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## Structuring servitization-related research

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**Title:** Structuring servitization-related research

**Year:** 2018

**Version:** Accepted manuscript

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### Please cite the original version:

Rabetino, R., Harmsen, W., Kohtamäki, M., & Sihvonen, J., (2018). Structuring servitization-related research. *International journal of operations and production management* 38(2), 350–371. <https://doi.org/10.1108/IJOPM-03-2017-0175>

## STRUCTURING SERVITIZATION-RELATED RESEARCH

### 1. Introduction

Born in the late 1980s, research on product-service integration took off in the mid-2000s after the publication of many foundational articles (Brax, 2005; Davies, 2004; Gebauer et al., 2005; Mathieu, 2001a, 2001b; Mont, 2002; Oliva and Kallenberg, 2003; Tukker, 2004). Introduced by Vandermerwe and Rada (1988), the term ‘servitization’ gained popularity after two reviews by Baines et al. (2007) and Baines et al. (2009a). In the following years, servitization became nearly synonymous with companies moving from selling products and basic services to selling product-service systems (PSS). These PSS typically include advanced lifecycle services and involve changes in companies’ business models (Durugbo, 2013; Rabetino et al., 2015). Evidence demonstrates that some iconic manufacturers across industries, such as Caterpillar, IBM, and Rolls-Royce, have escaped the product commoditization trap and increasingly garnered benefits from their shift to services (Huikkola et al., 2016). This strategic shift has inspired a growing number of publications providing knowledge and avenues for future research. Knowledge has accumulated within related scholarly communities (Lightfoot et al., 2013), i.e., groups of scholars who “are linked by shared interest in distinct yet related problems in the same research area” (Vogel, 2012: 1018-9).

Researchers from the above communities have adopted different perspectives. In addition to the industrial marketing-led and service operations management-led servitization research (the mainstream), Kamp and Parry (2017: 12) recognize other “aligned research communities” that “refer to servitization-related concepts without using the term itself.” In this fast-growing domain (Kowalkowski et al., 2017b), the coexistence of multidisciplinary viewpoints, methods, and terminologies has increased complexity, which limits knowledge accumulation (Geum and Park, 2011; Pawar et al., 2009; Tukker, 2015). Although meticulous review efforts already exist (Baines et al., 2007; Baines et al., 2009a; Boehm and Thomas, 2013; Brax and Visintin, 2017; Luoto et al., 2017; Velamuri et al., 2011), the inclusion of a limited number of articles and the use of different strategies to organize conceptual contributions hinder the integration of the results. Thus, there is a need to create an accurate understanding to permit better integration and a deeper analysis of the interactions among adjacent but detached research communities (Cavalieri and Pezzotta, 2012; Boehm and Thomas, 2013; Lightfoot et al., 2013).

This article combines a bibliometric analysis with a qualitative content review to address two related research questions: 1) how servitization-related research is structured and 2) how the structure of the domain might affect its future development. While complementing previous reviews, this study differs from them in its objectives, research design, and coverage. Borrowing insights from the sociology of science, the aim of this study is to discuss the intellectual structure of the field. In contrast to previous studies providing qualitative interpretations of the field, this review also provides a quantitative analysis based on more than 1,000 articles and their references. Thus, this article clarifies the structure and boundaries of the domain, qualitatively elaborates the content of servitization-related research, and offers a list of themes that are considered important to the future development of the field.

## 2. Methodology

Servitization-related research examines the shift by manufacturers from a product-centric to a service-centric business model that provides complex hybrid offerings often referred to as customer solutions (Tuli et al., 2007), integrated solutions (Davies, 2004), or PSS (Tukker, 2004). This shift from products to services has been denoted servitization (Vandermerwe and Rada, 1988), service transition (Oliva and Kallenberg, 2003), service infusion (Brax, 2005), servicization (Quinn et al., 1990), service growth in product firms (Kowalkowski et al., 2017b), and value migration (Davies 2004). Because servitization-related research uses several terms, the systematic literature review method is most suitable for identifying all relevant research.

### 2.1. Literature search

A sample of articles was first identified by conducting a systematic search based on a search string containing the most popular keywords in previous literature reviews (Boehm and Thomas, 2013; Lightfoot et al., 2013; Velamuri et al., 2011). Setting the end of the search period for February 10, 2017, peer-reviewed scholarly articles and reviews in English (published and in press) were searched for by introducing selected keywords in Elsevier's Scopus and Thomson Reuters' Web of Science (WOS) search engines. Lengthy strings were used in the search, which returned many irrelevant hits that were manually removed by reviewing the abstracts, rather than narrow strings that could prevent the system from finding relevant articles. Following Newbert (2007), the selected articles were required to contain a minimum of one of the chosen primary keywords in the title, keywords, or abstract to avoid unrelated articles. Each of the selected articles was also required to include a minimum of one of the selected supplementary words in the text to ensure substantive relevance. The applied search string is as follows:

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[("primary search phrase 1" OR "primary search phrase 2" OR ...) IN (title OR abstract OR keywords)] AND [("supplementary search phrase 1" OR "supplementary search phrase 2" OR ...) IN (full text)]
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The primary search terms were as follows: "complex products and systems", "custom\* solutions", "from products to services", "integrated product-services", "integrated solutions", "product service syste\*", "product/service syste\*", "product-service offerings", "product-service syste\*", "service infusion", "service science", "service transition", "servicification", "servicisation", "servicization", "serviti\*", or "solution business models".

The supplementary search terms were as follows: "advanced services", "after-sales service", "business solution", "capability contract", "complex service systems", "customer care service", "customer support service", "customer-centric", "dematerialization", "down stream integration", "experiential services", "extended products", "full service", "functional product", "functional sales", "high-value manufacturing", "hybrid offering", "industrial service business", "industrial service offering", "industrial service\*", "installed base service", "integrated product and service offering", "integrated solution", "IPS2", "manufacturing-

oriented services", "operational services", "outcome-based contract", "outsourcing services", "performance services", "performance-based contract", "post-sales service", "process-related services", "product life-cycle services", "product service bundling", "product-based service", "productization", "product-oriented services", "product-related services", "result-oriented services", "service addition", "service agreement", "service engineering", "service orientation", "service package", "service strategy", "service\*", "service-dominant logic", "service-driven manufacturing", "service-supporting clients", "service-supporting processes", "service-supporting products", "solution business", "solution selling", "tertiarisation", "tertiarization", "total care product", "total solution", "use-oriented services", "value-in-use", "value migration", or "value-added solutions".

