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Changes in the intellectual basis of servitization research: A dynamic analysis

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ABSTRACT

The aim of this paper is to identify the changes in the intellectual structure of research on servitization between 1980 and 2015 by using a proven methodology such as bibliometric technique. The results show that the provision of services in any organization is taking on greater strategic importance. This paper contributes to understand how this topic has evolved thus completing the investigation carried out by other authors. It also highlights the research lines that have been developed until now and the future directions for servitization research.

1. Introduction

Servitization is the process of increasing value by adding services to products (Vandermerwe and Rada, 1988). It is a means of creating value added capabilities that are distinctive and sustainable in comparison with those of competitors (Baines et al., 2009). The process of servitization is the innovative development of an organization's capabilities in the sense that rather than merely offering products it can provide customers with complete product-service systems (Neely, 2008; Visnjic Kastalli and Van Looy, 2013). Competing strategically through the provision of services is becoming a distinctive feature of innovative manufacturing firms (Lightfoot et al., 2013). The provision of products into which services have been integrated is the means adopted by many enterprises to differentiate themselves from their competitors and obtain a competitive advantage. There is consequently a growing interest in the role these services play in maintaining the competitiveness of manufacturing companies, and this has led to the appearance of a series of research works analyzing the academic literature, with the intention of evaluating the state of the art, identifying the advances made, and proposing future research agendas (Cavalieri and Pezzotta, 2012; Beuren et al., 2013; Bustinza et al., 2017a,b).

It may be posited that as a discipline advances, thanks to the contribution made by researchers proposing original theories and novel concepts, academics commonly examine the state-of-the-art through literature reviews, seeking to understand the impact that specific contributions have made to the subject. Hence it is no surprise that several literature reviews have been published, to which we shall refer in due course, designed to identify and analyze the main research streams in servitization. These reviews have adopted a qualitative approach. In other words, the studies that analyze each one of the literature reviews have been chosen based on the expert knowledge and critical judgement of the scholars conducting the review.

Specifically, Baines et al. (2007); Beuren et al. (2013) and Sakao et al. (2009) examine how the literature characterizes the concept of product-service systems (PSS) in terms of scope and content. Baines et al. (2009) classify the studies on servitization and

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hybrid value creation (respectively) according to the key themes they address. Similarly, Lightfoot et al. (2013), identify the themes that are of greater interest for different research communities involved in servitization-related studies.

Beyond previous reviews on the state of the art in servitization, Baines et al. (2017) develop a plan for practitioners seeking to servitize. For this, they review the literature to identify what has been published. Databases were identified to cover the broad range of relevant research communities comprehensively (these included Scopus, Web of Science, among other). Then they used a simple grading system to rank papers according to the extent to which they address servitization, and associated topics of PSS and advanced services. Identify 232 articles.

Brax and Visintin (2017) focus on the path or process by which manufacturing companies transition to service business. (p. 20) "the main goal was to identify original patterns of servitization-related organizational < transition > ". To this end, they review the literature to identify what has been published on the subject. For this they analyzed all major article databases (Ebsco, Emerald, ProQuest, Sage, Science Direct, Springer and Taylor & Francis) in Febrery 2015. The first coding round focused on identifying servitization related content, possible transition patterns, requirements for servitization and 'in servitizing', and different configurations of offerings such as integrated solutions. 154 articles, according to the authors' opinion, provided an original model of servitization as organizational transition were thus identified as the 'core articles' in the data-set. The work maps most of the models and examples that have appeared in the scientific literature.

Few authors have incorporated other novel approaches to literature reviews as Luoto et al. (2017) or Rabetino et al. (2017).

Martín-Peña et al. (2017) identify the studies and disciplines that have had the greatest impact on servitization among manufacturing firms, with a view to illustrating the intellectual structure of this discipline. This article is based on bibliometric techniques of citations and co-citations. As it can be seen, all reviews of literature − whether qualitative or quantitative − begin by identifying what is published on the subject under analysis. In reviews of the literature in which qualitative methods are used, it is the researcher who determines the relevance of each document unlike what happens in a bibliometric analysis of cities and co-cities in which the relevance or influence of a document is determined from the analysis of co-citation.

In short, only one study has been published that uses bibliometric analyses (Martín-Peña et al., 2017), in which a future line of research involves the need to analyze the intellectual structure of servitization from a dynamic perspective. With the exception of Kowalkowski et al. (2017) that analyze the evolution of the research on service growth, but without using bibliometric techniques.

In order to cover this gap, the aim here is to identify the changes that happened in the intellectual structure of research on servitization. With this purpose in mind, we have studied the evolution of the literature on servitization using bibliometric techniques. The bibliometric techniques used in this paper are known as citation and co-citation analysis. This paper therefore complements prior reviews. In this study, we gain a better understanding of the nature and evolution of extant servitization-related research thanks to the use of bibliometric techniques.

Bibliometric analysis applies a set of quantitative methodologies based on statistical analytical techniques and social network techniques, considering an analysis of the co-citations made in scientific articles. The analysis of co-citations is an effective methodology for the detailed mapping of the relationships between the core ideas of a particular scientific domain, and also serves to identify the scientific articles that are fundamental to the respective scientific field (Ferreira et al., 2016). Citation and co-citation analysis are based on the premise that authors cite documents they consider to be important in the development of their research. Therefore, frequently cited documents are likely to have exerted a greater influence on the discipline than those less frequently cited. The consensus in the previous literature, apparent in the structure of co-citations, permits identifying what has been referred to as a discipline's knowledge base or intellectual structure. An analysis of co-citations reveals a discipline's intellectual structure in an objective manner, as it allows empirical verification and replication.

In sum, this paper contributes to servitization literature in a number of ways. First, we identify four subperiods, identifying in each one the main clusters of servitization. This can help servitization scholars become more aware of the sub-fields of research and encourage more collaboration between researchers. Second, a study is made of the changes that have taken place in the paradigms that have informed the research on servitization over time. Third, the study aims to establish future research directions for servitization. This should provide some fresh insight and contribute further understanding about servitization research. Finally, this work contributes by filling a gap in the literature with the intention of providing a robust review and synthesis of the previous literature on servitization.

This work is structured in three sections, the first section provides a description of the methodology used, with the aim being to identify the most influential documents and their evolution over time by means of an analysis of cites and co-citations. The second section presents the results of an empirical study and its discussion. Finally, the conclusions, limitations, and future lines of research are covered in the last section.

2. Research methodology

The procedure followed to develop this analysis consists of four steps: i) identification of the scientific studies published on servitization in the period analyzed; these documents comprise the so-called citing sample, ii) establishment of the subperiods of analysis, iii) identification of the intellectual structure of each subperiod, and iv) analysis of the intellectual structure's changes in influence on servitization.

