps

With reference to the exemplificatory case presented in Figure 8, the position of the market barycentre has been calculated: $p_b = 7.9\%$ and $v_b = 1.2$. When compared with the analysed company's position ($p_i = 11.2\%$ and $v_i = 3$), the two GAP values are determined as follows:

$$Profitability\ GAP = (p_i - p_b) = (11.2 - 7.9) = 3.3 \quad (5)$$

$$Variety\ GAP = (v_i - v_b) = (3 - 1.2) = 1.8 \quad (6)$$

Being above the average both in terms of profitability and variety of services offered, these values describe a company that can be classified in a dominant position. This is an example of position of probable competitive advantage that company management must be able to manage.

7. Conclusions

The purpose of the present study was to provide an updated and solid picture of the servitization phenomenon on a worldwide scale. The investigation on more than 190.000 manufacturing companies showed disparities in the extent of servitization process among the 116 countries analysed, both in terms of percentage of servitized manufacturing companies and variety of offered product-related services. In particular, this study provides significant new evidences on the servitization extent in 38 different countries. The analysis reveals that, on a worldwide scale, the 38% of the manufacturing companies can be classified as servitized. United Kingdom, United States of America and Australia resulted the countries with the highest percentage of servitized companies in the manufacturing sector (more than 50%). In general, "maintenance and support" and "retail and distribution" are the most commonly provided services.

A remarkable finding is that both the service variety and the percentage of servitized manufacturing companies seem to be influenced by company dimension, geographical location and commodity sector.

The strengths of this investigation were the large size of the analysed sample and its representativeness in terms of company dimension, geographical location and commodity sector.

Providing a quantitative vision of the servitization process, this study can help researchers and practitioners in their understanding of the process. Operatively, this output can be used by a generic company to perform an analysis of its positioning with respect to its competitors. The findings herein presented support the view that the "optimal" servitization strategy is likely to be affected by the context in which the specific company operates. On the basis of this consideration, we suggest a preliminary data-driven approach to compare the service offering of a company with a properly defined set of companies.

The main limitation of this study probably stems from the specificity of the method of analysis, which is based on a specific taxonomy of product-related services: a different choice (for example in the number or typologies of categories of services) can lead to different results.

Further efforts are needed to ensure effective monitoring of the worldwide servitization process over time. A natural progression of this work is to analyse factors (such as: leadership, technology, degree of competition, financial resources) that may enable the servitization process in manufacturing companies.

References

Ahamed Z, Inohara T, and Kamoshida A. (2013). "The Servitization of Manufacturing: An Empirical Case Study of IBM Corporation." *Int. J. Bus. Adm.* 4 (2): 18–26.

Alghisi A, and Saccani N. (2015). "Internal and External Alignment in the Servitization Journey-Overcoming the Challenges." *Prod. Plan. Control* 26 (14–15): 1219–1232.

Arnold JM, Javorcik B, Lipscomb M, and Mattoo A. (2016). "Services Reform and Manufacturing Performance: Evidence from India." *Econ. J.* 126 (590): 1–39.

Baines T, Ziaee Bigdeli A, Bustinza OF, Shi VG, Baldwin J, and Ridgway K. (2017). "Servitization: Revisiting the State-of-the-Art and Research Priorities." *Int. J. Oper. Prod. Manag.* 37 (2): 256–278.

Baines TS, Lightfoot H, Benedettini O, Whitney D, and Kay JM. (2010). "The Adoption of Servitization Strategies by UK-Based Manufacturers." *Proc. Inst. Mech. Eng. Part B J. Eng. Manuf.* 224 (5): 815–829.

Baines TS, Lightfoot HW, Evans S, Neely A, Greenough R, Peppard J, Roy R, et al. (2007). "State-of-the-Art in Product-Service Systems." *Proc. Inst. Mech. Eng. Part B J. Eng. Manuf.* 221 (10): 1543–1552.

Baines TS, Lightfoot HW, and Kay JM. (2009). "Servitized Manufacture: Practical Challenges of Delivering Integrated Products and Services." *Proc. Inst. Mech. Eng. Part B J. Eng. Manuf.* 223 (9): 1207–1215.