The first round of searching returned 4,572 hits (3,058 from Scopus and 1,514 from WOS). After excluding duplicates and scanning for relevance by reviewing the abstracts, 894 articles were preselected. To be selected, an item had to address product-service integration or the servitization process. Books, book chapters, and conference papers were excluded. The lists of references in the selected articles were examined to identify potential additional papers. Additionally, other major databases were used to identify potential missing articles: ABI Inform Complete, Ebsco, Emerald, Sage Journals, Springer, and Taylor & Francis Online. Multiple searches were also performed by including the keywords in Google Scholar. After adding a new set of relevant articles, the final sample consists of 1,092 articles from 296 sources.

## 2.2. Author co-citation analysis

Bibliometric analysis provides a methodology to structure, analyze, and bridge related scholarly communities. In particular, co-citation analysis has been increasingly used to comprehend the structure of scientific fields (Pilkington and Fitzgerald, 2006). In this study, author co-citation analysis was chosen as the main method. By analyzing the number of times a pair of authors is cited together in the same document, this method aims to identify researchers who represent similar ideas and boundary-spanning scholars (Nerur et al., 2008). The VOSviewer software program (Waltman et al., 2010) was used as the main analytical tool.

The co-citation analysis is based on the core 1,065 authors who met the threshold of a minimum of 15 citations. This threshold is the optimal solution, representing a trade-off between accuracy and clarity in the results. By progressively adjusting the parameters, three major scholarly communities were identified: 1) PSS, 2) solution business, and 3) service science, management, and engineering (SSME). These communities, which consist of six different research clusters that account for eleven research streams, are presented in detail in the next section. Although the classification of the 1,092 articles primarily drew on the co-citation analysis, the abstracts were reviewed and misclassified items were reclassified based on their content before estimating the descriptive statistics presented in this article. For the sake of clarity, the outcome showing the clusters (but not the streams) is presented in the final co-citation network. The bibliometric analysis is combined with a qualitative content

review to examine the structure of the servitization-related domain. While precision is added using a large sample in a quantitative analysis, the qualitative content analysis exposes the major concerns of the different research clusters and how concepts and methods are utilized in different scholarly communities.

### 3. Structuring the domain

The amount of servitization-related research has rapidly increased over the past fifteen years (Kowalkowski et al., 2017b). This progress has been accompanied by 51 literature reviews, which typically focus on a subfield, such as PSS (Annarelli, et al., 2016; Baines et al., 2007; Beuren et al., 2013; Cavalieri and Pezzotta, 2012; Tukker, 2015), solutions (Nordin and Kowalkowski, 2010), or servitization (Baines et al., 2017; Baines et al., 2009a; Brax and Visintin, 2017). Others have mapped the entire field (Boehm and Thomas, 2013; Lightfoot et al., 2013; Velamuri et al., 2011). Only Martín-Peña et al. (2017) and Hsu and Chiang (2014) provide bibliometric analyses of servitization and SSME, respectively.

Previous reviews have identified scholarly communities that are related subject-wise but disconnected in practice. Lightfoot et al. (2013) recognize five communities: services marketing, service management, operations management, PSS, and SSME. Other authors have identified most of these streams, albeit under different names. Clear exceptions are the identification of the SSME community by Baines et al. (2009b) and the information systems stream by Boehm and Thomas (2013), which were not isolated by any other review. In addition, Lightfoot et al. (2013) and Baines et al. (2009b) recognize service management as a community, whereas Boehm and Thomas (2013), Velamuri et al. (2011), and Pawar et al. (2009) embed this community within larger groups referred to as the business management, organization view and integrated solutions groups, respectively.

Departing from these studies, this article uses the 1,092 selected articles and their reference lists to conduct a bibliometric analysis, which results in a co-citation network (Figure 1) that isolates three communities. The PSS community (467 articles) is composed of two clusters: the environmental agenda (125 articles) and the PSS design and development cluster (342 articles). The solution business community (516 articles) consists of three clusters labeled customer solutions (102 articles), project-based integrated solutions (54 articles), and operations management in service transition (360 articles). Finally, service science is a single-cluster community (109 articles). Presenting the 300 strongest co-citation links, the lines in Figure 1 reveal scholars who act as links between communities (e.g., Davies, Gebauer, Vargo, Neely, and Baines).

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FIGURE 1 ABOUT HERE  
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A substantive and sustained growth in the number of servitization-related publications can be corroborated for the PSS and service business communities after 2007 (Figure 2). Next,

the analysis focuses on the three communities separately to addresses their clusters and streams in detail.

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FIGURE 2 ABOUT HERE

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### 3.1. The PSS community

Addressing design- and sustainability-related concerns, PSS scholars (quadrants one and two in Figure 1) have proposed a model of the functional economy that is based on the eco-design, cleaner production, efficient delivery, and remanufacturing of sustainable PSS (Pawar et al., 2009; Velamuri et al., 2011). Building on the idea of dematerialization (van Weenen, 1995), the PSS scientific community is oriented toward selling functionality instead of products while considering social-, environmental- and ownership-related aspects (Baines et al., 2007). There are different clusters within this community, each of which emphasizes the above aspects differently (Table 1).