Once the scientific studies on servitization have been identified and the subperiods of analysis established, the next step involves using the articles published in each stage to study the bibliographical references that the articles cite through an analysis of co-citations. The analysis of co-citations has been one of the more widely used bibliometric methods in recent decades when presenting the intellectual structure of a field of research (Sánchez-Riofrío et al., 2015). Furthermore, the analysis of social networks has enabled

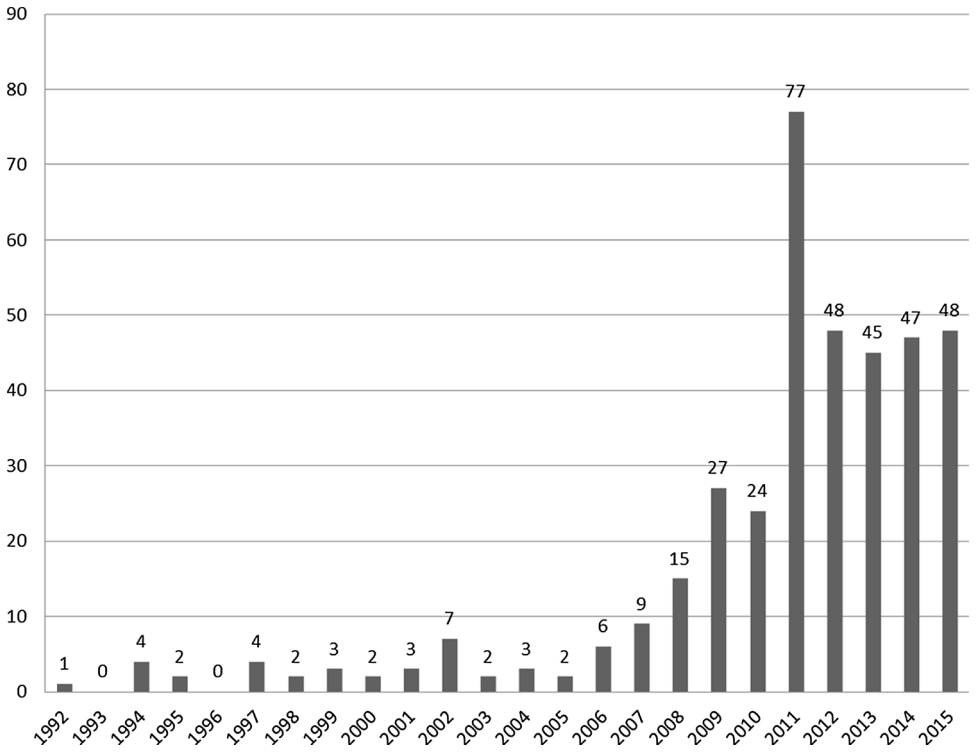

Fig. 1. Evolution of the number of publications in the WoS between 1992 and 2015.

us to represent the intellectual structure in each subperiod, and the factor analysis has rendered it possible to identify different clusters or sub-fields of knowledge, with all this helping to recognize the underlying intellectual structure in each subperiod, as a prior step to the analysis of the changes in influence of the sub-fields of knowledge over time.

2.1. Identifying the scientific studies published on servitization: choice of keywords

The term servitization was coined by Vandermerwe and Rada in 1988, and it has given rise to an extensive series of concepts and related terms. As a first step, and with the intention of recovering the documents published on servitization in the WoS, we proceeded to identify other keywords related to the term by beginning the search in the main collection of the WoS for the entire time period covered by the databases. We have followed the same procedure used by Martín-Peña et al. (2017: 84ö85); resulting in a total of 21 keywords that conformed the terms for the search of the relevant literature.

We then proceeded to identify in the WoS (not including proceedings[1] which are not indexed) all the documents published up to December 2015 that contain at least one of these terms in the title, keywords or abstract.

The search process provided a total of 381 documents. Fig. 1 graphically shows the number of servitization published documents over each year.

2.2. Establishing the subperiods of analysis

No documents on Servitization were published in the WoS before 1992, so this year was therefore used to launch the timeframe for the analysis. A study of the lifecycle of research on Servitization shows that there was a jump in the annual number of papers published in 2006 (see Fig. 1).

Various subperiods of analysis were then formed with a view to analyzing any influential changes that had taken place. These subperiods were 1992 (the year in which a document on Servitization was first published in the WoS) to 2005, 2006–2008, 2009–2011, and 2012–2015. These four subperiods correspond to the various stages of development of the research on Servitization. Thirty-five papers on Servitization were published in the WoS between 1992 and 2005, i.e., a period of 14 years. This represents an annual average of 2.5 publications for the subperiod in question − which could be considered an incubation period. The number of publications grew between 2006 and 2008, when an average of ten documents were published per year, suggesting that Servitization was beginning to gain importance, now entering a period of initiation. The 2009–2011 period was one of rapid development, with an average of 43 documents published per year, with the maximum number (77) recorded in 2011. The period from 2012 to 2015 was a time of stability and consolidation, with an estimated average of 46 publications per year. This interval of 25 years is considered adequate, since it constitutes an important segment of time that has witnessed the stages of growth and maturity of an academic

discipline (Ronda-Pupo and Guerras-Martín, 2012).

These subperiods are similar to those set by Kowalkowski et al. (2017) in their analysis of the evolution of research on service growth in product firms for articles indexed in Scopus. These authors identify a first subperiod setting the boundaries, which in our work we have called "incubation", a second subperiod of emergence, which in our study we differentiated between "initiation" and "development", for the reasons indicated above, and a third established subperiod, which in our work we call "consolidation".

2.3. Identification of each subperiod's intellectual structure

2.3.1. Analysis of co-citations

The documents published in each subperiod ("citing sample") were used to create a new file −henceforth referred to as the "citing sample"- which contains all the bibliographic references cited, with the aim being to create the matrix of co-citations for each one of the subperiods.

The references cited were examined through a co-citation analysis, which was based on the number of times that each possible pair of bibliographic references were cited together[2]. It may therefore be deduced that the more often two papers are cited simultaneously, the more closely related they are to each other as regards their contribution to the topic in question. The co-citation matrix for each one of the subperiods were created using BibExcel software.

2.3.2. Analysis of social networks

Based on an analysis of co-citations from the previous stage, network theory was used to identify the most cited documents that form the core of the network of cited documents.

Newman (2003:2) defines a network as "a set of items, which we will call vertices or sometimes nodes, with connections between them, called edges". Systems taking the form of networks (also called "graphs" in much of the mathematical literature) abound in the world. Examples include the internet, the World Wide Web, social media, or other connections between individuals, organizational networks or networks of citations between papers, and many others (Newman, 2003). Typical social network studies address issues of centrality (which individuals are best connected to others or have the most influence) and connectivity (whether and how individuals are connected to one another through the network). Network analysis techniques have been used in this study, as they enable the determination of the centrality indices for nodes (bibliographic references).