Barravecchia F, Franceschini F, and Mastrogiacomo L. (2018). "A Service Network Perspective to Evaluate Service Matching in Early Design." *J. Serv. Theory Pract.* 28 (3): 356–383.

Beuren FH, Gomes Ferreira MG, and Cauchick Miguel PA. (2013). "Product-Service Systems: A Literature Review on Integrated Products and Services." *J. Clean. Prod.* 47: 222–231.

Brax SA, and Visintin F. (2017). "Meta-Model of Servitization: The Integrative Profiling Approach." *Ind. Mark. Manag.* 60: 17–32.

Bureau van Dijk. (2017). "Aida Database." https://aida.bvdinfo.com.

Bureau Van Dijk. (2018). "ORBIS." 2018. orbis.bvdinfo.com in September 2018.

Bustinza OF, Bigdeli AZ, Baines T, and Elliot C. (2015). "Servitization and Competitive Advantage : The Importance of Organizational Structure and Value Chain Position." *Res. Technol. Manag.* 58 (5): 53–60.

Dachs B, Biege S, Borowiecki M, Lay G, Jäger A, and Schartinger D. (2014). "Servitisation of European Manufacturing: Evidence from a Large Scale Database." *Serv. Ind. J.* 34 (1): 5–23.

Durugbo C. (2014). "Strategic Framework for Industrial Product-Service Co-Design: Findings from the Microsystems Industry." *Int. J. Prod. Res.* 52 (10): 2881–2900.

Eggert A, Hogreve J, Ulaga W, and Muenkhoff E. (2014). "Revenue and Profit Implications of Industrial Service Strategies." *J. Serv. Res.* 17 (1): 23–39.

Eloranta V, and Turunen T. (2015). "Seeking Competitive Advantage with Service Infusion: A Systematic Literature Review." *J. Serv. Manag.* 26 (3): 394–425.

European Community. (2002). *Commission Regulation (EC). Gazzetta Ufficiale L 006, 10/01/2002 P. 0003 - 0034*.

Fang E, Palmatier RW, and Steenkamp JBEM. (2008). "Effect of Service Transition Strategies on Firm Value." *J. Mark.* 72 (5): 1–14.

Fleury A, and Fleury MTL. (2014). "Local Enablers of Business Models: The Experience of Brazilian Multinationals Acquiring in North America." *J. Bus. Res.* 67 (4): 516–526.

Fraunhofer-ISI. (2011). "European Manufacturing Survey." 2011. http://isi.fraunhofer.de/isi-