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TABLE 1 ABOUT HERE

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Starting in the new millennium, scholars within the PSS sustainability agenda (Tukker and Tischner, 2006) have studied the configuration of sustainable PSS in B2B and B2C contexts (Durugbo, 2013), while analyzing the impact of these eco-efficient PSS on the environment and economic growth (quadrant two in Figure 1). Most of these studies also focus on the policy implications and societal impacts of sustainable production and consumption (Bartolomeo et al., 2003; Manzini et al., 2001; Mont, 2002; Tukker, 2004). From the mid-2000s onward, scholars within the second cluster have adopted an engineering approach to emphasize PSS design and development (quadrant one in Figure 1). The PSS development stream focuses on the integration of PSS solutions and combines engineering- and business-oriented approaches such as operation strategies and management (Baines et al., 2009b). The central topics are servitization strategies, organizational structure, value chain organization and positioning, PSS availability and performance, and service operations capabilities and management.

Concerning PSS design, different streams exist. Regarded as the service/product engineering (SE) approach, one stream adopts the post-mass production paradigm to support manufacturers when applying novel procedures to increase the service content through the lifecycle of their products (Tomiya, 2001). The approach concentrates on the application of engineering methods and computer-aided tools (e.g., CAD; service explorer) for co-designing lifecycle environmentally friendly integrated products and services (Bullinger et al., 2003; Sakao and Shimomura, 2007). Integrated product and service engineering (IPSE) research analyzes the technical requirements and engineering methods applied during the

integrated design, planning, development, production, and delivery processes of optimized lifecycle-oriented PSS. Viewed as novel business models in which ownership transfer is not always a necessary condition (Sundin and Bras, 2005), PSS are alternatively referred to as industrial product-service systems (IPS<sup>2</sup>) (Datta and Roy, 2010; Meier et al., 2010) or integrated product and service offerings (IPSO) (Lindahl et al., 2014). Other authors consider manufacturing engineering and production management insights to understand how manufacturers can design technical services for inclusion in modular lifecycle-oriented PSS (Aurich et al., 2004; Morelli, 2003).

A different stream focuses on functional product (FP) development and involves multiple-stage modeling of FPs, which are combinations of hardware, software and services that are designed in an integrated manner by partners in a supply chain to deliver a promised functionality to end customers. These FPs are typically sold using a business model known as functional sales (Alonso-Rasgado et al., 2004). Finally, the IS research stream focuses on requirements engineering and the ICT-aided modeling and development of value propositions and service operations processes of PSS (Becker et al., 2010; Berkovich et al., 2011).

The coexistence of multiple PSS streams has resulted in an extensive terminology. When describing the transition from selling products and basic services to selling PSS, different sub-streams have used different labels. However, servitization (Baines and Lightfoot, 2013; Dimache and Roche, 2013) and servicification (Tomiyama, 2001) are clearly the most widespread concepts. The lexicon also includes overlapping concepts to describe complex offerings such as PSS (Manzini et al., 2001), functional or total care products (Alonso-Rasgado et al., 2004), functional sales (Sundin and Bras, 2005), eco-efficient producer services (Bartolomeo et al., 2003), and hybrid products/value bundles/value creation (Berkovich et al., 2011).

### 3.2. The solution business community

The solution business community includes different clusters that embody the servitization mainstream (Table 2). The first cluster (quadrants four and five in Figure 1) builds on seminal works challenging the IHIP paradigm of marketing (e.g., Lovelock and Gummesson, 2004; Vargo and Lusch, 2004) and focuses on the integration and marketing of hybrid value propositions that are typically referred to as customer solutions. This stream emphasizes selling processes, customer relationship management, and value-co-creation with customers (and related topics such as value-in-use, ownership, and pricing models). The core debates also include the design of encounter mechanisms for involving customers in value co-creation processes (Grönroos and Helle, 2010; Tuli et al., 2007).

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TABLE 2 ABOUT HERE

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Referred to as operations management in service transition (quadrants five and seven in

Figure 1), and with theoretical bases in industrial marketing, engineering, and service operations and innovation management, the second cluster combines two streams. Scholars in the operations management stream focus on after-sales industrial services, operations strategies, supply chain management, and organizational change (Benedettini et al., 2015; Johnstone et al., 2009; Martínez et al., 2010; Neely, 2008). Many of the scholars in this stream act as boundary spanners (e.g., Baines and Neely) and connect concepts from operations management in service transition and PSS clusters.

Sharing the above subjects, scholars in the service transition/infusion stream originally described servitization as a step-by-step pathway on a products-to-services continuum in which manufacturers provide comprehensive service portfolios for their installed bases (Oliva and Kallenberg, 2003; Stremersch et al., 2001). Alternatively, other researchers have described servitization as a deep strategic change toward the provision of customized and long-term (integrated) solutions (Penttinen and Palmer, 2007; Windahl et al., 2004). This stream focuses on the antecedents, drivers, characteristics, and outcomes of and barriers to the transition from products to products and services. By also studying alternative service strategies and business models, this group analyzes how servitization can help manufacturers avoid the commoditization trap (Matthyssens and Vandenbempt, 2010) while addressing the multifaceted needs of customers (Gebauer, 2008; Kohtamäki et al., 2013). Rooted in the marketing and industrial marketing fields, service management research heavily influences this cluster. For instance, by extending the concept of the service package (Fitzsimmons and Fitzsimmons, 1994), the idea of an installed base service (Oliva and Kallenberg, 2003) connects service transition research with both operations and services management research (Park et al., 2012).

The third cluster adopts a particular view of the service transition while integrating concepts from operations management and strategy to analyze organizational and operational subjects related to organizational design and capability development during the implementation of long-term integrated solutions-based business models (quadrants three and four in Figure 1). This cluster consists of two streams. The first stream builds on concepts such as system integration and CoPS to describe manufacturers' value migration toward lifecycle integrated solutions (e.g., Davies et al., 2006, 2007; Davies, 2004). A central concern is the long-term "financial sustainability" of these projects (Pawar et al., 2009: 470). Additionally, "procuring complex performance" is a recent concept that connects research on CoPS to similar studies from service operations management that use the notion of "performance-based contracting" (Lewis and Roehrich, 2009; Smith et al., 2014; Spring and Araujo, 2014). The second stream focuses on project integration and management, business networks, and business models (Kujala et al., 2011; Liinamaa and Wikström, 2009).