The measure of centrality is understood to be a set of algorithms calculated in each network. It enables us to know the position of the vertex inside the network, as well as its structure. The measure of centrality used in this study is closeness centrality. The indicator of the degree of closeness (or centrality) of each node enables the identification of the publications with the greatest impact, measured by closeness. It involves an agent's proximity, or closeness, to all the other agents that make up the network. The measure of centrality allows us to obtain the centrality of every key term (bibliographic references) in relation to the distance to all other key terms in the network.

In other words, according to the concepts of network theory, most networks contain nodes (individuals, organizations or bibliographic references) that are central because their position provides them with better access to information and a greater opportunity to use it.

Note that the nodes' closeness values can range from 0 to 0.95, and in this case the first threshold consists of documents with closeness values of 0–0.31, the second of documents with values of 0.32–0.63, and the third of documents with values from 0.64 to 0.95 (Ronda-Pupo and Guerras-Martín, 2010). So, we can define which are the most influential documents or central documents, the least influential or peripheral documents and those of a medium relevance or semi-peripheral documents. Thus, the high or low relevance of each bibliographic reference in the configuration of academic thinking is determined. This analysis is performed in each of the periods.

That is, considering that the closeness values of the nodes (bibliographic references) are within a range that changes from one temporal subperiod to another, the range for each subperiod was stratified as follows:

Maximum closeness of subperiod j: Max_j

Minimum closeness of subperiod j: Min_j

$Max_j - Min_j = D_j$

Total distance subperiod j: D_j

The first threshold contains those papers that belong to the network's periphery, recording values for the degree of centrality of between Min_j and $[Min_j + (D_j/3)]$. The works belonging to the network's semi-periphery are placed within the second threshold, with their degree of centrality ranging from $[Min_j + (D_j/3)]$ to $[Min_j + 2*(D_j/3)]$. Finally, the third threshold contains those works that lie at the heart of the network, with degrees of centrality ranging between $[Min_j + 2*(D_j/3)]$ and Max_j.

The number of references cited more than once and which constitute the core of the co-citation network varies from one period to another. Each value represents a node's contribution to the network, which means that the higher a document's degree of centrality, the greater its importance in the network. The results of the analysis of centrality are graphically depicted using the UCINET software package and NetDraw (Borgatti, 2002).

2.3.3. Factor analysis for each subperiod

The co-citation matrix was used to carry out a factor analysis for each one of the bibliographical references (cited sample) that occupied the highest positions of centrality in the co-citation network. The factor analysis conducted using the co-citation matrix allowed us to determine the references that were grouped together. In this study, a factor analysis was carried out for each subperiod

Table 1
Descriptive statistics.

Subperiod	Number of different references	Number of references that have been cited more than once	References closeness range		Range core network		Number of references that have been cited more than once and that are located in the core of the network
			Maximum	Minimum	Maximum	Minimum	
1992–2005	1094	41	6.667	3.777	6.667	5.703	25
2006–2008	995	65	67.368	35.556	67.368	56.764	7
2009–2011	5059	628	85.656	26.038	85.656	65.783	2
2012–2015	7471	1028	77.334	21.382	77.334	58.683	38

using varimax rotation for variables with a load factor of at least | ± 0.7|. In specific studies on the co-citation analysis White and McCain (1998) recommend the use of a load factor of more than | ± 0.7| when the aim is to clearly identify the subject matters of the factors to be analyzed. This enabled us to identify the intellectual structure of the research in each subperiod by means of its component factors.

2.4. Analysis of changes in influence

Once the factors, or intellectual structure of the research, had been identified, we analyzed the behavior patterns in each subperiod, which allowed us to describe the evolution of the intellectual structure of the literature on servitization. This involved following the logic of the procedure developed by White and McCain, (1998), which enabled us to distinguish various behavior patterns.

3. Results and discussion

This section shows the results obtained in accordance with the methodology followed, which has been explained in the previous section. The cited sample for each one of the subperiods identified was used to analyze the changes in the intellectual structure and the evolution of the research on servitization. The most influential bibliographic references in each subperiod were therefore grouped according to the position they occupied in the co-citation network. The factors were also analyzed, after which the references in each stage were classified, as was their corresponding importance. The bibliographic references with the greatest level of centrality in each subperiod are presented in Table A1 in Appendix A.

A review was conducted of the 30 references with a higher degree of closeness in each one of the subperiods, with the exception of the last stage, in which the review involved the 38 references that make up the core of the network of co-citations. Table 1 provides the descriptive statistics for each one of the subperiods in terms of the references' indicators of closeness.

A preliminary analysis of these data led to the discovery of one aspect that should be emphasized, as only one reference appeared in all four stages, which was specifically the one made to Goedkoop et al. (1999). This makes sense, as it was the first work on the concept of PSS companies, with these companies seeking to improve their performance and pay more attention to their customers.

The results of the sample's factor analysis for each stage, along with the results that allow a comparison to be made of the analysis of the intellectual structure, are shown below in order to identify current tendencies in the literature on servitization. A description is also presented of the content of the factors explaining the highest percentage of variance in each stage and the publications with the highest load factors. The results of the factor analysis for each one of the stages are summarized in Table 2.

3.1. First stage of research on servitization (1992–2005): incubation period

The period between 1992 and 2005 is the incubation period for research on servitization. Fig. 2 shows the composition of the 30 works with the highest degree of centrality. In this period, the 30 works form the core of the co-citation network, thus representing the multidisciplinary and incipient nature of this research. Those which stand out are the works by Stoughton et al. (1998), Charter and Tischner (2001), Friend (1994), and Stahel and Giarini (1989), which have the highest centrality index. The factor analysis identified four factors that explain 77.8% of the variance in this period.

The first factor, which we have called **'Service Engineering',** explains 40% of the variance, and groups together 15 of the 30 papers comprising the co-citation network. These works analyze the effect of information technology (IT) and technological change. Rayport and Sviokla (1995) emphasize the importance of using IT to provide customers with greater value when it is combined with traditional processes, while Dosi (1982) and Micheline et al. (1994) analyze how technological change and technological innovation improve with IT when applied to production processes. Scherer (1999) goes even further by considering the importance of technology in company growth and development, as it facilitates the provision of new products and services (Hirsch and Eschenbächer, 2000; Griliches, 1992).

The second factor involves those papers that for the first time seek to incorporate services into the context of industrial enterprises, and we therefore call it **'Service Strategy in Industrial Companies'**. The importance of this factor is that it establishes the basic principles of the service-oriented strategy, following a strategic management and marketing approach. From a strategic perspective, it identifies the orientation of services within the company's strategy and according to its results (Bowen et al., 1989; Morris

Table 2
Explained variance by stages.

