CIRP Journal of Manufacturing Science and Technology 29 (2020) 141–156

Contents lists available at ScienceDirect

CIRP Journal of Manufacturing Science and Technology

journal homepage: www.elsevier.com/locate/cirpj

Definition of a conceptual scale of servitization: Proposal and preliminary results

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ARTICLE INFO

Article history:
Available online 1 December 2018

Keywords:
Servitization
Servitization scale
Servitization level
Service infusion
Product-service systems

ABSTRACT

The servitization process, i.e. the gradual shift from product-centred value propositions to complex product-service systems offerings, has led many manufacturing companies to modify their business models and internal organization. It is clear that this is a rather short-sighted definition not taking into account how much a company is product or service-oriented, i.e. its servitization level. The idea herein discussed is to formalize the concept of a servitization scale, trying to operationalize the concept of servitization level shared by researchers and practitioners. The goal is to provide a conventional tool to measure or compare the servitization level of different manufacturing companies. To provide a preliminary evidence the possible use of the proposed scale, the paper presents: (i) an in-depth analysis of the servitization level of medium-large size Italian companies in the manufacturing sector; (ii) some examples of possible applications of the scale to support the strategic decision-making process and planning of the servitization process.

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Introduction

Since its formalization [1], the concept of servitization has stimulated the interest of academics, managers and policy makers. Several statistics shows the importance of the phenomenon [2–4]. To date, Neely [5] probably provided one of the more comprehensive definition of the process: servitization is defined as "the innovation of organisation's capabilities and processes to better create mutual value through a shift from selling product to selling Product-Service Systems (PSS), i.e. integrated offerings of products and services".

According to Kowalkowski et al. [68] service infusion can be defined as "the process whereby the relative importance of service offerings to a company increases". The two concepts of servitization and service infusion are strictly related: going through a process of service infusion is necessary to increase a company's servitization level.

Although scholars have long debated the impact of servitization strategies in manufacturing companies and the relevant factors [6–8], few studies focussed on the discretization of the servitization process.

According to Baines et al. [9] the definition and understanding of "stages in the change process as manufacturing businesses adopt services" is a critical reasearch prioritiy. The same view is shared by Brax and Visintin [10] who state that the path of servitization and the positioning of companies deserve more attention.

The investigations presented in this paper try to fill this gap by proposing a conceptual scale to discretize the servitization continuum. The proposed scale investigates the factors that differentiate servitized companies and provides a practical support to the strategic decision-making process in order to: (i) analyse the servitization level of a specic company; (ii) define an evolutionary path to purse a sustainable competitive advantage; (iii) compare the servitization level of a company with the competitor's position and (iv) analyse specific commodity sectors so as to support a company in the identification of its optimal business strategy. The scale is defined to make the use of this tool objectivable and verifiable.

By introducing some operating assumptions, the scale is used for an in-depth analysis of the servitization level of a sample of more than 9000 medium-large sized Italian companies in the manufacturing sector.

The remainder of the paper is structured as follows. A review of the literature is presented in Section "Literature review" to discuss the servitization process and its discretization, the concept of Product-Service System, and the taxonomy of product-related services applied in this study. The methodology of the study is

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https://doi.org/10.1016/j.cirpj.2018.11.003
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provided in Section "Research methodology". The development of the proposed scale is described in Section "Scale development". Section "The servitization scale" outlines the proposed servitization scale, describing in detail the features of each level. Section "A case study: the overall Italian scenario of servitization" proposes the analysis of the servitization level distribution and antecedents for a sample of manufacturing companies in Italy. Implications and possible practical applications of the proposed scale are given in Section "Operational use of the servitization scale". The concluding section summarizes the original contributions of the paper, focusing on the benefits, limitations and possible future developments.

Literature review

The servitization process has been investigated from several viewpoints: (i) few authors directly address the definition of servitization [1,5,11–14] or its evolutionary trajectory in manufacturing [6,15,16]; (ii) Wise and Baumgartner [17], Malleret [18], Eggert et al. [19] and Kastalli and Van Looy [20], analyses the reasons why companies look at servitization as a possible innovation strategy; (iii) a number of researchers analyse the methods and guidelines for the implementation of servitization strategies [21–25]; (iv) some studies are related to the required capabilities and the challenges that manufacturers have to tackle when servitizing [26–30], the architecture of servitized organisations [22,31] and the effect of its adoption as a competitive manufacturing strategy [17,20,21,32]; (v) a variety of authors addressed the design challenge in servitized manufacturing companies [33–38]; (vi) also proposing an ecosystem approach as a way in which manufacturing companies can extend their value offering redesigning the supply chain [39,40].

Discretization of the servitization process

Service infusion has been observed to increase the value of the industrial companies offerings [11,12,41,42]. Martinez et al. [29] were the first to introduce the concept of servitization level defining the paradigm of servitization continuum. According to the authors, there is a continuum of different solutions between these two extreme cases and the servitization level depends on the extent of interaction between supplier and customer:

- Low servitization: "Interaction with few peripheral mainly transactional services"
- High servitization: "Product and service co-designed; total solution"

Although fully shareable, this definition may not be very operative in the case, for example, in which two or more different business realities need to be compared.

The journey of manufacturing companies shifting from a product-centered strategy to the offering of Product-Service Systems has been the object of the studies of Kowalkowski et al. [15]. According to Raddats and Kowalkowski [43], manufacturers undertake a service infusion journey with the aim of differentiating their products also increasing their incomes.

Brax and Visintin [10] 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.

Rapaccini et al. [44] proposed a maturity model for assessing the New Service Development (NSD) processes in manufacturing companies. The model in based on a five-stage scale on which key elements are evaluated according to the following dimensions: (1) the approach used to manage processes and projects (2) the use of specific resources, skills and tools (3) the involvement of customers, suppliers and other stakeholders and (4) the adoption of performance management systems.

Product-Service Systems and servitized manufacturing companies

The concepts of servitization and Product-Service Systems (PSS) are strongly related. While the former refers to the transformation process, the latter refers to the output of the servitized manufactuirng companies.

The term Product-Service Systems was first used by Goedkoop et al. [45]. In the last two decades the term has evolved and varied. According to Baines et al. [46], "PSS are market proposition that extends the traditional functionality of a product by incorporating additional services". In this view, servitized manufacturing companies extend their tradional physical outputs adding service components in order to enrich their value proposition. PSS-based strategies have been proved to increase profitability and sustainability of manufacturing companies [47–50].

Alongside the diffusion of the PSS concept, several researcher have proposed a categorization of PSSs based on different dimensions [51–55]. A number of researchers agree on the categorization of PSS into the following three typologies [46,56–58]:

(i) Product Oriented PSS, this is a PSS where ownership of the tangible product is transferred to the consumer, but additional services, such as maintenance contracts, are provided;
(ii) Use Oriented PSS: this is a PSS where ownership of the tangible product is retained by the service provider, who sells the functions of the product, via modified distribution and payment systems, such as sharing, pooling, and leasing;
(iii) Result Oriented PSS, this is a PSS where products are replaced by services, such as, for example, voicemail replacing answering machines.

This categorization partially helps to classify servitized companies according to the type of PSS they offer to the market.

However, the authors of this paper believe that the distinctive characteristics of servitized companies still need substantial discussion in scholarly literature. In this view, a conceptual scale to discretize the servitization continuum is proposed in this paper.

Research methodology

The research methodology of the proposed research paper comprises a combination of quantitative and qualitative approaches. Three main phases can be identified. Firstly, a systematic literature review was conducted to identify studies and theoretical frameworks to support the definition of a conceptual scale of servitization. Secondly, a focus groups with experts from different disciplinary and professional background supported the authors to obtain further in-depth information on the servitization transition. Along with discussions of this theoretical background, the focus group defined the dimensions and the levels of the scale of servitization (see Sections "Scale development" and "The servitization scale"). Finally, the proposed scale was applied in order to analyse the servitization level of a sample of 9615 Italian manufacturing companies (see Section "A case study: the overall Italian scenario of servitization").

Scale development

The servitization scale hereafter proposed is based on the results of a preliminary qualitative analysis performed by a focus

group. The focus group was composed of the three authors and of a team of seven experts and practitioners. In particular, four senior managers with at least 10 years of expertise in their working field were involved. They were selected from four companies producing: cars, advanced technology solutions for digital manufacturing; agricultural equipment and aeronautic components. In addition, three senior consultants with experience in several manufacturing sectors were involved. In detail, the focus group followed a structured procedure schematically presented in Fig. 1 and hereafter described in three steps.