This multidisciplinary community focuses on many subjects, including service innovation and operations management, servitization paths, service strategies and business models, and challenges/barriers during the adoption of servitization strategies. The shift toward advanced offerings has been described as servitization (Vandermerwe and Rada, 1988). Alternative terms are servicizing (Reiskin et al., 1999), servicization (Quinn et al., 1990), service transition (Fang et al., 2008), tertiarisation (Léo and Philippe, 2001), service infusion (Brax, 2005), and service orientation (Martin and Horne, 1992). This list can be augmented by terms such as service addition (Matthyssens and Vandenbempt, 2010), product-service innovation



(Bustinza et al., 2017), value migration (Davies, 2004), service-driven manufacturing (Gebauer et al., 2012), and moving downstream (Wise and Baumgartner, 1999). Terms such as solutions (Galbraith, 2002; Storbacka, 2011), integrated solutions (Davies, 2004; Windahl et al., 2004; Wise and Baumgartner, 1999), and customer solutions (Tuli et al., 2007) are used to denote the integration of products and services.

### 3.3. The service science community

Rooted in and overlapping with the IS stream of the PSS community (Lightfoot et al., 2013), the service science community (Chesbrough and Spohrer, 2006; Maglio, et al., 2009) also finds conceptual scaffolding in the services marketing stream and studies related to new service development (Ostrom et al., 2010). Above all, the community has adopted ideas from the service-dominant logic (SDL) and the concept of value co-creation (Vargo and Lusch, 2004). As a multidisciplinary approach with fuzzy boundaries, this group has only been identified as a research community per se by Baines and his coauthors (Baines et al., 2009a, 2009b; Lightfoot et al., 2013).

This scholarly community views the service system as “the basic abstraction of service science” (Maglio et al., 2009: 395). Still transitioning through its foundational stage, service science integrates people, technology, information and organizations while defining a service system as a value co-creating configuration of resources that is linked to other service systems by value propositions (Spohrer et al., 2007). Thus, this stream dynamically combines organizational, technological, and human understanding to study how service systems should be configured and evolve to foster service innovation and quality, and how value is co-created within those dynamic systems (Vargo and Lusch, 2011).

## 4. Research within and across communities: An assessment through the lens of the sociology of science

Insights from the sociology of science can serve as a vehicle to assess the intellectual structure and the developmental state of the servitization-related domain. Such an endeavor calls for analyzing the domain as a system of “knowledge production and validation” (Whitley, 1984a: 332) that involves “research paradigms, vocabularies, theories, analytical tools, and rules for judging research quality and impact” (Macinnis and Folkes, 2010: 901). This article focuses on three major points. 1) To what extent can the three communities be grouped under a single scholarly domain? 2) Assuming a single domain, what is its degree of maturity? 3) What are the main challenges for the future development of the domain as a scientific field in its own right?

### 4.1. The links among communities

Although shared subjects exist, the above communities have evolved in isolation, with only a small number of scholars establishing research collaborations (Baines et al., 2009a). For instance, the number of articles co-authored by scholars from different communities remains low, illustrating the lack of interdisciplinarity. The three communities remain relatively endogenous and find most of their theoretical support in their own research. For each community, approximately 70% of the references belong to the same community. Thus,

servitization-related research is a fragmented multidisciplinary domain composed of three sharply bounded communities that draw on different disciplines, concepts, methodologies and terminologies.

The clusters grounded in business studies can be described as a ‘fragmented adhocracy’ (Whitley, 1984b) that involves political pluralism, a high degree of technical and strategic task uncertainty, and a low degree of interdependence and coordination of research strategies between researchers from partially isolated communities rooted in many subfields of business (and engineering) studies. The current developmental state hinders the integration of results and increases ambiguity in terms of the applied concepts and research techniques (Whitley, 1984a). The engineering-oriented clusters within the PSS community differ from the solution business clusters and could instead resemble a ‘professional adhocracy’ in which strategic dependence and technical task uncertainty are low, but functional dependence and strategic task uncertainty remain high (Whitley, 1984b).

Therefore, much servitization-related research seems ad hoc, with slight theoretical coordination of tasks or results, which suggests that classifying the entire domain as a ‘fragmented adhocracy’ is still valid. Consequently, grouping the three communities under a single conceptual umbrella is challenging at best. However, acknowledging only papers from the servitization mainstream “underestimates the total body of work available in relation to servitization” (Kamp and Parry, 2017: 12). Although the SSME community and some of the PSS streams appear detached from the servitization mainstream, this research includes servitization-related articles whose findings could foster the development of the domain (Baines et al., 2017).

#### 4.2. The current developmental state

The above assessment of the links between communities indicates the existence of a theoretically nascent domain (Kowalkowski et al., 2017b). First, the domain is not entirely positioned inside any scientific discipline but at the junction of several consolidated disciplines. This position creates an opportunity to differentiate this domain from adjacent disciplines (Hambrick and Chen, 2008) while leveraging the knowledge of those disciplines (Macinnis and Folkes, 2010). Differentiation is a necessary condition for a scholarly field to gain recognition and legitimization while avoiding confrontation with consolidated disciplines (Hambrick and Chen, 2008). However, these multidisciplinary roots have resulted in the inclusion of many topics, methods and concepts, which might explain both the rapid growth in the number of publications and blurring of boundaries within the domain (Macinnis and Folkes, 2010). Furthermore, multidisciplinary roots and the use of multiple labels and concepts can hinder the process by which a field might gain legitimacy and recognition from adjacent disciplines due to the lack of a strong identity.

In another attribute signaling youth, the domain still lacks a critical mass of formal structures such as specialized journals, associations, and conferences (Hambrick and Chen, 2008). Structures have been developing slowly, particularly specialized conferences and edited special issues (Kowalkowski et al., 2017a). However, there are no publication outlets that are entirely devoted to research on servitization. Of the 1,092 articles, 610 were published in 30 journals, typical of the concentration of publications in journals from adjacent fields during

the early development of a research domain (Acedo et al., 2006). Structures within the field of research constitute the ultimate space for socialization and play a fundamental role in the construction of the identity, boundaries, and content of the domain (Macinnis and Folkes, 2010). Structures play a central role in supporting the acquisition of a higher degree of scientific maturity in an academic field (Fuchs and Turner, 1986). Thus, the evolution of formal structures will determine the direction in which and the pace at which servitization-related research develops and integrates.