Factor/Label	Focus	No. of docs by stage and factor	Initial Eigen-Values Total	Sum of the saturations to the square of the rotation		
				Total	% of the Variance	% Accumulated
Stage 1: 1992–2005						
Service Engineering	Information Technology	15	17.543	12.000	40.00	40.001
Service strategy in industrial companies	Management/Marketing	6	3.332	5.158	17.19	57.194
Sustainability	Environment	7	1.287	4.222	14.07	71.266
Service innovation	R + D	2	1.172	1.954	6.51	77.780
Stage 2: 2006–2008						
Service strategy in industrial companies	Management/Marketing	15	11.539	8.397	27.98	27.989
Integrated solutions strategy	Management	4	3.873	4.303	14.34	42.334
Product-Service Systems (PSS)	Operations management	5	3.298	3.882	12.93	55.273
Sustainability	Environment	3	2.475	3.152	10.50	65.780
Service Engineering	Information Technology	3	1.309	2.759	9.19	74.978
Stage 3: 2009–2011						
Co-creation	Marketing	14	9.811	9.585	31.95	31.951
Integrated solutions strategy	Management	9	7.118	5.745	19.15	51.103
Product-Service Systems (PSS)	Operations management	6	3.432	4.684	15.61	66.716
Service dominant logic	Marketing	1	1.361	1.423	4.744	71.460
Stage 4: 2012–2015						
Integrated solutions strategy	Management	20	12.187	12.187	40.62	40.622
Product-Service Systems (PSS)	Operations management	7	5.297	5.297	17.65	58.278
Co-creation	Marketing	1	1.452	1.452	4.84	63.120
Service dominant logic	Marketing	2	1.277	1.277	4.25	67.378

and Davis, 1992). The marketing approach, however, analyzes the incorporation of services from the customer's point of view, focusing on perception and value creation as regards the quality of the service (Anderson and Narus, 1995; Parasuraman et al., 1988).

The third factor incorporates papers related to Environmental Management and sustainable development, and we have therefore called it **'Sustainability'**. These works follow an Environmental Management approach, and present research concerned with sustainable production, emphasizing the importance of dematerialization and the production of services as a means towards business growth that is concerned about its impact on the environment (Popov and DeSimone, 1997; Stahel, 1997) and the creation of an institutional framework (Hinterberger and Luks, 1998).

The fourth factor is composed of the works by von Weizsäcker et al. (1997) and by Vergragt (2000), and the research focuses on the role played by technology and innovation systems, whose objective is to redirect technological progress to obtain greater efficiency through the development of new services. We have therefore called this factor '**Service Innovation'.**

3.2. The second stage of research on servitization (2006–2008): initiation period

In the period, which we have referred to as Initiation, dating from 2006 to 2008, four works occupy the central position in the co-citation network, namely, those by Goedkoop et al. (1999), Scheuing and Johnson (1989), Mathieu (2001b), and Oliva and Kallenberg (2003), with a closeness value of over 67.368. These works basically analyze PSS and the way in which services are introduced into industrial organizations.

The factor analysis carried out allowed us to identify five factors around which the thirty references analyzed are grouped. In this second period, the discipline of Strategic Management has acquired greater importance, while IT has less. The results of the factorial analysis single out five factors that explain 74.97% of the variance.

The first factor continues with research on the incorporation of services, and we have therefore maintained the title **'Service Strategy in Industrial Companies'**. During this period, the topic of service strategy became the most relevant line of research, and the number of articles increased to 15. The approach used in these works is principally that of Strategic Management and Marketing, although it should be noted that this factor also contains classical works in the discipline, such as the one by Prahalad and Hamel (1990). More specifically, from a strategic perspective the publications whose subject matter is related to this first factor mainly analyze the service-based strategy as a source of competitive advantage in manufacturing companies (Wise and Baumgartner, 1999; Mathieu, 2001a; Sawhney et al., 2004), and which additionally permits those companies that define such a strategy to improve their performance (Morris and Davis, 1992; Neu and Brown, 2005; Bowen et al., 1989). With regard to the Marketing approach, several works analyze customer satisfaction and loyalty in services (Levitt, 1960; Vargo and Lusch, 2004a; Vargo and Lusch, 2004b), or the importance of after-sales service in industrial companies (Cohen et al., 2006).

Factor 2 focuses on the concept of the '**Integrated Solutions Strategy'**, which is new in the second stage, and explains 14.34% of the variance. The works involving the second factor focus on analyzing the tendency within a business strategy of providing customers with integrated solutions rather than solely products. Companies that opt for an integrated solutions strategy provide their products together with services. These packages create more value for customers, and companies can improve their performance