By analysing a total sample of 200 medium-large companies (number of employees greater than 50), operating in the manufacturing sectors, the focus group was asked to define a taxonomy of the most common servitization statuses. For each company, the focus group analysed a textual overview of the company's activities and businesses to identify the servitization position of the company. As a result, the focus group agreed on the definition of a conceptual servitization scale which is discussed in Section "Scale development".

The purpose of this section is to describe the clustering activity carried out to define the levels of the proposed servitization scale. The design choices respond to the need to discretise the servitization process in a rational, solid and repeatable way. To this end, the construction of the conceptual scale required some empirical assumptions. By analysing successive samples of medium-sized manufacturing companies (number of employees over 50) randomly extracted from the ORBIS database, the focus group defined (i) the servitization scale, (ii) the relevant dimensions and (iii) their levels [59].

Step 1. Selection of the servitization process dimensions

Relaying on a systematic literature analysis, the focus group has identified a set of dimensions capable of describing the servitization process. Relevant articles were identified through a bibliometric query in the Scopus database [60]. The keywords used were: servitization, service transition, service infusion and Product-Service Systems. This query resulted into a total of 1603 documents, of which 635 published on peer-reviewed journal. According to the aim of this activity, a preliminary screening of this sample reduced its dimension to 132 articles published on a variety of journals including, among others, CIRP Journal of Manufacturing Science and Technology, International Journal of Production Management; Journal of Operations Management; International Journal of Production Research, Journal of Cleaner Production, CIRP Annals.

After this preliminary analysis, the focus group agreed to define five dimensions as representative of the servitization level of a generic manufacturing company: revenue strategy, design, organization, quality control and management and customer relationship [11,12,20,22,29,61,62].

Table 1 reports a brief description of each scale dimension and its relationship with the enterprise decision level (Strategic, Tactical and Operational). The dimensions were defined by the focus group for a generic company, regardless of its core business. These five dimensions were defined taking into account the nature of the servitized manufacturing companies and their internal changes occurring in the process. Although some researchers used the level of service revenues of a manufacturing company to measure the level of servitization [22], the focus group adopted an approach aimed to extend the analysis to the internal factors that concur to produce economical outcomes (service revenues, service profitability and productivity, etc.). Three other dimensions were initially taken into account: innovation focus, service revenue ratio and investments in services. These dimensions were eventually removed since, according to the experts, indirectly included into the other five.

Step 2: discretization of the dimensions

Each servitization dimension was discretized in a set of levels to describe the potential evolutive steps of a company along the

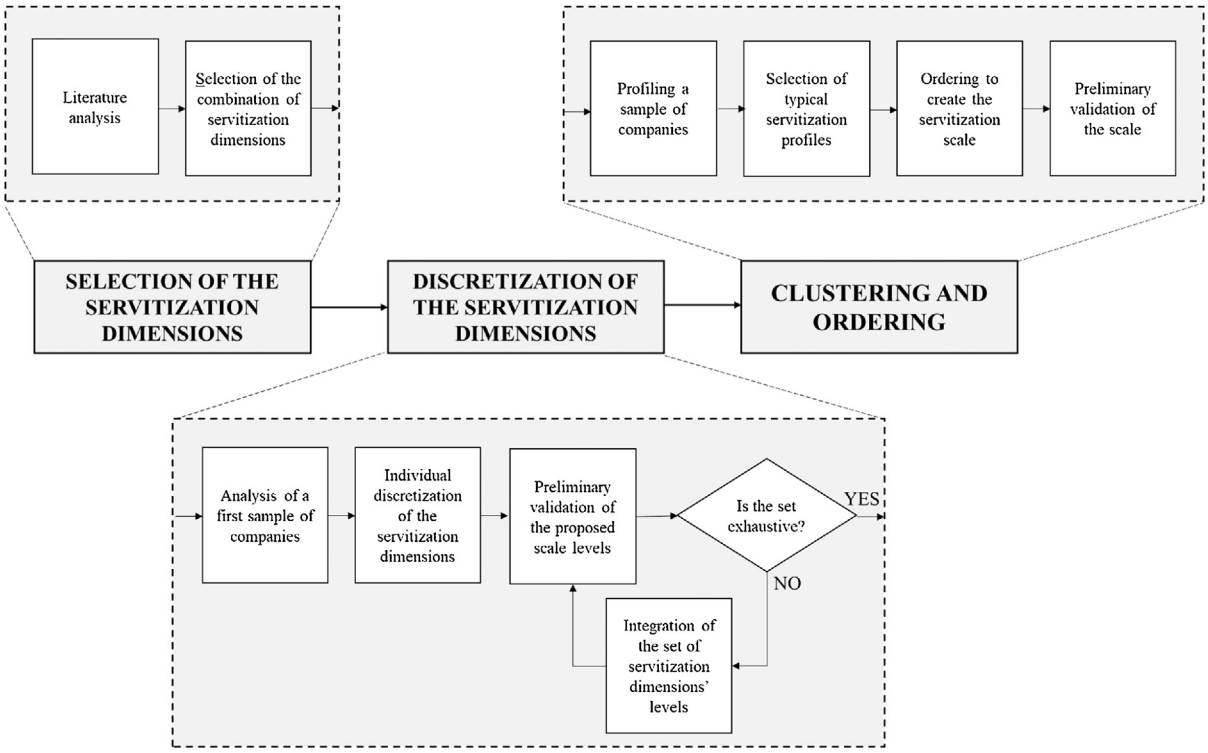


Fig. 1. Schematic procedure for the definition of the servitization scale.

Table 1
Servitization dimensions identified for the analysis and their relationship with the different decision levels in the enterprise.

Servitization dimensions	Description	Strategic	Tactical	Operational
Revenue strategy	The revenue strategy of a company encompasses its current revenue generation process and the plans for reaching long-term revenues goals.	X	X	
Design	This dimension reflects the objectives and objects of the design activities of a company	X	X	X
Organization	The prevalent focus of the corporate organization in term of function and business units	X	X	
Quality control and management	The main focus of quality activities		X	X
Customer relationship	The extent of interactions between a company and its customers		X	X

servitization process. A first sample of $n_1 = 50$ medium-large manufacturing companies was randomly extracted from the ORBIS database. For each company, a textual overview of the company's activities and businesses was provided merging information from different sources (ORBIS database, Chamber of Commerce, company's website, etc.) to identify the positioning of the company with respect to each of the dimensions of the analysis (see Tables A1 and A2).

An iterative procedure was then used to validate and possibly enrich the set of detected levels. At each iteration, a sample of $n_2 = 25$ medium-large manufacturing companies was randomly extracted. For each company, the focus group was required to indicate its position on the previously defined levels. The procedure was ended after two iterations, when no additional levels were identified. Final results are reported in Table 2 (Table B1 reports a complete description of all the dimension levels).

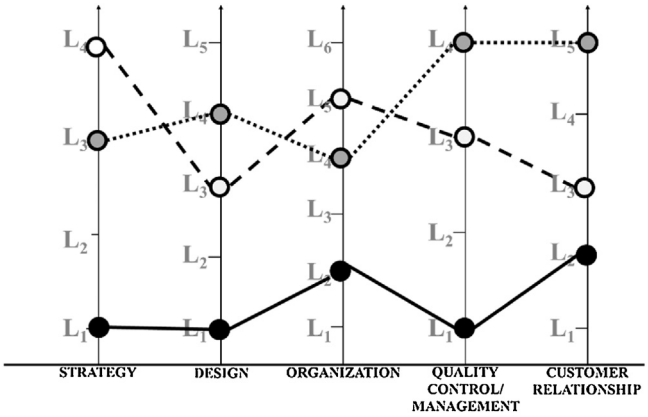


Fig. 2. Examples of servitization profiles.

Step 3: clustering and ordering

A third sample of $n_3 = 50$ manufacturing companies was again extracted from the ORBIS database. For each analysed company, a servitization profile is constructed, e.g. (L_2,L_2, L_3, L_2, L_3). As an example, Fig. 2 shows a series of servitization profiles related to three different companies.