#### 4.3. Theoretical and methodological challenges

Scholarly communities that aspire to develop into consolidated research fields must gain legitimacy (Hambrick and Chen, 2008). In addition to strong argumentation about its contribution (Merton, 1973), gaining legitimacy requires scholars in a young domain to convince members that the domain's agenda is long term and to adopt the "style of research" of adjacent fields (Hambrick and Chen, 2008: 46), which in most cases, requires importing concepts and methods from established disciplines.

Regarding theory development, much servitization-related research is still based on a rather narrow range of theories. While different theories have been applied to describe servitization (Gebauer et al., 2012; Windahl and Lakemond, 2010), "much of the research still lacks a strong theoretical foundation, and substantial theoretical extensions are rare" (Kowalkowski et al., 2017b: 2). Most articles (85%) in the dataset do not build up their theoretical framework from a grounded theory but merely combine arguments from previous servitization-related research (Table 3).

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TABLE 3 ABOUT HERE  
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For articles that build on a particular theory, some differences exist between communities. First, articles from the PSS community that are not practical applications present conceptual discussions without any dominant theory. Second, the prevailing theory in service science is SDL. Third, although SDL has gained adherents among marketing scholars within the solution business community, researchers from the service operations management stream remain more skeptical in recognizing SDL as a fruitful scaffold to build upon. Research within the latter group is mainly grounded on the resource-based view, contingency theory, and other organization theories. Theories from the strategic management field are also relevant approaches among business-oriented scholars. The capabilities view and evolutionary economics are particularly widespread within the cluster denoted project-based integrated solutions.

Methodology-wise, conceptual articles and qualitative studies dominate servitization-related research (Table 4). Although different methodologies such as action research (e.g., Dimache and Roche, 2013), ethnographic research (e.g., Prior, 2013), narrative analysis (e.g., Luoto et al., 2017), and interventionist studies (e.g., Laine et al., 2012) have been utilized, many

articles are based on cross-sectional and descriptive case studies. Nevertheless, some significant differences arise when comparing the three communities. Most articles from the PSS community are practically oriented and largely based on combining the application of specific methods, such as modeling and simulations, with illustrative cases. Instead, qualitative methodologies and case studies from Western countries are the dominant research strategy and dominant method, respectively, in the solution business community (and service science).

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TABLE 4 ABOUT HERE  
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One benefit of this accumulated case study research is a better contextualized, thorough understanding of processes and outcomes, but case study research has not materialized into substantial theoretical development and knowledge accumulation. The dominance of research based on case studies might increase the technical task uncertainty because different production conditions lead to outcomes that are not easy to replicate and do not remain stable under different conditions (Whitley, 1984b). Presenting both theoretical contributions and strong methods is a necessary condition for acceptance by highly ranked journals. Servitization-related research has been exploratory, with an overrepresentation of descriptive case studies that are not all theoretically driven and aimed at theory building. Research with such characteristics is more likely to be underrepresented in top-ranked journals. As shown in Table 5, nearly one-half of the articles have been published in journals that are either unranked or have impact factors of less than one (Thomson Reuters), which may be due to the absence of major theoretical contributions, excessive use of exploratory/descriptive case studies, or newness of the field. Establishing a new field of research takes time, and the publication of only a limited number of papers in high-impact journals may prevent the domain from gaining legitimization.

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TABLE 5 ABOUT HERE  
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## 5. Conclusions

This study aims to examine the structure of servitization-related research and how the structure of the field might affect its future development. By analyzing more than 1,000 articles and their references based on a combination of qualitative and quantitative analyses, the content and boundaries of the domain were mapped, the characteristics of each stream of research elaborated upon, and opportunities for the future development of the field acknowledged. Thus, the present study will help newcomers to the field navigate the foggy research landscape and experienced researchers bridge these research communities. In both cases, mapping the structure of the field provides a starting point for understanding the

conceptual roots and the development of the theories, concepts and methods utilized by the different communities, and it facilitates better positioning of future research.

### 5.1. Future research

The future development of the domain calls for greater knowledge accumulation within and across communities. The research outcomes are not sufficiently accumulative, as demonstrated by the large number of terms, transition models and service classifications and the increasing but still limited number of cross-citations. To improve the connectedness of scholarly communities, researchers must build on past research while promoting interdisciplinary studies and borrowing ideas from other research communities. As Lightfoot et al. (2013: 1429) conclude, "...it would be immensely valuable to bring together researchers from the different communities to debate and so refine our understanding of the major research themes." While the PSS community should look for "theories about the business sense of servicing" in the management literature (Tukker and Tischner, 2006: 154), business scholars can benefit from the applied knowledge developed by PSS scholars.

Although it makes sense that different but commensurable communities remain independent so that they can mature and improve theory, interdisciplinary collaboration toward a common agenda must increase to expand the structures of the field and answer research questions in a more comprehensive manner. Some attempts, such as that by Sakao et al. (2011), provide good examples. Overall, more 'critical research' is needed to challenge prevailing assumptions, which suggest that servitization describes large manufacturers in mature Western industries moving linearly and forward along a unidirectional product-service continuum toward solution offerings through organic growth and using a standard service strategy regardless of the customer segment (Kowalkowski et al., 2017b; Luoto et al., 2017).

Communities can also learn by borrowing from adjacent fields. Indeed, this review exposes the need to extend and develop the domain using well-established theories and theoretical frameworks from different disciplines (Eloranta and Turunen, 2015; Gebauer et al., 2012). Additionally, most research has been conducted at the firm level, whereas, from a philosophical perspective, studies mostly utilize positivist research designs following a realist approach. By adopting such underlying assumptions, the human dimension of servitization can be misunderstood or neglected.