en/i/projekte/fems.php.
Gaiardelli P, Songini L, and Saccani N. (2014). “The Automotive Industry: Heading towards Servitization in Turbulent Times.” In *Servitization Ind.*, edited by Lay G., 55–72. Cham: Springer.
Gebauer H. (2008). “Identifying Service Strategies in Product Manufacturing Companies by Exploring Environment–strategy Configurations.” *Ind. Mark. Manag.* 37 (3): 278–291.
Gebauer H, Friedli T, and Fleisch E. (2006). “Success Factors for Achieving High Service Revenues in Manufacturing Companies.” *Benchmarking An Int. J.* 13 (3): 374–386.
Gebauer H, Ren GJ, Valtakoski A, and Reynoso J. (2012). “Service-Driven Manufacturing: Provision, Evolution and Financial Impact of Services in Industrial Firms.” *J. Serv. Manag.* 23 (1): 120–136.
Huxtable J, and Schaefer D. (2016). “On Servitization of the Manufacturing Industry in the UK.” In *Procedia CIRP*, 52:46–51.
Juehling E, Torney M, Herrmann C, and Droeder K. (2010). “Integration of Automotive Service and Technology Strategies.” *CIRP J. Manuf. Sci. Technol.* 3 (2): 98–106.
Kowalkowski C, Gebauer H, Kamp B, and Parry G. (2017). “Servitization and Deservitization: Overview, Concepts, and Definitions.” *Ind. Mark. Manag.* 60: 4–10.
Kowalkowski C, Kindström D, Alejandro TB, Brege S, and Biggemann S. (2012). “Service Infusion as Agile Incrementalism in Action.” *J. Bus. Res.* 65 (6): 765–772.
Kowalkowski C, Windahl C, Kindström D, and Gebauer H. (2015). “What Service Transition? Rethinking Established Assumptions about Manufacturers’ Service-Led Growth Strategies.” *Ind. Mark. Manag.* 45: 59–69.
Krucken L, and Meroni A. (2006). “Building Stakeholder Networks to Develop and Deliver Product-Service-Systems: Practical Experiences on Elaborating pro-Active Materials for Communication.” *J. Clean. Prod.* 14 (17): 1502–1508.
Lay G. (2014). *Servitization in Industry*. Cham: Springer.
Léo PY, and Philippe J. (2001). “Offer of Services by Goods Exporters: Strategic and Marketing Dimensions.” *Serv. Ind. J.* 21 (2): 91–116.
Li JH, Lin L, Chen DP, and Ma LY. (2015). “An Empirical Study of Servitization Paradox in China.” *J. High Technol. Manag. Res.* 26 (1): 66–76.
Lingegård S, and Lindahl M. (2015). “Integrated Product Service Offerings for Rail Infrastructure–benefits and Challenges Regarding Knowledge Transfer and Cultural Change in a Swedish Case.” *J. Clean. Prod.* 98: 166–174.
Martinez V, Bastl M, Kingston J, and Evans S. (2010). “Challenges in Transforming Manufacturing Organisations into Product-Service Providers.” *J. Manuf. Technol. Manag.* 21 (4): 449–469.
Mastrogiacomo L, Barravecchia F, and Franceschini F. (2017). “A General Overview of Manufacturing Servitization in Italy.” *Procedia CIRP* 64: 121–126.
Mastrogiacomo L, Barravecchia F, and Franceschini F. (2018). “Definition of a Conceptual Scale of Servitization: Proposal and Preliminary Results.” *CIRP J. Manuf. Sci. Technol.*, 10.1016/j.cirpj.2018.11.003.
Mathieu V. (2001). “Service Strategies within the Manufacturing Sector: Benefits, Costs and Partnership.” *Int. J. Serv. Ind. Manag.* 12 (5): 451–475.
Meier H, Roy R, and Seliger G. (2010). “Industrial Product-Service Systems-IPS2.” *CIRP Ann. - Manuf. Technol.* 59 (2): 607–627.
Neely A. (2007). “The Servitization of Manufacturing: An Analysis of Global Trends.” In *14th Eur. Oper. Manag. Assoc. Conf.*, 1–10. Turkey Ankara.

Neely A. (2009). “Exploring the Financial Consequences of the Servitization of Manufacturing.” *Oper. Manag. Res.* 1 (2): 103–118.
Neely A. (2013). “Servitization in Germany: An International Comparison.” *Cambridge Serv. Alliance*.
Neely A, Benedettini O, and Visnjic I. (2011). “The Servitization of Manufacturing: Further Evidence.” In *18th Eur. Oper. Manag. Assoc. Conf.* Vol. 1.
Oliva R, and Kallenberg R. (2003). “Managing the Transition from Products to Services.” *Int. J. Serv. Ind. Manag.* 14 (2): 160–172.
Peillon S, Pellegrin C, and Burlat P. (2015). “Exploring the Servitization Path: A Conceptual Framework and a Case Study from the Capital Goods Industry.” *Prod. Plan. Control* 26 (14–15): 1264–1277.
Raja JZ, and Frandsen T. (2017). “Exploring Servitization in China: Challenges of Aligning Motivation, Opportunity and Ability in Coordinating an External Service Partner Network.” *Int. J. Oper. Prod. Manag.* 37 (11): 1654–1682.
Rapaccini M, Saccani N, Pezzotta G, Burger T, and Ganz W. (2013). “Service Development in Product-Service Systems: A Maturity Model.” *Serv. Ind. J.* 33 (3–4): 300–319.
Shi VG, Baines T, Baldwin J, Ridgway K, Petridis P, Bigdeli AZ, Uren V, and Andrews D. (2017). “Using Gamification to Transform the Adoption of Servitization.” *Ind. Mark. Manag.* 63: 82–91.
Tukker A. (2004). “Eight Types of Product-Service System: Eight Ways to Sustainability? Experiences from Suspronet.” *Bus. Strateg. Environ.* 13 (4): 246–260.
Vandermerwe S, and Rada J. (1988). “Servitization of Business: Adding Value by Adding Services.” *Eur. Manag. J.* 6 (4): 314–324.
Vezzoli C, Ceschin F, Diehl JC, and Kohtala C. (2015). “New Design Challenges to Widely Implement ‘Sustainable Product-Service Systems.’” *J. Clean. Prod.* 97: 1–12.
Visnjic Kastalli I, and Looy B Van. (2013). “Servitization: Disentangling the Impact of Service Business Model Innovation on Manufacturing Firm Performance.” *J. Oper. Manag.* 31 (4): 169–180.
Zhu QQ, Jiang PY, Huang GQ, and Qu T. (2011). “Implementing an Industrial Product-Service System for CNC Machine Tool.” *Int. J. Adv. Manuf. Technol.* 52 (9–12): 1133–1147.