Among the resulting profiles, the following clustering phase was aimed at identifying a set of typical profiles able to describe the most common servitization statuses. The final result was the identification of six different and ordered reference profiles defining the levels of the servitization scale (see Fig. 3).

Table 2
Servitization dimensions and relevant levels.

Servitization dimension	Dimension levels	Scale levels
Revenue strategy	• Product-based	L_1
	• Product and service oriented	L_2
	• Solution oriented	L_3
	• Functionality oriented	L_4
Design	• Product-centered design	L_1
	• Product oriented design	L_2
	• Service oriented design	L_3
	• Service-centered design	L_4
Organization	• Only production-related functions	L_1
	• Almost only production-related functions	L_2
	• Structure focused on manufacturing with a service business function	L_3
	• Balanced organizational structure between product and service functions	L_4
	• Service business functions are predominant	L_5
	• Only service-related functions	L_6
Quality control/management	• Exclusive focus on product technical requirements	L_1
	• Mainly focused on product technical requirements	L_2
	• Focus on product and service requirements	L_3
	• Focus on service requirements and service experience	L_4
Customer relationship	• Limited to the sale stage	L_1
	• Customer assistance and sale stage	L_2
	• Sale, assistance plus one additional PSS lifecycle stage	L_3
	• Sale, assistance plus additional PSS lifecycle stages	L_4
	• Covering all the PSS lifecycle	L_5

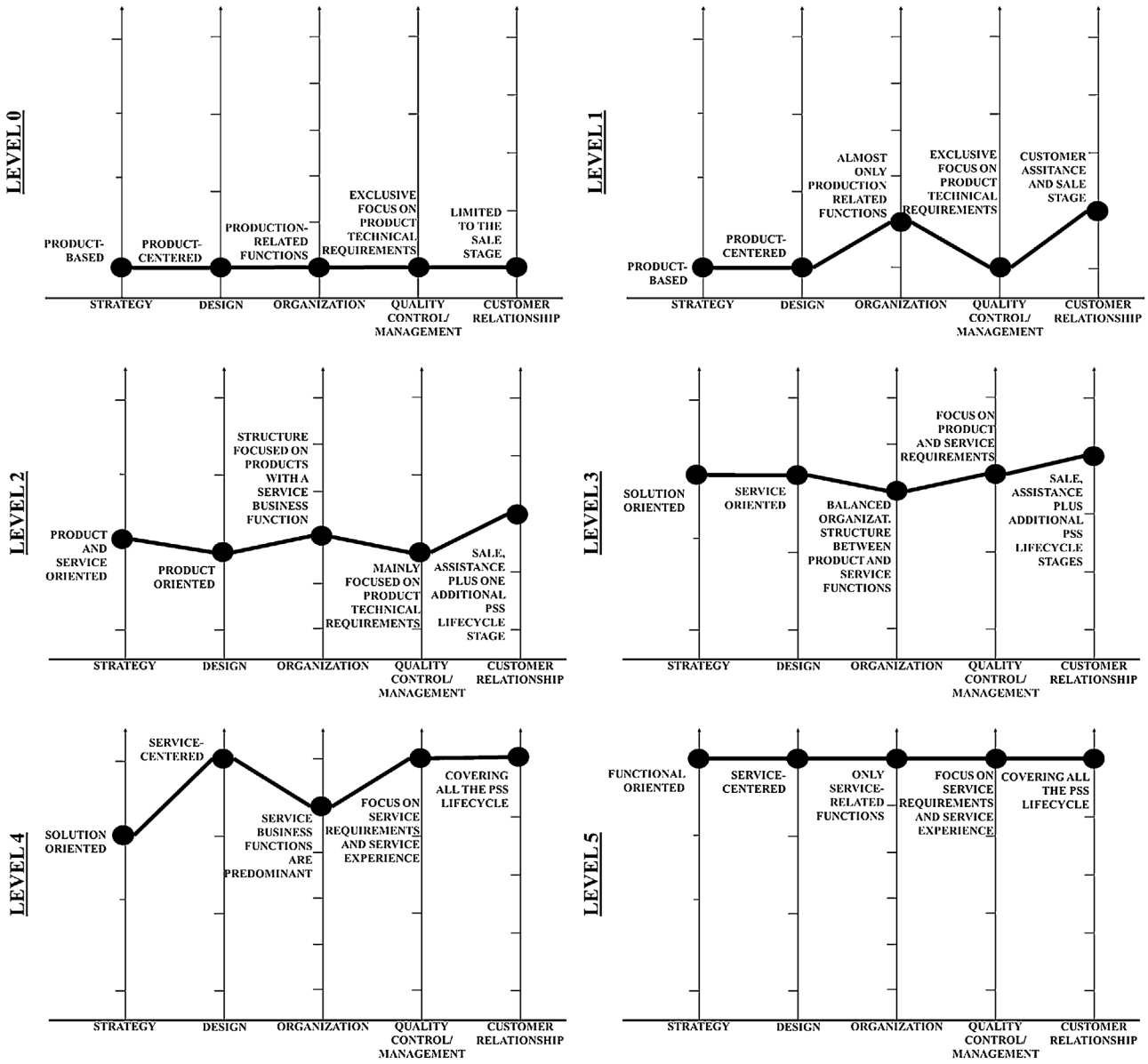


Fig. 3. Graphical representation of the six levels of the proposed servitization scale.

This outcome was experimentally validated on a final sample of $n_4 = 50$ companies, randomly extracted from the ORBIS database. Company information was used to build the servitization profile so as to check the exhaustiveness of the proposal.

It is clear that, being a selection of the most representative profiles, these six levels are not exactly representing all the possible company's profiles. In other words, it is perfectly possible to see intermediate profiles between two different levels. As an example, Tables A1 and A2 report the analysis carried out for two different companies. Being extracted from public sources, the information used in this analysis phase is of public domain and for this reason we have decided to expound the names of the companies exemplified. The servitization profile related to Ferrero S.p.A. (see Table A1) is aligned with Level 1 of the servitization scale. Concerning the second company, i.e. Cisco Systems Inc., the servitization profile is close to Level 2 of the servitization scale (see Table A2), with a small difference on the customer relationship dimension.

The servitization scale

In their study, Martinez et al. proposed the existence of a servitization continuum [29]. Following their considerations, we propose a servitization scale consisting of six levels, from the lowest – identifying pure manufacturing companies – to the highest – characterizing companies that abandoned the production physical products to devote to service provision. The extent of interaction between customer and supplier is the key factor considered to define the different servitization levels: increasing the servitization level means increasing the number of activities carried out at the interface between the customer and supplier. Table 3 summarize the six levels of the proposed scale.

The goal of the next sub-sections is to analyse each scale level trying to specify clear boundaries to facilitate researchers, managers, analysts and policy makers in the use of the scale.

For each scale level, details and practical examples are proposed. The examples portray real company scenarios as

Table 3
Servitization scale description. Type of outputs and company focus.

Scale levels	Level 0 Pure manufacturing companies	Level 1 Predominantly manufacturing companies	Level 2 Slightly servitized companies	Level 3 Moderately servitized companies	Level 4 Highly servitized companies	Level 5 Completely servitized companies
Level description	Manufacturing companies producing only physical products	Manufacturing companies producing almost only physical products	Manufacturing companies producing physical products and providing a category of product-related services covering a phase of the product life-cycle	Manufacturing companies producing physical products and providing more than one category of product-related services covering more than one phase of the product life-cycle	Manufacturing companies producing physical products and providing a number of categories of product-related services covering all the phase of the product life-cycle	Companies selling physical products or their use/result and providing number of categories of product-related services covering all the phase of the product life-cycle.
Outputs	Products	Products + mandatory standard services (i.e. Guarantee)	Products + one product-related service	PSS: products + product-related services	PSS: products + customized product-related services covering all the product lifecycle	PSS: products + customized product-related services covering all the product lifecycle. The production of the physical components of the PSS are typically outsourced.
Revenue strategy	Product-based	Product-based	Product and Service oriented	Solution oriented	Solution oriented	Functionality oriented
Design	Product-centered	Product-centered	Product oriented design	Service oriented design	Service-centered design	Service-centered design
Organization	Only production-related functions	Almost only production-related functions	Structure focused on manufacturing with a service business function	Balanced organizational structure between product and service functions	Service business functions are predominant	Only service-related functions
Quality control/ management	Exclusive focus on product technical requirements	Exclusive focus on product technical requirements	Mainly focused on product technical requirements	Focus on product and service requirements	Focus on service requirements and service experience	Focus on service requirements and service experience
Customer relationship	Limited to the sale stage	Customer assistance and sale stage	Sale, assistance plus one additional PSS lifecycle stage	Sale, assistance plus additional PSS lifecycle stages	Covering all the PSS lifecycle	Covering all the PSS lifecycle

described by interviewed managers and enriched with information from corporate web sites, and public databases. For confidentiality reasons, explicitly required by the responders, we decided to mention the companies through fancy names.