The current situation calls for conceptual development based on theoretical pluralism and research at different/multiple levels. The findings demonstrate the need for middle-range theories addressing the servitization process, especially the particularities of organizational change processes during servitization (Baines et al., 2017). By acknowledging the tensions emerging from the servitization process, servitization could provide a valuable context to further develop paradox theory (Smith et al., 2010). Additionally, by extending the dynamic capabilities approach, future studies could add clarity about the micro-foundations (Abell et al., 2008) of different servitization strategies. Similarly, strategy-as-practice provides a micro-perspective of strategic change (Spee and Jarzabkowski, 2009), which can expand servitization research beyond the positivist worldview using discourse analytic and narrative approaches (Rabetino et al., 2017). This avenue may help researchers study the human dimension of servitization while providing an understanding of how micro-practices develop

and how managers' praxis shapes servitization strategies. Future research on servitization could also apply sense-making theory (Weick, 1969) or identity theory (Nag et al., 2007) to investigate the effects of servitization on different dimensions of the social psychology of organizing and organizational behavior. Practical aspects of the process also call for future research on methods to measure the degree of servitization and distinguish among different servitization evolutionary paths/patterns (Brax and Visintin, 2017; Story et al., 2016).

Regarding the methodological choices, research on servitization remains highly inductive and heavily based on explorative qualitative strategies. When the development of theory is based on case studies in Western economies, the cases might have limited generalizability outside this specific context. Using a longer timeframe by designing retrospective and longitudinal cases could also provide further insights. There is a need for not only fewer descriptions and more theory-building and confirmatory case study research building on previous research but also novel propositions that can be tested by applying quantitative methods to determine whether previous findings hold for a much larger sample from different countries and cultures beyond mature markets from Western countries.

## 5.2. Limitations

This review has limitations. First, a few articles may have been overlooked due to differences in terminology. Some publications may also have been overlooked because the limit for the search was February 10, 2017 or because such publications were not cited in the literature or were not available in the databases employed. Second, although the classification of the articles into communities was supported by software and independently reviewed by the authors, this task is subjective and may present unclear cases. Third, the clustering process depends on technical decisions regarding different parameters. Thus, the outcome is always affected by the researchers' viewpoints. In addition to regular updates of qualitative and quantitative reviews, a natural step in extending this study would be to use document co-citation analysis and bibliographic coupling to study both changes in the intellectual structure of the servitization domain and emerging trends.