ANNEX A

Country	Sample size [companies]	Pure Manuf.	Pure Service	Servitized
United Kingdom	7842	42%	2%	56%
United States of America	26959	43%	4%	53%
Australia	1658	42%	7%	51%
Czech Republic	2652	53%	2%	45%
Finland	761	54%	2%	44%
Netherlands	1454	50%	7%	43%
Canada	3568	55%	4%	41%
Japan	13879	59%	0%	41%
Norway	644	58%	2%	40%
Germany	15246	59%	2%	39%
Switzerland	1722	59%	2%	39%
Sweden	1426	59%	2%	39%
China	34433	61%	1%	38%
Austria	1252	59%	3%	38%
South Africa	939	60%	3%	37%
France	4459	62%	2%	36%
Belgium	1277	63%	2%	35%
Italy	8458	66%	1%	33%
Spain	4054	65%	2%	33%
Slovakia	833	67%	1%	32%
Greece	681	67%	1%	32%
Hong Kong	4016	69%	0%	31%
Belarus	1245	69%	2%	29%
Portugal	1582	70%	1%	29%
Romania	1861	69%	2%	29%
Turkey	953	72%	0%	28%
Bulgaria	881	71%	1%	28%
India	978	73%	0%	27%
Vietnam	1503	72%	1%	27%
Russian Federation	8630	71%	2%	27%
Poland	2008	72%	1%	27%
Hungary	1293	72%	2%	26%
Republic of Korea	5143	73%	1%	26%
Argentina	1069	72%	2%	26%
Mexico	4107	69%	5%	26%
Brazil	6925	74%	2%	24%
Sri Lanka	1404	75%	1%	24%
Ukraine	2099	74%	3%	23%

Table A1. Servitization extent per country. Only countries with more than 600 companies are reported.