Level 0 — pure manufacturing companies

Level 0 of the servitization scale contains pure manufacturing companies, i.e. companies whose output consists of physical products exclusively. Such companies do not provide any kind of service directly. Any after-sales service, such as warranty repair is completely outsourced. Companies at Level 0 follow product-based revenue strategies, all profits are generated from the sale of their products. All the design activities are focused on the products. From the organizational viewpoint, such companies are composed of staff with skills related to the design and production of physical products. The goal of quality activities is exclusively to verify the compliance of production with the technical requirements defined by the design stage. The relationship with the customer is limited to the property sale. A consequence is a reduced information flow from customer to manufacturer. For the sake of clarity, Fig. 3 qualitatively compares the profile of the different servitization levels.

Alpha_Screw, a manufacturer of carbon and stainless-steel screws is an example of Level 0 company. It produces unified screws according to UNI EN, DIN and ISO standards. Customers can choose and order the desired product and its amount from the company's catalogue, thus the relationship with the customer is limited to the product sale phase.

Level 1 — predominantly manufacturing companies

Predominantly manufacturing companies are classified at Level 1 of the servitization scale. In addition to offering physical products, these companies internally deliver mandatory and standard services required by law, such as maintenance and/or replacement during the warranty period. Given the paucity of services, companies at Level 1 still follow product-oriented strategies: product design aims at achieving the optimal trade-off between production (and possible repair/replacement) costs and the costs for a better product quality. At this stage most of the profits are still generated by the sale of products. Quality activities are focused on the product rather than on the provided services. The customer relationship mainly coincides with the sale of the product. Sometimes, the relationship extends to the stages of customer assistance, in case of product malfunctioning.

Beta_lamps, a manufacturer of bed-side lamps is an example of Level 1 company. Also, customers choose and order the products from the company's catalogue. In case of problems during the warranty period, the customer may contact the company's customer service. The repairing of faulty products is managed by production staff. Customer service is handled by dedicated staff.

Level 2 — slightly servitized companies

Slightly servitized companies belong to Level 2 of the proposed servitization scale. Such companies combine product manufacturing with the delivery of a single generic typology of service. Typically, the service is related to the early stages of the product life

cycle, as it is for design, logistics, installation or training services. Given the service offer, such companies follow careful strategies of interaction with customers: already in the product design stage some aspects that will enhance and support the provision of the product-related service are taken into account. The revenue strategy is based on product sale and the offering of complementary services. The management of the service provision is typically demanded to a specific business unit which, sometimes, may not be well integrated into the organizational structure. The standard quality checks of the product are accompanied by structured controls on operations and results of the offered service. Through the service provision, the company can establish a relationship with the customer that goes beyond the pure product sale. The increased interaction allows the gathering of information that is used to improve business goals (i.e. marketing campaigns, product improvement, etc.).

Gamma_cycles, the manufacturer of professional cycle computers is an example of Level 2 company. Besides dealing directly with the production and assembly of the goods, the company ensures the maintenance and updating of the firmware and software.

Level 3 — moderately servitized companies

Moderately servitized companies match the production of physical products to the delivery of a plurality of services. They are classified as Level 3 companies. Customer selection is not only tied to the technical characteristics of the product, but also to the quality and variety of the offered services. Given the range of offered services, companies at Level 3 follow solution-oriented revenue strategies, their commercial offering is based on a bundle of products and services and revenues are generated from both. The design of PSS integrates both the product and the service perspective. The attention to the technical characteristics of the product is still very high, but services are an integral part of the project. Quality activities must consider the technical and functional characteristics of the products without neglecting the fulfilment of the services requirements. The relationships with customers are long-lasting and affecting more stages of the PLC. The growing number of activities carried out at the interface between provider and customer leads to an intensive exchange of information between the two parties over an extended time horizon.

Delta_mine, the manufacturer of machines and equipment for quarries and mines, is an example of company classified at Level 3 of the servitization scale. The company designs and realizes tailored plants according to customer's specifications, directly following the phases of transportation and assembly of its machines. It also deals with the setup phase and start of production. In case of need, a team of trained technicians can do troubleshooting or maintenance/repair operations.

Level 4 — highly servitized companies

Highly servitized companies, i.e. companies whose offering is characterized by a predominant service component, are classified at Level 4 of the servitization scale. Level 4 companies produce and provide products and services covering the entire PSS life cycle. Such companies may sell the good or its use to the customer, according to the type of contract. Most of the profits are generated from the provision of services, while products play a minor role.

The service offering allows a high customization of the PSS; its design is strongly result-oriented and applied technologies are considered only as a support. The competitive advantage does not derive only from the technical quality of the hardware components of the PSS, but from the ability to respond to customer needs through the provided services. Typically, business functions in charge of service provision are among the most important in the company. Quality activities are particularly focused on the assessment of service quality with a specific attention to service requirements and to customer satisfaction. The relationship with customers covers the entire life cycle of the PSS, from its design to its disposal. The constant flow of information throughout the PSS lifecycle can be profitably used for the improvement and design of new PSS generations.

Epsilon_robot, a company manufacturing industrial robots, is an example of Level 4 company. It designs, sets-up and manages automated production lines. Rather than buying the machines, its customers pay for their use. The company is responsible for all the related services: assembly, setup, personnel training, maintenance and eventually, their disposal. The customer does not obtain ownership of the asset but uses only the features and the offered services.

Level 5 — completely servitized companies

Completely Servitized Companies are companies that completely shifted from the production of physical products to the provision of services. These companies are classified at Level 5 of the servitization scale. Such companies can be defined as pure service-providers, simply differing from other service providers for their history and for the offering that reflects the characteristics of PSS: they offer PSSs whose physical production has been outsourced.

Completely Servitized Companies may retain the ownership of the PSS physical components, performing functions of customer's interest, financing the necessary investments, using their means and products, and dealing directly with their customers throughout and beyond the entire PSS life cycle. Business functions related to the provision of services are essential for companies at Level 5 of the servitization scale. The relationship with customers is constant and long lasting. Quality activities are focused on the assessment and control of the perceived service quality and the fulfilment of service requirements.

Zeta_security has been founded in the 90s as a manufacturer of video security systems, intrusion detection and access control systems. Over the years, the company diversified its product offering, including sale, installation, maintenance and updating activities in its portfolio of offered services. It also developed live video surveillance and private security services. In 2005, the company management decided to sell the business unit in charge of production to direct efforts and investments towards services. Today, the company buys the physical components of security systems from third parties, selling security services to its customers.

A case study: the overall Italian scenario of servitization

Relaying on personal, commercial and financial data provided by the AIDA database [63], this section proposes an analysis of the servitization level of medium and large size manufacturing companies in Italy according to the proposed scale.

Method of analysis

The data used in the presented study were drawn from the AIDA database. The AIDA database contains personal, commercial and financial data of about 1,000,000 companies registered in Italy [63]. Data were downloaded in March 2017. Only medium-large companies operating in the manufacturing sectors were considered, i.e. those with a number of employees greater than 50 and belonging to the NACE (Nomenclature statistique des Activités

économiques dans la Communauté Européenne) sectors classified with codes 10–32 [64]. These limitations resulted in a sample of 9615 companies.

In order to discriminate the service activities provided by each analysed company, we followed the guidelines proposed by Neely [5]. Since the AIDA database provides a textual overview of the core activities carried out by every indexed company, an automatic lexicographical search within the textual overview has been implemented.

Different sets of keywords have been defined to describe activities related to each Product-Related Service typology; according to the taxonomy reported in Table 5. To build the keyword list; the authors analysed 200 overviews randomly drawn from the sample of analysed companies; selecting those believed to be representative of nine different typologies of product-related service activities. After a preliminary selection; the list of keywords was then extended with variants and synonyms to get the final set. The same approach was used to define a list of keywords to describe manufacturing activities. We refer the reader to a previous work of the same authors for further details about the lists of keywords used for this study [2].