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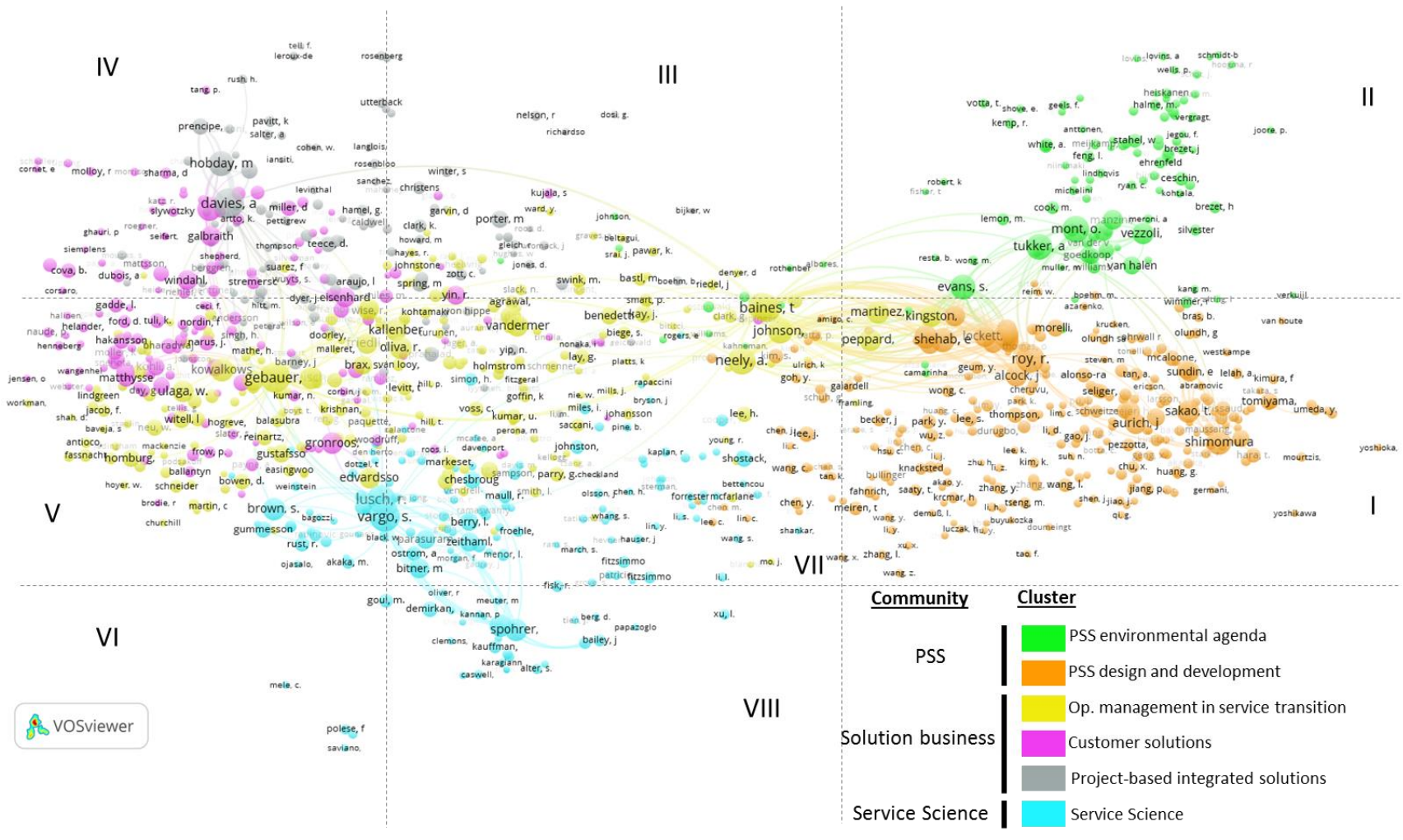
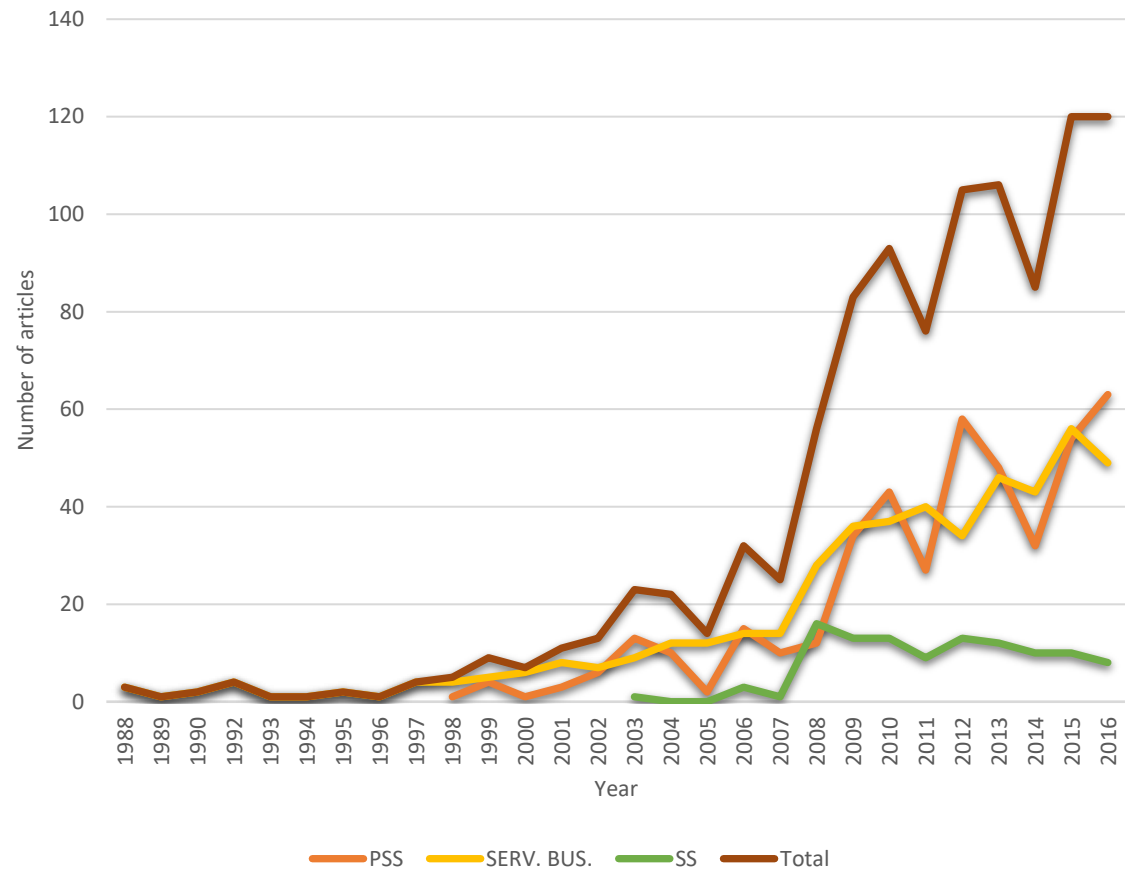


Figure 1: Research clusters identified by VOSviewer (including the 300 strongest co-citation links)



\*Articles published in 2017 and in-press articles (as of February 10, 2017) were incorporated in the analysis but not into Figure 1.

Figure 2: The evolution of the number of publications

Table 1: Main research streams within the product-service systems (PSS) scholarly community

Clusters	Streams	Representative definitions		Main concepts
		The transition process	The integrated offering	
PSS sustainability and environmental agenda		(Servicizing) “the emergence of this growing class of product-based services, which blurs the distinction between manufacturing and traditional service sector activities” (White, Stoughton, & Feng, 1999: 2).	(PSS) “A system of products, services, networks of actors and supporting infrastructure that continuously strives to be competitive, satisfy customer needs and have a lower environmental impact than traditional business models” (Mont, 2004: 71).	PSS concept; sustainable development; policy; eco-efficiency; eco-design; eco-efficient producer services; environmental impact; dematerialization; performance contracting; business model; product-service system methodology.
	Functional product (FP) development	No particular concept.	(FP) “...also known as ‘total care products,’ are products that comprise combinations of ‘hard’ and ‘soft’ elements. Typically, they are described as comprising hardware combined with a service support system” (Alonso-Rasgado, Thompson, & Elfström, 2004: 515).	FP; total care products; functional sales (business model); remanufacturing; design for remanufacturing; supply chain.
	Integrated product and service engineering (IPSE)	(Servicification) “...adding more services to [companies’] customized products. This ‘servicification’ of products is made available by integrated product service engineering” (Sundin et al., 2009: 56).	(IPS <sup>2</sup> ) “...a new solution-oriented approach for delivering value in use to the customer during the whole life cycle of a product” (Meier, Völker, & Funke, 2011: 1175).	IPSE; integrated product and service offerings; IPS/IPS <sup>2</sup> ; service delivery; lifecycle; availability contracts; value in use; functionality; environmental impact; total offering; business models; B2B; OEMs; SE; service network.
	Service engineering (SE)	(Servicification) “intensifying service contents (servicification) is crucial not only for arriving at environmentally conscious design and manufacturing but also for creating more added value in future advanced societies” (Tomiyama, 2001: 614).	(PSS) “...hybrid solutions including products and services that create higher value for customers...” (Shimomura, Nemoto, & Kimita, 2015: 145)	SE; servicification; computer-aided design; service artifacts, content, and channels; quality function development; failure mode and effect analyses.
	Information systems (IS)	No particular concept.	(PSS) “are bundles of physical technological elements and service elements that are integrated to solve customer problems” (Berkovich, Leimeister, Hoffmann, & Kremer, 2012: 161).	Modeling; hybrid products; value bundles; requirements engineering; SE; bundling; service network.
	Product-service system (PSS) development	(Servitization) “...essentially describes the move on the PSS continuum from “product plus services as an add-on” to complete service delivered through the product” (Dimache & Roche, 2013: 1437).	(PSS) “...is a specific business concept that focuses primarily on customers’ demands and is meant to provide them with all the product benefits (functionality, utility, self-esteem offered by brand) without necessary ownership, while being less harmful to the environment” (Dimache & Roche, 2013: 1437).	PSS integration; servitization; availability; performance; lifecycle; service operations and delivery; supply chain.