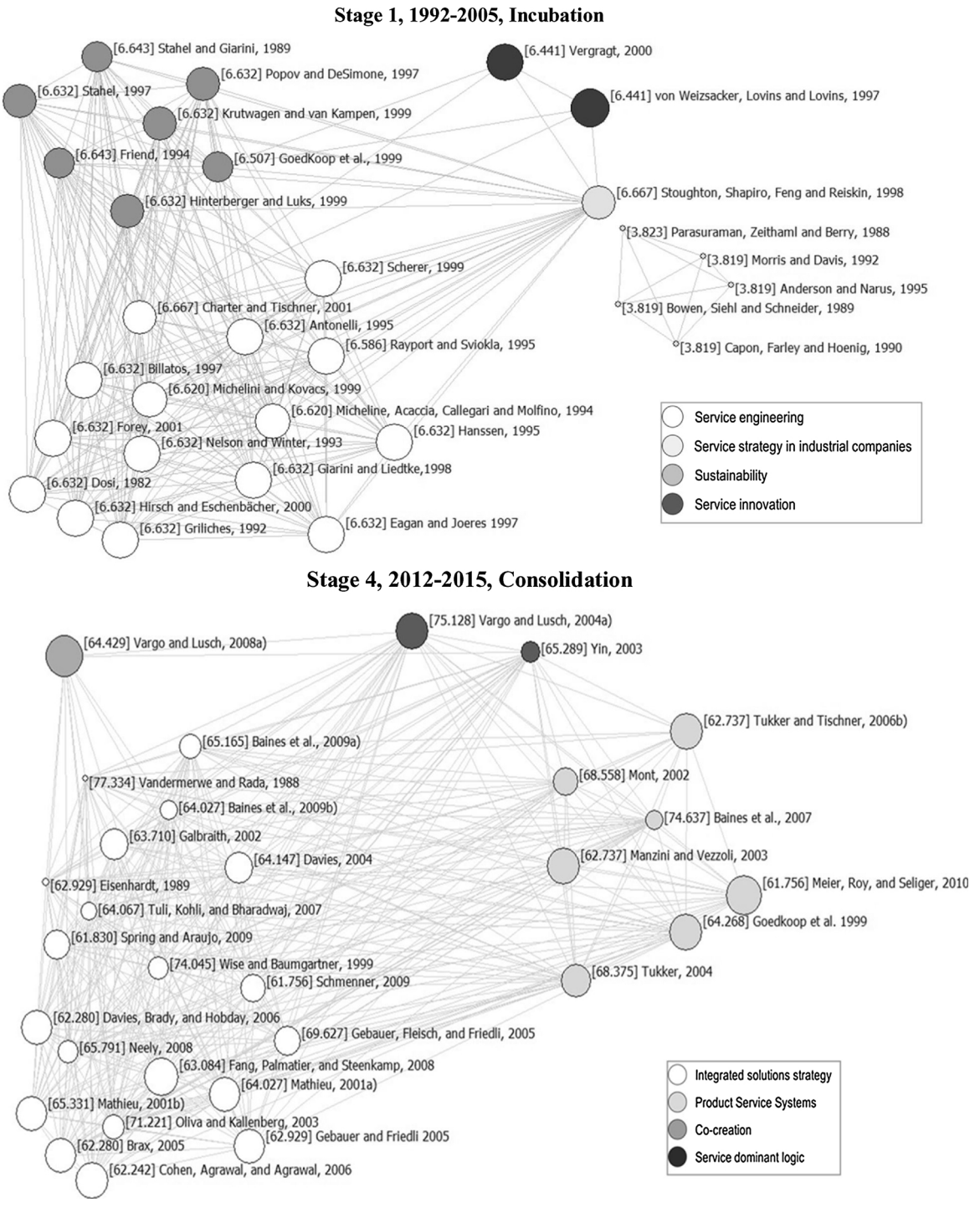

Fig. 2. The intellectual structure of servitization by research area.

(Brax, 2005; Galbraith, 2002). Goods and services converge in an integrated solutions strategy, but service-oriented principles dominate (Kotler, 2003). This factor covers the work by Vandermerwe and Rada (1988), who as noted were the first authors to coin the term servitization, which is defined as the increased provision to the market of more complete packages, i.e., combinations of goods, services, support, self-service, and knowledge, with the goal of adding value to the provision of basic services. The works comprising this second factor are clearly focused on Strategic Management.

The works comprising the third factor principally analyze the development of **'Product-Service Systems (PSS)'** in response to the innovation strategy focused on developing and selling a system of products and services that satisfy customers' stated needs (Botta,

2007; Kleinaltenkamp, 2001; Spath and Demuß, 2006; Aurich et al., 2006; Akao, 1990). The approach followed in these works is related to innovation in services and Operations Management. Like the previous factor, this third factor is new in the second stage, thus confirming the appearance of new research domains in servitization.

Factor 4 comprises three works that relate the concept of PSS and '**Sustainability**' (Mont, 2002; Morelli, 2003; Tukker and Tischner, 2006a). This factor explains 10.50% of the variance in the second stage, as opposed to 14.07% in the first stage. The concept of PSS, which provides the customer with utility through the use of services rather than products, is analyzed as a possible response to the challenge of sustainability. This fourth factor is clearly focused on the Environment, as shown by the study scope of the journals in which the works are published.

The fifth factor focuses mainly on '**Service Engineering**', which involves the introduction of ITs and the creation and provision of services, such as the development of design tools like CAD (Arai and Shimomura, 2004, 2005), so as to facilitate the provision of PSS (Goedkoop et al., 1999) in industrial companies. Nevertheless, this factor is less important than it was in the previous stage and, as explained forthwith, does not appear in the same way in the remaining periods.

3.3. The third stage of research on servitization (2009–2011): development period

This period may be considered the growth and development phase of the research on servitization, highlighting the appearance of new research topics. In this stage, the core of the co-citation network consists of two works by Vargo and Lusch (2004a, 2008a), which gather together the principles of *Service Dominant Logic (SDL)*. In this stage, the Marketing perspective prevails in the research. This is a change in paradigm, whereby exchange based on tangible goods and intrinsic value gives way to an exchange based on intangible resources, the co-creation of value, and relationships.

The factor analysis carried out allowed us to identify the following factors: 'Co-creation', 'Integrated Solutions Strategy', 'Product-Service Systems' and 'Service dominant logic'. The Marketing approach acquires particular relevance when compared to the previous period, with the appearance of new lines of research: the co-creation of value and service dominant logic, although research on the integrated solutions strategy and PSS remains equally important.

The first factor, which contains 15 works, explains 31.95% of the variance. We have called this factor '**Co-creation**', since it comprises those works that develop research on the co-creation of value. These works are founded on service dominant logic, and follow a marketing approach. The basic premise is customer participation in the value-creation process via the services provided by the company. The term 'service logic' was first coined by Normann (2001), emphasizing the company's role as the organizer of the value-creation process in which the customer is the co-producer of value rather than its receiver. For Payne et al. (2008), the co-creation of value is an interactive process between the customer's experience and the service provider's learning. Vargo and Lusch (2004b) reconsider the basic characteristics of services (heterogeneity, intangibility, inseparability and perishability), while Normann and Ramirez (1993), Lovelock and Gummesson (2004), and Edvardsson et al. (2005) present the concept of service from the perspective of the co-creation of value, i.e., from the customer's point of view based on value in use. Vargo and Lusch (2008a), on the other hand, recognize service as the basic unit of exchange in which the company cannot create value independently, but needs the customer in order to adjust its value, since this value will only be determined by the people benefitting from the service.

The eight works grouped together in the second factor continue dealing with the subject matter of '**Integrated solutions strategy**', which was first explored in the preceding period. This topic has maintained its importance because although it is the second factor in this period, it explains 19.15% of the variance, and this percentage is higher than the figure of 14.34% recorded in the 2006–2008 period. This is because the works in this factor constitute the theoretical and conceptual foundations of what is known as servitization. The incorporation of services responds to customers' specific needs, whereby the value created for the customer is greater, and constitutes a source of differentiation (Davies, 2004). The service strategy is specifically considered to be a continuum, from the production of goods to the production of services, thus resulting in an evolution in which companies provide a more appropriate combination of products-services (Oliva and Kallenberg, 2003; Mathieu, 2001a,b). The manufacturing process responds to a change in strategy (Davies et al., 2006; Galbraith, 2002), and should imply a change in the understanding of managerial behavior (Vandermerwe and Rada, 1988). In this stage, the topic begins to explore in greater depth those aspects that pave the way for the prevalence of services in the strategic orientation of industrial companies.

The third factor consists of six works dealing with **'Product-Service Systems'**, and explains 15.6% of the variance. The importance of this research is similar to that of the second period. This factor follows an Operations Management approach, and focuses on the development of PSS, which have economic potential in terms of value in use (Tukker, 2004), since customers seek the satisfaction of their needs (Manzini and Vezzoli, 2003), or generate synergies that increase competitiveness and attain economic and environmental benefits through the development of a sustainable and eco-efficient system (Goedkoop et al., 1999; Mont, 2002; Aurich et al., 2006).