The search for keywords within the textual overview provided by AIDA allowed to identify the number of service typologies offered by each manufacturing company. Fig. 4 provides a schematization of the method. Inputs are the textual overviews of the company activities and the sets of keywords characterizing Product-Related Service typologies and manufacturing activities. Primary outputs of the classification method are: (i) the presence of manufacturing activities and (ii) the typologies of product-related services reported in the textual overview of the company.

Company classification rules

Two fundamental criteria differentiate and characterize the different levels of servitization: (i) the number of types of services that a company offers (according to the taxonomy reported in Table 6), and (ii) the stage of the Product Life Cycle (PLC) in which the services are located.

To automate the sample analysis and operationalize the definitions of the servitization levels, we introduced a set of classification rules. For each level of servitization, Table 4 shows the relevant rule. Since the textual overview of the firm contained in AIDA does not allow to discriminate between Pure (Level 0) and Predominantly Manufacturing Companies (Level 1), these two level have been merged.

In addition to these basic rules, two assumptions are introduced: (i) even if not expressly clarified in the textual overview provided by AIDA, companies that offer services related to the last phase of PLC are likely to offer services also during the previous PLC stages. Operatively this means that, for the purpose of this analysis, companies offering *Disposal and Conversion* services are considered to concurrently offer additional services; (ii) *Management and Operating services* are complex services, typically characterized by a variety of related services distributed along the entire PLC. Operatively this means that companies offering *Management and Operating services* are herein considered to be at Level 3 or greater of the servitization scale.

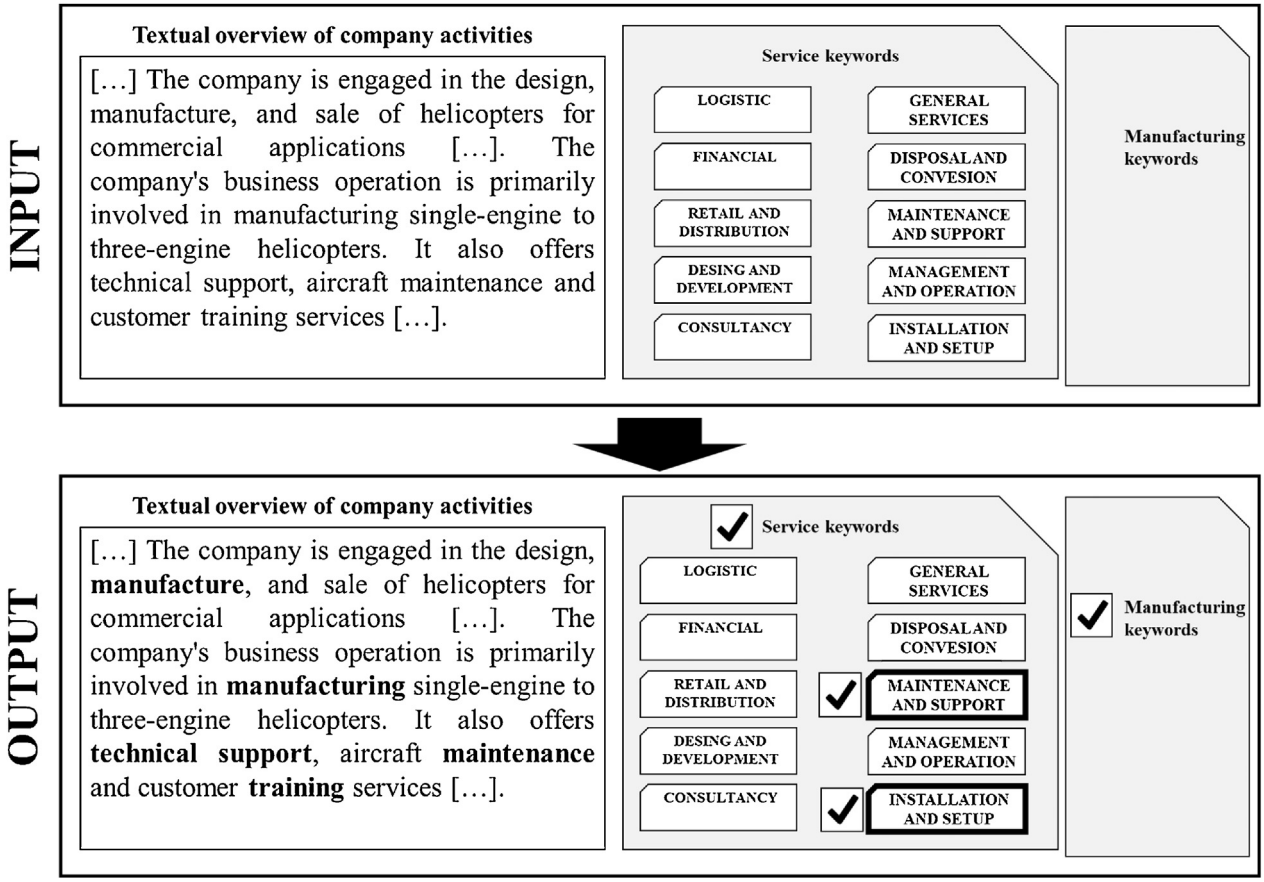


Fig. 4. Schematization of the classification method.

Table 4
Classification rules introduce to analyse the AIDA database.

	Rules of categorization
Level 0 & Level 1	All manufacturing companies that do not describe any service activity in their overview are classified in this category.
Level 2	All the companies presenting a single service typology in their description are herein classified.
Level 3	Companies offering two or three service typologies are classified as Level 3 companies.
Level 4	This category contains the companies that, in their overview, show evidence of more than three typologies of services.
Level 5	This level contains all the companies that besides presenting more than four typologies of services, do not include any evidence of manufacturing activities in their textual overview.

A reference framework for Product-Related Services

In a previous study, as a result of the analysis of secondary data concerning around 9000 manufacturing companies, the authors proposed a taxonomy of product-related services [2]:

- *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 labor 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 5, this taxonomy can be related to a selection of the most significant ones available in the literature [21,52,65,66].

Result analysis

By applying the classification rules spelled out in the previous paragraphs to the considered sample of manufacturing companies, a picture of the distribution of the servitization level can be obtained. The sample obtained is composed of 8269 medium (no. of employees between 50 and 250) and 1346 large (no. of employees greater than 250) companies. The sample covers more than the 90% of all the medium and large manufacturing companies in Italy. Fig. 5 shows that the 61% of companies can be classified as Pure Manufacturing Companies (Level 0) or Predominantly Manufacturing Companies (Level 1): their service offer is null or not detectable from database information. The remaining 39% of the companies provide a diversified range of services: the 24% of the sample is composed of Slightly Servitized Company (Level 2) and the 9% of the companies offers a broader range of services (Level 3). The remainder of the companies is highly focused on service-oriented strategies: the 4% of the sample is made of Highly Servitized Companies (Level 4), while about the 1% has abandoned the production of physical products to focus their business on the provision of services (Level 5 of the servitization scale).

The analysis shows that Italian manufacturing companies still have scope for service provision. Many manufacturing companies are characterized only by a limited range of services. The company size is certainly a key factor of servitization, probably because larger companies have economic and personnel resources that can be dedicated to service provision. Fig. 6 shows that half of the large manufacturing companies offers one or more types of services, compared to the 36% of medium size companies. This difference is even more pronounced when considering intermediate servitization levels (Levels 2 and 3) where the 45% of large size companies offers one to three types of product-related services.

The analysis also highlights different propensity to servitization depending on the commodity sector. As an example, Fig. 7 shows the distribution of the servitization level for companies belonging to three different NACE sectors: 13 (Manufacture of textiles), 28 (Manufacture of machinery and equipment) and 26 (Manufacture of computer, electronic and optical products). It is noteworthy how NACE 26 show a higher propensity to servitization than the other two sectors. We believe this is a factor of interest that companies that want to compete and excel in a given commodity sector cannot underestimate.

Operational use of the servitization scale

The above analysis provides an example of how the proposed servitization scale can be operatively used to construct a picture of the positioning of a given group of companies with respect to the option of servitizing and, as a consequence, offering more structured and complex PSSs.