Table 2: Main research streams within the solution business scholarly community

Clusters	Streams	Representative definitions		Main concepts
		The transition process	The integrated offering	
Customer solutions		(Servitization) “Offering fuller market packages or “bundles” of customer-focused combinations of goods, services, support, self-service, and knowledge. But services are beginning to dominate” (Vandermerwe & Rada, 1988: 314).	(Solution) “A solution is a customized, integrated combination of products, services and information that solves a customer’s problem” (Sawhney, Wolcott, & Arroniz, 2006: 78).  (Full service) “...a comprehensive bundle of products and/or services that fully satisfies the needs and wants of a customer related to a specific event or problem” (Stremersch et al., 2001: 2).	Customer solutions; service innovation; service orientation; service business; service strategies; business models; business-to-business services; organizational design; service networks.
		(Service infusion) “...an organization-wide embracement of a basic set of relatively enduring organizational policies, practices, and procedures intended to support and reward service-giving behaviors that create and deliver service excellence” (Kowalkowski, Witell, & Gustafsson, 2013: 19).	(Product services) “A type of service which is independent from the company's goods, meaning that a client may experience the company's service without consuming its goods” (Mathieu, 2001b: 453).	
Operations management in service transition	Service transition /infusion	(Service transition) “a unidirectional repositioning along a product-service continuum—from basic, product-oriented services towards more customized, process-oriented ones—ultimately leading to the provision of solutions” (Kowalkowski, Windahl, Kindström, & Gebauer, 2015: 59).	(Integrated solutions) “...a combination of physical products or services, or both, plus knowledge are used to provide a specific outcome fulfilling the customers' needs” (Windahl & Lakemond, 2010: 1278).  (Installed base service) “...the range of product- or process-related services required by an end-user over the useful life of a product in order to run it effectively in the context of its operating process” (Oliva & Kallenberg, 2003: 163).	Solutions; integrated solutions; service strategies; service offering; service business; service orientation; organizational structure; manufacturing industries/companies.
	Operations management	(Servitization) “...has been introduced to describe a growing propensity for manufacturing firms to develop service offerings that extend beyond their traditional core product offerings” (Benedettini et al., 2015)	(Integrated solutions) “...a bundle of physical products, services and information, seamlessly combined to provide more value than the parts alone, that addresses customer’s needs in relation to a specific function or task in their business system; it is long-term oriented, integrates the provider as part of the customer’s business system, and aims at optimizing the total cost for the customer” (Brax & Jonsson, 2009: 541).	
Project-based integrated solutions		(Value migration) “By expanding the scope of the product offering to include services, firms can capture life cycle profits associated with servicing an installed base” (Davies, 2004: 731).	(Integrated solutions) “...firms design, integrate, and deliver complex products and systems (CoPS) on a project basis in small batches or as one-offs for business users, operators, service providers and/or government agencies” (Brady, Davies, & Gann, 2005: 360).	Integrated solutions; solutions; system integrator; capabilities; lifecycle; project business; business models; project management; project delivery.

Table 3: Theoretical frameworks by community

Theoretical Background/Community	PSS	Solution Business	Service Science	Total
Previous research within the community*	94.0 %	80.8 %	64.2 %	84.8 %
SDL/co-creation	0.0 %	4.5 %	30.3 %	5.1 %
Contingency theory	0.2 %	1.9 %	0.0 %	1.0 %
Other organization theories	0.2 %	2.7 %	0.0 %	1.4 %
RBV/DC/KBV/evolutionary economics	0.4 %	4.7 %	0.0 %	2.4 %
Strategy	0.4 %	2.1 %	0.0 %	1.2 %
Activity/actor network theory/practice/social practice	0.6 %	0.2 %	2.8 %	0.6 %
Other	4.2 %	3.1 %	2.7 %	3.5 %
Total	100.0 %	100.0 %	100.0 %	100.0 %

\*Many of these studies cite some theories (particularly from foundational studies) but only as a secondary tool to build the storyline.

Table 4: Methodologies by community

Methodology/Community	PSS	Solution Business	Service Science	Total
Conceptual or future research direction	23.6 %	16.7 %	57.8 %	23.7 %
Literature review	6.9 %	3.1 %	1.8 %	4.6 %
Qualitative	27.8 %	50.2 %	15.6 %	37.2 %
Quantitative	4.1 %	14.0 %	6.4 %	9.0 %
Mixed methods	2.1 %	5.2 %	2.8%	3.7 %
Practitioners' journal	0.9 %	7.8 %	6.4 %	4.7 %
Other (e.g. modeling, simulation, or application)	34.6 %	3.0 %	9.2 %	17.1 %
Total	100.0 %	100.0 %	100.0 %	100.0 %

Table 5: Impact of research by community

Impact Factor/Research Community	<1	1-2	2-3	3-4	>4	Not Ranked	Total
Solution business	14.9 %	37.0 %	14.7 %	3.9 %	0.2 %	29.3 %	100.0 %
PSS	8.4 %	26.6 %	11.3 %	18.6 %	0.6 %	34.5 %	100.0 %
Service Science	13.8 %	24.8 %	12.8 %	5.5 %	0.9 %	42.2 %	100.0 %