The fourth factor contains only one publication (Vargo and Lusch, 2004a), which is the core of the co-citation network. We have therefore called it '**Service dominant logic**'. This work focuses on servitization from the perspective of Marketing, and considers the basic proposals of service dominant logic, which integrate products with services, the co-creation of value, and customer relations.

3.4. The fourth stage of research on servitization (2012–2015): consolidation period

The fourth stage comprises the period between 2012 and 2015. This is considered a period of consolidation, in which the discipline of servitization has reached a level of maturity with more solid lines of research thanks to the greater volume of bibliographic references. The principal perspectives used as a reference for the study of the product-service combination are Strategic

Management (Vandermerwe and Rada, 1988; Wise and Baumgartner, 1999), Marketing Management (Oliva and Kallenberg, 2003; Vargo and Lusch, 2004a; Gebauer et al., 2005), and Operations Management (Baines et al., 2007).

With regard to the co-citation network created, the works with a closeness index above 77.3 are those by Vandermerwe and Rada (1988), Vargo and Lusch (2004a), Wise and Baumgartner (1999), Baines et al. (2007), Oliva and Kallenberg (2003), and Gebauer et al. (2005). Special mention should be made of the fact these authors featured in various factors in the periods analyzed previously, and this highlights the consolidation of their contributions to servitization. As stated in the previous paragraphs, the multi-disciplinary nature of the term therefore allows it to be studied in different knowledge areas.

As might be expected, this period comprises four factors that are closely related to those in the previous periods. The first factor is called '**Integrated Solutions Strategy**', and consists of 20 works with an explained variance of 40.62%, which denotes an index of relevance as regards the other factors analyzed in this period. When attention is paid to the explained variance associated with this line of research in the previous periods, it is noted that it is higher in this last period than in the preceding ones (19.15% in 2009–2011 and 14.3% in 2006–2008), proving that the search for integrated solutions was the greatest concern in studies at that time.

The position of the second factor, '**Product-Service Systems**', also makes it one of the research lines of reference, and it now attains a certain level of importance with regard to the previous stages. PSS is understood to be a combination of the product-service in itself (Tukker, 2004), and the change in tendency highlighted in the academic literature during this period needs to be emphasized. In this respect, the study of PSS is oriented towards an environmental approach, and is considered a tool by which to minimize impacts on the environment resulting from production (Mont, 2002; Meier et al., 2010), a sustainability factor (Goedkoop et al., 1999), or an innovation that respects the environment (Manzini and Vezzoli, 2003).

The third factor, which is known as **'Co-Creation',** has an explained variance of 1.45% on the basis of the works comprising this factor (Vargo and Lusch, 2008a). The foundational premises of service dominant logic are revised for the development of a service science. The customer is always a co-creator of value, this implies value creation is interactional, as shown in this period.

The fourth factor, which has an explained variance of 1.27%, is called '**Service Dominant Logic**'. As mentioned earlier, this concept was coined by Vargo and Lusch (2004a), who extend this line of research on the so-called 'service dominant logic', and on this occasion provide a service orientation towards the creation of value, exchange, market, and marketing.

3.5. Research topics into servitization: analysis of change in influence

Fig. 2 shows the intellectual structure of the research from 1992 to 2005 (*incubation period)* and 2012 to 2015 (*consolidation period)* presenting the documents that integrate each factor together, and with node size representing the document's load factor or the extent to which the documents helps to explain the factor. Fig. 2 provides a schema of the changes in the intellectual basis of servitization research.

A general analysis, from the point of view of the evolution of the factors identified over the period of time in question (1992–2015), has allowed us to identify various behavior patterns: research lines that have lost influence, such as Service Engineering, Service Innovation, and Co-creation; research line that have gained influence, such as the Integrated Solutions Strategy, while the lines that have been recording an upward trend over the different stages since their appearance are PSS and Service Dominant Logic.

We specifically highlight the following results:

First, the beginnings of the research on servitization dealt with the incorporation of services as a complementary strategy to the manufacturing of goods in industrial companies. The factor we have called **Service Strategy in Industrial Companies** therefore already appears in the first period of analysis, explaining 17.19% of the variance (see Table 2), while it stands in first place in the second period (27.98% of explained variance).

Second, the 2006–2008 period is a second milestone, when the works constituting the theoretical and conceptual foundations of the research on servitization truly began to make their mark. More specifically, the second factor in this period, which we have called **Integrated Solutions Strategy**, analyzes the business strategy oriented towards the integrated incorporation of products and services. The design of new business models based on the search for integrated solutions that will satisfy customer needs is therefore considered, and this is understood as 'Servitization'. With regard to the analysis of its temporal evolution, this factor is reflected in the following periods: 2009–2011 therefore explains 19.15% of the variance, and 2012–2015 explains 40.62% of the variance. These results highlight the importance of a servitization strategy, whereby it is considered a corporate or development strategy.

Third, the evolution of the intellectual structure is coherent and continuous, thus reflecting the continuum that the consideration of service supposes. Factor labelling **Product-Service Systems (PPS)**, therefore appears as a line of research with a certain amount of relevance in the second period, which increases the indices of explained variance in each period, and rises from 12.93% in 2006–2008 to 17.65% in the last stage. PPS came into being as a research stream that was similar to the topic of servitization, as an initiative for a new business model.

Fourth, **Service Dominant Logic** and **Co-creation** begins to acquire particular relevance from the third period onwards due to the importance of the marketing perspective in the literature. From this perspective, the interaction between the provider company and the customer has led to the service being considered a unit of analysis in itself, with the product being a mere transmitter that facilitates the development of bespoke services for each specific customer.

Finally, there are three factors that appear only in the first two periods (Incubation and Initiation), when the research on servitization has not yet been consolidated, and these are 'Sustainability', 'Service Engineering', and 'Service Innovation'. With regard to the factor that we have called **Sustainability**, this indicates that only when servitization had not yet been consolidated did

contributions appear from environmental sciences, being published in journals with a clear focus on sustainability and clean production.

The most salient aspect regarding the '**Service Engineering'** factor is that it is the line of research that records the highest explained variance in the first period (40%), while in the second it falls sharply to 9.19% (see Table 2), and then disappears completely from the central positions in the remaining periods analyzed here. Something similar occurs with the '**Service innovation'** factor, which appears solely in the first period. These findings highlight the natural development that takes place when a new study discipline comes into being, in which the initial approaches are clearly oriented towards ITs, but then give way to new study focuses, such as Strategic Management, Marketing, and Production Management in all matters related to the process of providing services. In sum, it may be affirmed that the discipline is advancing and consolidating its position.

4. Conclusions

The theoretical area of servitization has become an extremely important topic for scholars and the business community. Increased competition across all markets and product categories have left the majority of firms searching for additional ways to gain a competitive advantage via service introduction, infusion, or transition. The research has therefore acquired special significance with a view to providing the basic guidelines and precepts for its development within the business field.