The positioning analysis on the servitization scale can provide some technical views and lead to strategic perspectives:

1. it may be useful to better understand the reference market so as to detect any shortcomings, weaknesses or strengths compared to direct competitors. Do they offer different service typologies? Is the company (among the) leader(s) in terms of components of offered services?
2. If coupled with an analysis of the profitability of the PSS offering, the analysis of the servitization level of a set of companies may allow the determination of an "optimal" servitization level depending on the set of analysed companies. Does a higher servitization level necessarily mean better performance (in terms of profits, turnover, return on investments, etc.)?
3. The results of the profitability analysis can be used to define a strategic development trajectory designed to evolve and optimize the business offering. Should the company modify the service components of its PSSs or, its general service offering, in order to improve its performance? How?

Table 5
Relationship between the proposed and other taxonomies concerning product-related services [21,52,65,66].

Type of product related service	Mathieu [65]			Oliva and Kallenberg [21]				Tukker [52]			Gebauer [66]								
	Customer service	Product service	Service products	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	Prouct 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	

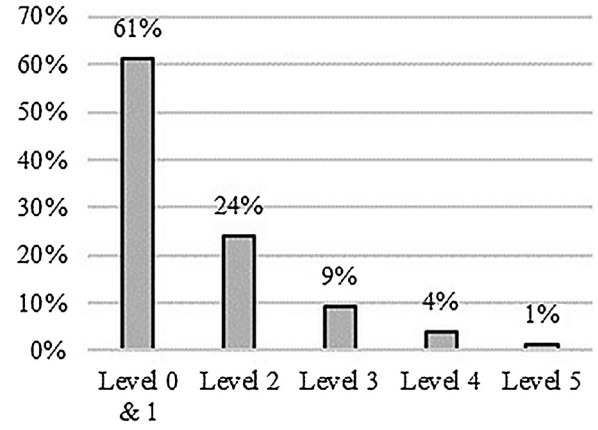


Fig. 5. Distribution of the servitization level in Italian manufacturing companies (sample of 9615 medium-large companies).

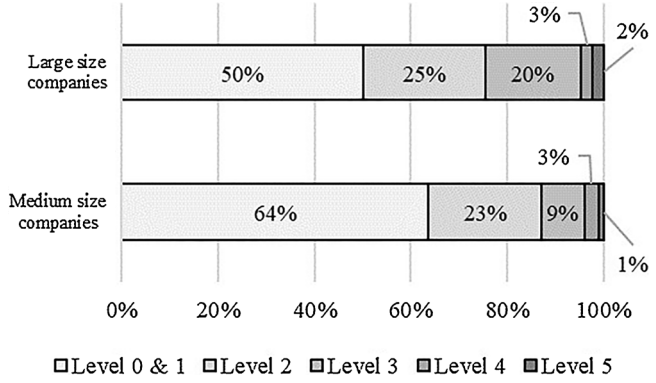


Fig. 6. Distribution of the servitization level of Italian manufacturing companies: the size of the company as a significant factor for servitization. The sample is composed of 5605 large size and 1346 medium size companies.

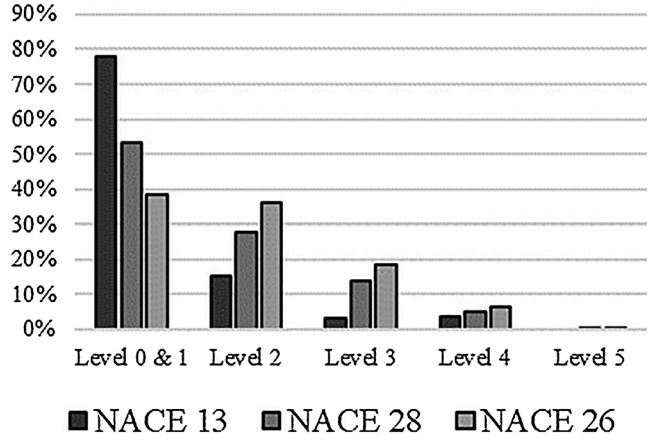


Fig. 7. Distribution of the servitization level depending on the commodity sector: NACE 13 (Manufacture of textiles, sample of 395 companies), NACE 28 (Manufacture of machinery and equipment, sample of 1664 companies) and NACE 26 (Manufacture of computer, electronic and optical products, sample of 320 companies).

The next sub-sections detail some possible applications of the proposed servitization scale.

Driving the service infusion process

The application of the servitization scale may drive manufacturing companies to analyse their internal organization taking into account the dimensions that mainly determine their servitization level. For this purpose, the scale gives a practical support to indicate internal areas that need improvements and to depicts the current status of a company and the future goals to be achieved. Much of the value of the application of this tool as support to drive the service infusion is to be found in the evaluation process that implies. This internal analysis may help manufacturing companies to: (i) assess the their current status according to the five servitization dimensions; (ii) identify specific targets to be achieved in order to optimize their servitization level and (iii) mapping their portfolio of offerings and distinctive activities. This information may be the basis for the development of new PSS configurations (for instance by means of the PROTEUS PSS Configurator). For example, Fig. 8 shows a clarifying example. The solid line represents the current status of the company, derived from an internal analysis of the dimension of the scale. While the dotted line represents the targets to be reached in order to advance the servitization level of the company. In this specific case can be seen that two of the three dimensions are in line with the objectives and the other two require investments and improvements.

Industry analysis

As showed in Section "The servitization scale", the scale may give a robust support for the analysis and representation of the servitization distribution of specific manufacturing sectors. This kind of analysis may be useful for: (i) policy makers and planners in order to measure the impacts of new regulations or incentives; (ii) new entrant or incumbent companies, that want to analyse the competitor's position and (iii) researcher, to characterize and measure the servitization level of a set of companies and to relate their servitization level to specific antecedents or barriers.

As an example, Fig. 9 shows the servitization level of a subsets companies that produce industrial packing settled in the northern and in the southern Italian regions of Italy. This graph shows a significant difference in the distribution pattern of servitization level between the two subsets. This exemplified evidence may support policy makers in the introduction of incentives aimed at optimizing the servitization level of the analysed industrial sector.

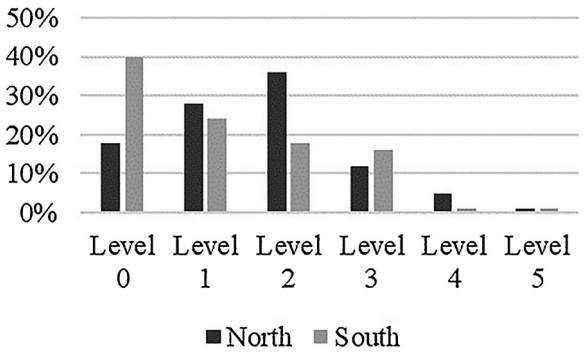


Fig. 9. Servitization level distribution of industrial packing manufacturing companies settled in the northern and in the southern Italian regions of Italy.

Company positioning

Another possible application of the proposed scale of servitization is the benchmarking of the servitization level of a company against other companies, e.g. selected based on common features, such as the specific niche market, size, geographic location. In general, given a subset of appropriately identified companies, it is possible to produce a positioning analysis which, coupled with an analysis of company profit data, can be used to support the strategic choices of the company management.

To date, there is no general evidence of a direct relationship between a company servitization level and its success, e.g. in terms of revenues or return on investments [20,67]. Each case is specific and must be adequately studied, for example (but not exclusively) by combining the positioning analysis with an indication regarding competitor companies' profitability, for example in terms of return on investments (ROI). As an example of qualitative analysis, Fig. 10 plots the servitization level vs. profitability for an explanatory set of companies. Each point on the graph indicates the position of a specific company.