ANNEX B

Company	Textual Overview (Keywords highlighted)	Results
FINCANTIERI S.P.A	The Company is an Italy-based company engaged in the industry sector. The Company is active in the ship**build**ing constructions. The Company's activities are divided into four business divisions. The Ship**build**ing division **produces** cruise ships, ferries, naval vessels and mega yachts, as well as offers ship **repair**, **conversion**, **refitting** and **refurbishment**. The Offshore division focuses on the design and **construction** of support vessels for the oil and gas exploration and production market. The company is engaged in the design and **construct**ion of merchant and naval vessels. It was founded in 1959. The registered business office of the company is located in Trieste, Italy. The company **build**s cruise ships and large ferries; and surface vessels, such as frigates, corvettes, and patrol vessels, as well as submarines, yachts, and special ships. It develops and **build**s naval systems, including stabilizers, solutions, and components for propulsion and power generation; and industrial turbines, as well as diesel engines for marine and industrial applications. The company also provides **repair** and **conversion** services for passenger ships and offshore vessels, as well as offers research and technical **consultancy** services in the naval and maritime field. The company is considered one of the world's largest ship**build**ing groups; and world leader in the **construct**ion of cruise ships and large ferries.	**Manufacturing activities** (build, produce, construct) **Consultancy services** (consultancy) **Maintenance and Support services** (repair) **Disposal and conversion services** (conversion, refitting, refurbishment) ➔ **SERVITIZED MANUFACTURING COMPANY**
BURGO GROUP S.P.A.	Engaged in the **manufacture** of pulp, paper, and paperboard. The company is engaged in the **manufacture** of pulp, paper, and paperboard. The company is the leading southern European **produce**r of graphic papers, specializing in the **production** of Coated Woodfree (CWF) and Coated Mechanical Reels (CMR) paper used to print catalogues, magazines, commercial matter and books. The company was incorporated in 1996.The company specializes in the **production** of graphic, mainly coated, papers as well as newsprint and paper for telephone directories, uncoated printing and office paper, special paper and packaging paper. The company is also involved in the collection and processing of waste paper; engineering, design, and **construction** of paper mills. The company's mission is to be the preferred southern European paper **manufacturer** for clients in terms of quality of products. The company is a member of RIPE NCC, an independent, not-for-profit membership organization that supports the infrastructure of the Internet through technical coordination in its service region; and CEPIPRINT asbl, the Association of European Publication Paper Producers based in Belgium, whose mission is to help its members to conduct and improve their business, acting in compliance with national and international competition legislation, by: providing high quality statistical analysis on relevant industry-related environmental issues, promoting the image of its members' products and industry, and coordinating its activities with other international organisations within the paper industry. The company's headquarters is located in Altavilla Vicentina. The group has subsidiaries in Belgium, Spain, Luxembourg, France, the United Kingdom and Germany. Customers of the company include publishing industry, book manufacturers, office supplies manufacturers, packaging industry, media arts sector, and commercial sector.	**Manufacturing activities** (build, produce, production, construction, manufacture) ➔ **PURE MANUFACTURING COMPANY**
PERKIN ELMER ITALIA S.P.A.	The company is engaged in providing technology, **services**, and solutions to the diagnostics, detection and analysis, and photonics markets. It was incorporated in 1964 and has its registered business office located in Milano, Italy. The company has team of professional staff and other specialists with expertise in providing necessary **assistance** and **services** to its clients. It operates as a subsidiary of PerkinElmer, Inc., which is an American multinational corporation focused in the business areas of human and environmental health, including environmental analysis, food and consumer product safety, medical imaging, drug discovery, diagnostics, biotechnology, industrial applications, and life science research and is headquartered in Waltham, Massachusetts.	**Maintenance and Support services** (service, assistance) ➔ **PURE SERVICE COMPANY**

Tab. B.1. Examples of application of the keyword research method

ANNEX C

KEYWORDS

MANUFACTURING

Transformation
Blending
*Construct**
*Manufact**
*Assembl**
*Refin**
Production
Process
Build
Work
Treat
Print
Produce
Industrial firm
Producing
Treatment
Coating
Casting
Weaving
Tanning
Dressing
Finishing
Make

PRODUCT-RELATED SERVICE

Consultancy services	Design and development services	Financial services	Logistic services	Installation and setup services
*Consult**	*Custom**	*financial*	*transportation*	*installation*
consultancy	*co-develop**	*leasing*	*trucking*	*implementation*
consulting	*Personali**	*hiring*	*consignment*	*procurement*
planning	*Customiz**	*hire*	*logistic*	*test activities*
certification	*personal design*	*financing*	*storage*	*training*
	*personal develop**	*loans*		
	custom-built	*insurance*		
	engineering services	*intermediation*		
	design service	*financing*		
	development service			

Management and operating services	Maintenance and support services	Disposal and conversion services	Retail e distribution services	General services
supervision	*repair*	*demolition*	*retail*	*service*
life-cycle management	*maintenance*	*conversion*	*marketing*	
conduction	*support*	*dismission*	*promotion*	
manages and operates	*servicing*	*recycling*	*store*	
	aftermarket	*upgrades*		
	spare part	*modernization*		
	technical service	*refitting*		
	inspection	*refurbishment*		
	optimization service			
	restoration			
	assistance			

Tab. C.1. Keyword list used for the segmentation among pure manufacturing, servitized and pure service companies. Product-related Service keywords are divided by service type. Symbol "*" indicates any possible character(s).