As the research gains a certain importance and degree of maturity, studies appear involving bibliographic reviews for the purpose of identifying the state-of-the-art, although the vast majority have done so from a qualitative perspective. We have used a proven quantitative methodology, as is the bibliometic analysis. This paper analyzes the changes in the intellectual structure of servitization using co-citation analyses and networks. Parkhe et al. (2006) emphasize the considerable theoretical and practical importance over the topic of networks. During our research, network analysis has allowed us to identify the most relevant nodes (references) and the interdependences among them, both have been crucial in determining the overall structure of research by subperiod. Following the same path of previous works (Martín-Peña et al., 2017), this paper not only identifies the research topics, but also adopts a dynamic perspective to examine the changes in influence recorded during the period under study.

Studying the patterns of co-citation led us to discover that the intellectual structure of the research carried out since 1992 has had four mainstays: 1) the service strategy as studied by industrial companies; 2) the study of servitization as an integrated provision of product-service; 3) the study of services using the service dominant logic approach, and 4) PSS. These results coincide with those reported by Pawar et al. (2009); Lightfoot et al. (2013) and Martín-Peña et al. (2017), who identified how research streams related PSS to the provision of integrated solutions (servitization), service marketing, co-creation of value during the provision of products and service dominant logic.

Concerning the evolution of the topics identified, they have moved from being more general to being more specific, from services as a form of product innovation to the development of integrated decisions in which the provision of services is as important as the product itself. It should be noted that the topics that have gained influence in all the stages since their appearance − in the second stage − are the Integrated Solutions Strategy and PSS. This highlights the way in which companies have undertaken the transition between providing products or services and providing 'value' through the use of integrated solutions by adding services to existing products, or by providing the customer with value and generating a sustainable long-term income (servitizing). Given the importance of these two factors, we consider that industrial organizations should treat servitization as a new strategic alternative at corporate level through which it is possible to achieve a competitive advantage and better results.

Regarding the approaches to the analysis of servitization, it is a multidisciplinary phenomenon, in which there is not one single approach, and the contributions have their roots in different disciplines. In the early stages (period of incubation and initiation), the IT and Sustainability approaches dominated the study of servitization, while the one that now dominates is Strategic Management, and the technological focus has even disappeared. This change in focus highlights the strategic importance of the incorporation of services into value creation in industrial companies, with this approach prevailing at the consolidation stage framed within Operations Management.

With regard to the Marketing approach, we should highlight service dominant logic, which has gained influence in the last two stages of development and consolidation, and the research is therefore focused on the perspective of services from the consumer's point of view on the basis of value in use, in which services have begun to be considered a basic unit of analysis. From this perspective, it is also worth stressing that the co-creation of value was the most relevant subject matter during the development period, with research focusing on the customer's participation in the value creation process via services.

These results have implications for research inasmuch as they facilitate the identification of research streams for new researchers. On the other hand, in practice and from a methodological perspective, this study provides a dynamic perspective that may be replicated in future research.

While the bibliometric analysis of servitization makes significant contributions to this research field, it also acknowledges potential paths for future research. Some relevant key actions will cast a prominent position in the formulation of a research agenda:

- A further development of topics related to IT, Sustainability and its relationship with servitization is necessary. It could consider IT as an enabler of servitizatión. It could also analyze servitization as an enabler of sustainability.
- Analyze the process of servitization in industrial companies as an effective instrument for moving society towards a resource-efficient, circular economy and creating environmental benefits.
- More empirical studies are needed to clarify the impact of servitization on business results. Objective measures that might be used to economically assess the implementation of advanced services in industrial firms (i.e., productivity, job creation, financial

returns, sales growth, consumer satisfaction, competitive advantage, etc.) (Bustinza et al., 2015; Kohtamäki et al., 2013).

- Better insight into the activities of current research communities, and a deeper analysis of interactions between communities.
- Future research should focus more on developing empirical studies that will reflect the results of servitization strategy in an objective long-term manner. More works are also necessary on how to undertake a servitization process using guidelines, tools, or techniques that will allow organizations to integrate goods and services.
- Explore the theoretical bases that support research on servitization, for example from the Theory of Resources and Capabilities or Contingency Approach.
- To go deep in the investigation on how service function needs to be internationalized or the internationalization of the company through the servitization. It would be necessary to study in depth the factors of success such as foreign customers or the business transformation in order to give an appropriate service to foreign markets (Ariu, 2016; Parida et al., 2015; Zhang et al., 2016).
- Servitization process requires a knowledge of capacities in order to be implemented or it could be done through alliances with Knowldge Intensive Business Services (Bustinza et al., 2017a,b). It would be necessary to go in depth into the study of the benefits, advantages and disadvantages that manufacturing firms can find when implementing services from strategic partnerships with Knowledge-Intensive Business Service (KIBS) firms.
- It is important to go deep on the study of how the collaboration boosts firms and the factors that have influence on the collaboration between product firms and service firms. Identifying generic network strategies for services or suggesting cross-category network archetypes. Such network archetypes, with typical capability profiles and strategic orientations, could be useful reference models for managers to optimise their current service networks or design new networks (Bigdeli et al., 2017, Zhang et al., 2016).
- A further analysis of what has been termed “Territorial Servitization” (Lafuente et al., 2016; Vendrell-Herrero et al., 2017). More work is needed to assess the impact of servitization on territorial competitiveness, the creation of new businesses, the development of digital infrastructures, etc.

A reflection on theories is important because they inform how a researcher or practicing manager interprets and solves servitization problems. This study allows the authors to reflect on the overall servitization journey to date, to spot trends and gaps in the literature, and to identify fruitful areas for future research. The research identifies the topics published in servitization. The authors also reflect upon the most cited papers. This gives the authors a richer understanding of the current state of servitization research.

Macro changes also influence the topics on which the servitization community focuses, and it follows that the theories explored to help explain those topics will vary. Such macro factors include the economic trends of expansion and recession, globalization, and increased transportation, changes in consumer expectations, advances in technology, and shifts in the world’s manufacturing base. The advent of new processes, environmental issues, as well as new information and communication technologies, has changed the nature of servitization practices over time, and theoretical developments have needed to respond accordingly.

Despite the objectivity of the methodology applied, there are certain limitations to the study that should be considered. In general, these limitations are associated to the database, as well as to the application of bibliometric analyses of citations and co-citations. As regards the database from which the documents’ sources were obtained, we agree with Martín-Peña et al. (2017) that the use of WoS versus Scopus cannot be expected to skew the results. In any case, the choice of one database or the other depends on the study’s objectives (Falagas et al., 2008). In our case, WoS was more appropriate given that it covers a wider timespan, which was necessary for our research (Scopus was published after 1995). Also, the analysis of quotations is more detailed.