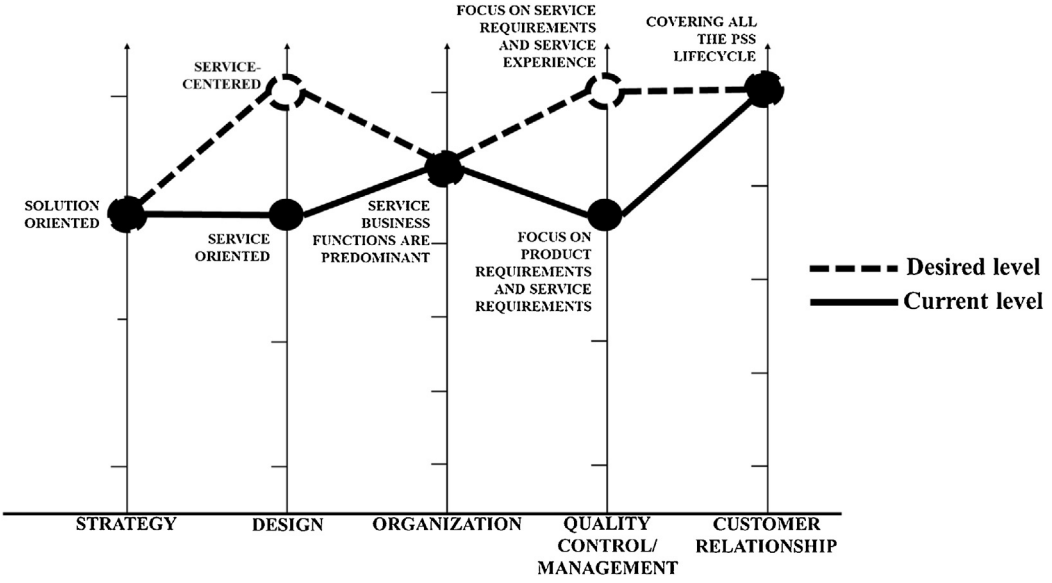


Fig. 8. Example of analysis of a specific servitization level (solid line) compared with a target servitization level (dotted line).

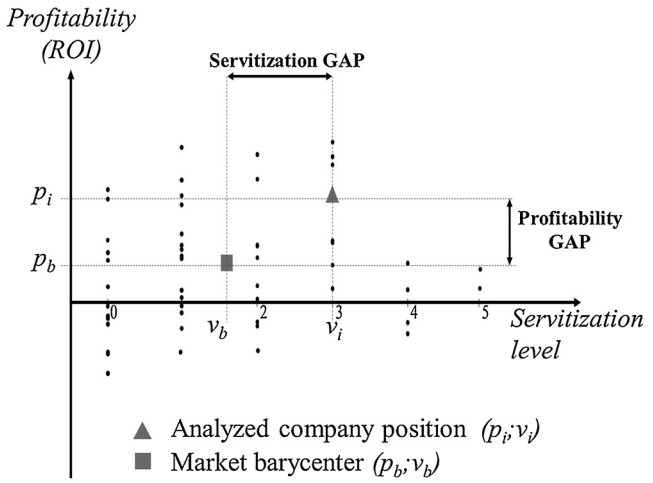


Fig. 10. Servitization level vs. profitability. This example refers to a subset of Italian companies in the Optical products sector (NACE 26). Data concerning ROI values were retrieved from the AIDA database [63].

The distribution of companies on this chart provides a picture of an industrial sub-sector in terms of its servitization level and its profitability with respect to the gain or loss generated on their investment (ROI). The position of a company can be related to that of the others, or, in general, to the position of the market barycentre (p_b; v_b):

$$p_b = \frac{\sum_{i=1}^{N}(n_i \cdot p_i)}{\sum_{i=1}^{N} n_i}, \quad v_b = \frac{\sum_{i=1}^{M}(m_i \cdot v_i)}{\sum_{i=1}^{M} M_i}, \tag{1}$$

where n_i and m_i are respectively the number of companies with profitability (p_i) and servitization level (v_i). As a result of such a comparison, two indicators can be obtained:

$$\begin{aligned} &Profitability\ GAP = (p_i - p_b), \\ &Servitization\ GAP = (v_i - v_b). \end{aligned} \tag{2}$$

These two indicators respectively indicate whether the company has a profitability and servitization level that differ from the market average. The joint information of these two GAPs could provide indications on the possible strategies to be undertaken: positive values of the profitability GAP indicates a good company positioning that needs to be managed; on the other hand, negative values of the profitability GAP suggest the opportunity to develop corrective actions, including possible modifications in the service offering.

Conclusion

This article provides a proposal of a scale to discretize the process of manufacturing servitization. A six levels servitization scale is identified to discriminate the status of a generic manufacturing company. Starting from the lowest level of scale that includes companies that do not provide any type of service, five other levels have been defined to segment the servitization continuum. Each level of the scale is differentiated according to the following dimensions: (i) revenue strategy, (ii) design focus, (iii) organization structure, (iv) quality control and management and (v) extent of the customer relationship. The use of the scale can be particularly useful for researchers, managers, analysts and policy makers in order to: (i) compare different companies; (ii) analyse specific commodity sectors; (iii) support companies in the identification of optimal business strategies, (iv) define improvement objectives, etc.

The scale use has been tested on a sample of Italian manufacturing companies producing some interesting outcomes: most of the analysed companies limit their offer to few categories of services and the range of services they offer depends on their size. The prevalent concentration (85%) of Italian manufacturing companies is concentrated on the first three level of the servitization scale (Levels 0, 1 and 2).

The scale proposed responds to the need for operational rules to univocally position a servitized (manufacturing) company within the servitization continuum. Despite the scale is defined to face a practical problem, it presents few potential limitations: (i) the assessment of the servitization level is charged to the evaluator and therefore subject to a margin of arbitrariness; (ii) the low resolution of the scale allows a preliminary rough classification of servitized companies only.

Future research will be spent on facing the above discussed limitations, trying to refine the resolution of the scale concurrently carrying out an in-depth validation of the scale.

Acknowledgement

This work has been partially supported by “Ministero dell’Istruzione, dell’Università e della Ricerca” Award “TESUN-83486178370409 finanziamento dipartimenti di eccellenza CAP. 1694 TIT. 232 ART. 6”.

Appendix A.

Table A1
Example of servitization analysis: the case of the Ferrero S.p.A. The textual description related to the servitization dimensions was obtained by merging information from different sources (e.g. ORBIS, company’s website and Chamber of Commerce).

Descriptive overview of the company		FERRERO – SOCIETA’ PER AZIONI	
Sector: NACE 10	Operating revenues: 3.371.471€	Number of employees: 1362	Country: Italy
ORBIS activity overview	The company is engaged in the manufacture of chocolate and other confectionery products. The company is considered as one of the world's largest chocolate producers, manufacturing approximately 100,000 tons of assorted products every year. The company manufactures a range of chocolate products, such as Kinder Sorpresa Eggs, a hollow egg-shaped chocolate with tiny toys inside; and Nutella chocolate and hazelnut spread. Its other product series under Kinder brand include Kinder Surprise, Fiesta Ferrero, Kinder Chocolate bars, Kinder Happy Hippo, Kinder Maxi, Kinder Délice and Kinder Bueno. The company also produces Mon Chéri chocolates and Pocket Coffee espresso-filled chocolates, Giotto, Ferrero Rocher chocolates, and Tic Tac breath mints. The company was founded by confectioner Pietro Ferrero in 1946. The company has opened a production facility in Brazil in 1997. The company is owned by the Ferrero family. Ferrero S.p.A. is based in Alba, Italy. It has operations worldwide and sells its sweets in the Americas, Asia, Australia, Europe, and the Middle East. Ferrero supports its international sales with a global network of 29 sales and 15 production subsidiaries. Four production sites are located in Italy (Alba), France, Brazil and the United States (New Jersey).		

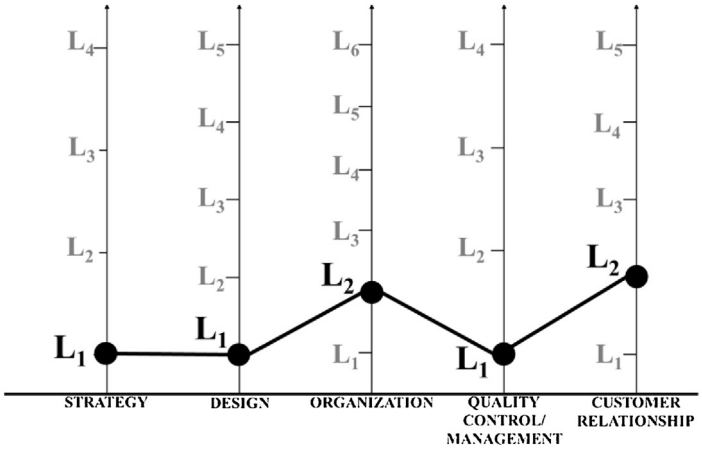
Servitization dimension	Textual description	Focus group evaluation
Revenue strategy	The company offers a wide range of chocolate products in all over the world. The features of the products limit the service offering to the mandatory services.	*Product-oriented (L_1)*
Design	Analysing the markets trends, the company has proposed innovative products. The design is driven by customers preferences.	*Product-centred (L_1)*
Organization	The organization is completely oriented to the production and distribution of chocolate products.	*Almost only production-related functions (L_2)*
Quality control and management	The main quality control operations are related to the raw materials used in the production and on the final products.	*Focus on product technical requirements (L_1)*
Customer relationship	There are few opportunities in which company's staffs directly meet customers.	*Customer assistance and sale stage (L_2)*
Servitization profile		

Table A2
Example of servitization analysis: the case of the Cisco Systems Inc. The textual description related to the servitization dimensions was obtained by merging information from different sources (e.g. ORBIS, company's website and Chamber of Commerce).

Descriptive overview of the company		Cisco Systems Inc.	
Sector: NACE 26	Operating revenues: 48.005.000 €	Number of employees: 72,900	Country: United States of America
ORBIS activity overview	Cisco Systems, Inc. designs and sells a range of products, provides services and delivers integrated solutions to develop and connect networks around the world. The Company operates through three geographic segments: Americas; Europe, the Middle East and Africa (EMEA), and Asia Pacific, Japan and China (APJC). The Company groups its products and technologies into various categories, such as Switching; Next-Generation Network (NGN) Routing; Collaboration; Data Center; Wireless; Service Provider Video; Security, and Other Products. In addition to its product offerings, the Company provides a range of service offerings, including technical support services and advanced services. The Company delivers its technology and services to its customers as solutions for their priorities, including cloud, video, mobility, security, collaboration and analytics. The Company serves customers, including businesses of all sizes, public institutions, governments and service providers. This company designs, manufactures, and sells Internet Protocol based networking products and services related to the communications and information technology industry. The company was founded in 1984 by a small group of computer scientists from Stanford University, and is based in San Jose, California, USA. The company is the worldwide leader in networking for the Internet. Its mission is to shape the future of the Internet by creating unprecedented value and opportunity for its customers, employees, investors and ecosystem partners. The company provides services associated with products relating to communications and information technology industry and its use. Its products are installed at corporations, public institutions, telecommunications companies, and businesses of all sizes and are also found in personal residences. The company also provides a line of products for transporting data, voice, and video within buildings, across campuses and around the globe.		

Servitization dimension	Textual description	Focus group evaluation
Revenue strategy	The company design and produce a wide range of technological networking products for the communications and information technology industry. In addition, the company offers a variety of related services including: advisory, technical support and assistance, training and product management, among others. The service offering is actually covering an important number of life-cycle's phases.	*Partially customer-oriented (L_2)*
Design	Hi-tech products of the company require attention to the design and the development of the hardware. Service importance is growing but the influence on product design is still limited.	*Service offering may affect design activities (L_2)*
Organization	The organigram of the company is structured as follows: an independent research and development area; two products-related business areas for big size companies and for medium/small business; one services business area. Is interesting to emphasize that Product-oriented business areas are also categorized on the basis on the type of customers.	*Structure focused on manufacturing with a service business unit (L_3)*
Quality control and management	As stated by the company, its approach to quality can be condensed down to one phrase "ensuring our customer success". Quality management is highly customer-focused in all the departments. The property of durability, reliability, security, environmental impacts, etc. are continuously verified.	*Focus on product technical requirements and customer satisfaction (L_2)*
Customer relationship	The company provides a wide range of services. The relationships cover a lot of the life-cycle phases of the products. for big company also in some initial phases concerning design of specific solutions.	*Sale assistance plus PSS lifecycle stages (L_4)*

Table A2 (*Continued*)

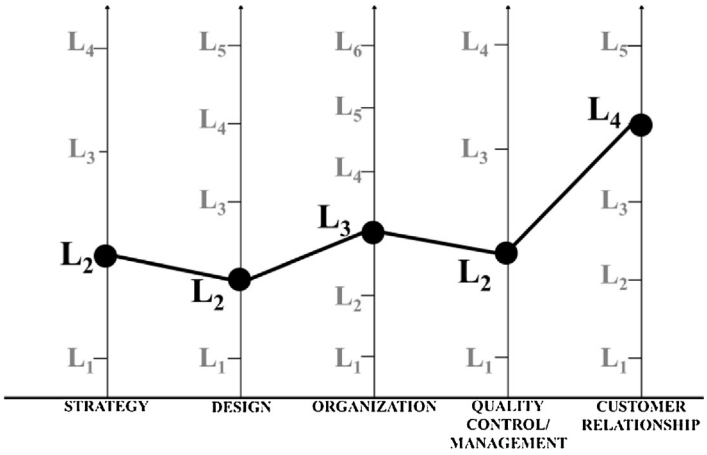
Servitization dimension	Textual description	Focus group evaluation
Servitization profile	**Servitization profile**	

Table B1
Description of the dimension levels of the servitization scale.

Servitization dimension	Dimension levels	Scale levels	Description
Revenue strategy	• Product-based	L_1	Revenue strategy based solely on the product sales.
	• Product and Service oriented	L_2	Revenue strategy based on product sales and on the offering on complementary services.
	• Solution oriented	L_3	Commercial offering based on a bundle of products and services.
	• Functionality oriented	L_4	Products are marginalized in the revenue strategy; the main source of revenue are the provision of specific outcomes.
Design	• Product-centered	L_1	All the design activities are focused on the products sold by the company.
	• Product oriented design	L_2	Products remains the focus of the design activities of the company, but the provision of complementary services may affect the definition of some product feature.
	• Service oriented design	L_3	The design starts with the definition of service requirements, product specifications need to be adapted to the service operation and to the service desired outcomes.
	• Service-centered design	L_4	Products are marginalized, often it is possible to assist to a commoditization of the product component of the market offering. All the design activities are focused on service design.
Organization	• Only production-related functions	L_1	The organizational structure of the company is solely composed of technical and production-related functions.
	• Almost only production-related functions	L_2	The organizational structure of the company is mainly composed of technical and production-related functions, there are few subordinate entities associated to the provision of services.
	• Structure focused on manufacturing with a service business function	L_3	Product-related function maintains the central role in the organizational structure, but an independent service business unit is mandated to manage the service provision and operations.
	• Balanced organizational structure between product and service functions	L_4	In the organizational structure both product and service related functions are identifiable. Powers and duties of the two kind of functions are balanced and they cooperate to offer bundles of products and services.
	• Service business functions are predominant	L_5	The organizational structure of the company is mainly composed of service-related functions, there are few subordinate entities associated to the manufacturing of products.
	• Only service-related functions	L_6	The organizational structure of the company is solely composed of technical service-related functions.
Quality control/ management	• Exclusive focus on product technical requirements	L_1	Quality control are exclusively aimed to verify the compliance with the product technical requirements.
	• Mainly focused on product technical requirements	L_2	Quality control are mainly aimed to verify the compliance with the product technical requirements, few controls are in place to verify the quality of the service provision.
	• Focus on product and service requirements	L_3	Both service and product quality controls are considered significant by the company. They receive a balanced allocation of resources in support of their activities.
	• Focus on service requirements and service experience	L_4	Quality control are exclusively aimed to verify the compliance with the service requirements and to provide a superior service experience.
Customer relationship	• Limited to the sale stage	L_1	Interactions between the manufacturing company and their customers is limited to the sale stage, further interactions are extremely rare.
	• Customer assistance and sale stage	L_2	The provision of complimentary after sale services allow the establishment of customer relationships that in some case exceed the sale stage.
	• Sale, assistance plus one additional PSS lifecycle stage	L_3	The interactions between customer and company exceed the sale stage, their interactions are considered significant and persistent in a stage of the PSS lifecycle.
	• Sale, assistance plus additional PSS lifecycle stages	L_4	The interactions between customer and company exceed the sale stage, their interactions are considered significant and persistent many stages of the PSS lifecycle.
	• Covering all the PSS lifecycle	L_5	The magnitude and the quality of the customer relationships is the core focus of the company that support the customers in all the PSS lifecycles.

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