Regarding the analysis of co-citations, we believe that it is relevant to discuss some of the criticisms that have sometimes arisen. As for the issue of the validity of self-citation, we agree with those authors for whom this is not a problem. In this regard, Garfield (1979:362) points out that “Since scientists tend to build on their own work, and the work of collaborators, a high self-citation count, more often than not, indicates nothing more ominous tan a narrow specialty”.

The inability of citation counts to identify premature discoveries has also been criticized. However, there are already specific techniques for this purpose that are characterized by being small, young, and potentially much more important than citation rate would indicate (Garfield, 1979). This is not, however, the aim of this research.

People talk about citations being a measure of the “impact” of scientific work. A highly cited work is one that has been found to be useful by relatively large number of researchers (Garfield, 1979). Co-citations are transparent, they may be replicated − they can thus be compared at different points in time − and they are also significant. This refers to the fact that they represent a scientific validation that has been carried out by many other researchers (Wilsdon et al., 2015).

In short, the use of bibliometric studies complements the research conducted using traditional qualitative methods, since the volume of scientific works currently published and the wide number of academic journals available rendered it unviable to use exclusively qualitative methods. We may therefore highlight the clearly practical application of our research, since it constitutes an important reference point for those researchers seeking to embark upon research in this field.

Notes

1. This type of publication is not considered “certified knowledge”.
2. The co-citation matrix is a square matrix (containing the same number of rows and columns), which is identical (the same numbers and names in the columns and rows) and symmetrical (the relationships are provided in a bidirectional manner) in which the columns and rows contain all the bibliographic references cited by the ‘citing sample’. The cells in the co-citation matrix therefore contain the number of times that each pair of bibliographic references have been cited together, and the cells that form the principal diagonal take the value of zero (because no document cites itself).

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Appendix A

Table A1
References with the greatest degree of centrality in each sub-period.

Stage 1: 1992–2005		Stage 2: 2006–2008		Stage 3: 2009–2011		Stage 4: 2012–2015	
Cent.	Article	Cent.	Article	Cent.	Article	Cent.	Article
6.667	Charter and Tischner, 2001	67.368	Oliva and Kallenberg, 2003	85.656	Vargo and Lusch, 2004a	77.334	Vandermerwe and Rada, 1988
6.667	Stoughton et al., 1998	66.667	Goedkoop et al., 1999	72.822	Vargo and Lusch, 2008b	75.128	Vargo and Lusch, 2004a
6.643	Friend, 1994	59.813	Scheuing and Johnson, 1989	62.952	Oliva and Kallenberg, 2003	74.637	Baines et al., 2007
6.643	Stahel and Giarini, 1989	58.182	Mathieu, 2001b	62.388	Lusch et al., 2007	74.045	Wise and Baumgartner, 1999
6.632	Antonelli, 1995	56.637	Brax, 2005	62.388	Wise and Baumgartner, 1999	71.221	Oliva and Kallenberg, 2003
6.632	Billatos, 1997	56.637	Kotler, 2003	62.141	Normann and Ramirez, 1993	69.627	Gebauer et al., 2005
6.632	Dosi, 1982	56.637	Vandermerwe and Rada, 1988	61.895	Vargo and Lusch, 2004b	68.558	Mont, 2002
6.632	Eagan and Joeres, 1997	54.237	Wise and Baumgartner, 1999	61.713	Mont, 2002	68.375	Tukker, 2004
6.632	Forey, 2001	53.782	Morelli, 2003	61.230	Baines et al., 2007	65.791	Neely, 2008
6.632	Giarini and Liedtke, 1998	53.782	Quinn et al., 1990	60.815	Goedkoop et al., 1999	65.331	Mathieu, 2001b
6.632	Griliches, 1992	52.893	Mont, 2002	60.000	Manzini and Vezzoli, 2003	65.289	Yin, 2003
6.632	Hanssen, 1995	52.893	Tukker and Tischner, 2006a	59.601	Shostack, 1977	65.165	Baines et al., 2009
6.632	Hinterberger and Luks, 1998	52.459	Vargo and Lusch, 2004a	59.375	Aurich et al., 2006	64.429	Vargo and Lusch, 2004a
6.632	Hirsch and Eschenbächer, 2000	52.033	Bowen et al., 1989	59.263	Parasuraman et al., 1985	64.268	Goedkoop et al., 1999
6.632	Krutwagen and van Kampen, 1999	52.033	Mathieu, 2001a	59.095	Grönroos, 2000	64.147	Davies, 2004
6.632	Nelson and Winter, 1993	50.794	Akao, 1990	58.984	Tukker, 2004	64.067	Tuli et al., 2007
6.632	Popov and DeSimone, 1997	50.794	Galbraith, 2002	58.818	Vandermerwe and Rada, 1988	64.027	Baines et al., 2009
6.632	Scherer, 1999	50.794	Vargo and Lusch, 2004b	58.489	Mathieu, 2001b	64.027	Mathieu, 2001a
6.632	Stahel, 1997	50.394	Arai and Shimomura, 2004	58.434	Fisk et al., 1993	63.710	Galbraith, 2002
6.620	Michelini and Kovács, 1999	50.394	Arai and Shimomura, 2005	57.841	Edvardsson et al., 2005	63.084	Fang et al., 2008
6.620	Micheline et al., 1994	50.394	Levitt, 1960	57.841	Mathieu, 2001a	62.929	Eisenhardt, 1989
6.586	Rayport and Sviokla, 1995	50.000	Aurich et al., 2006	57.788	Woodruff, 1997	62.929	Gebauer and Friedli, 2005
6.507	Goedkoop et al., 1999	50.000	Botta, 2007	57.523	Davies, 2004	62.737	Manzini and Vezzoli, 2003
6.441	Vergragt, 2000	50.000	Kleinaltenkamp, 2001	57.418	Chesbrough and Spohrer, 2006	62.737	Tukker and Tischner, 2006b
6.441	von Weizsäcker et al., 1997	50.000	Prahalad and Hamel, 1990	57.260	Payne et al., 2008	62.280	Brax, 2005
3.823	Parasuraman et al., 1988	50.000	Spath and Demuß, 2006	57.000	Lovelock and Gummesson, 2004	62.280	Davies et al., 2006
3.819	Anderson and Narus, 1995	49.612	Cohen et al., 2006	56.897	Galbraith, 2002	62.242	Cohen et al., 2006
3.819	Bowen et al., 1989	49.612	Morris and Davis, 1992	56.793	Vargo and Lusch, 2008a	61.830	Spring and Araujo, 2009
3.819	Capon et al., 1990	49.612	Neu and Brown, 2005	56.742	Normann, 2001	61.756	Meier et al., 2010
3.819	Morris and Davis, 1992	49.612	Sawhney et al., 2004	56.691	Yin, 2003	61.756	Schmenner, 2009

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