



Role of supply chain integration in the product innovation capability of servitized manufacturing companies

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ABSTRACT

Scholars, managers, and policy makers are increasingly interested in the potential of servitization to enhance the innovation capabilities for manufacturing companies, among others. Collaboration within the supply chain appears to play a relevant role in the transition to service provision because of its relational character. Combining these elements in the same model, this study sheds light on the relationship between innovation capabilities and integration levels, both internally and externally with customers and suppliers, considering the level of servitization in different firms. Using partial least squares structural equation modeling (PLS-SEM) on a sample of Basque manufacturing companies, this study reveals significant differences between manufacturing companies with low- and high-level services regarding the impact of customer integration on product innovation capability. The same result was not found for other supply chain dimensions—internal and supplier integration. These findings can be related to the prominent role of customer relationships and contacts in developing innovation capabilities in manufacturers' services considered by some previous research. In addition, by analysing the different dimensions of supply chain integration separately, internal integration was found to be an enabler of external integration.

1. Introduction

The servitization of manufacturing companies has become a topic of growing interest for scholars, business practitioners, and policy makers. In the mid-2000s, the number of publications on services in product-oriented companies increased greatly (Rabetino et al., 2018), reaching approximately 100 articles per year (Gebauer et al., 2016). Similarly, well-known companies, such as IBM, Xerox, Michelin, and Rolls-Royce, have made an interesting evolution from being merely industrial companies to obtaining a relevant share of their revenues and results from services. For their part, policy makers in developed economies promote the service development by manufacturing companies as a means to overcome the declines in GDP growth and employment in the industrial sector (Crozet and Milet, 2017).

Moving from products to services can be a challenging transformation for manufacturing companies (Oliva and Kallenberg, 2003). A new business model in which transactional character loses importance in favor of a relational character must be defined (Neely et al., 2011). Collaboration becomes relevant, encompassing not only relationships

with customers, but also those with providers, and inside the organisation. This approach of becoming closer both internally—within the company—and externally—with suppliers and customers—is captured by the supply chain integration concept (Flynn et al., 2010). For this research, supply chain integration is defined as the strategic collaboration of both intraorganisational and interorganisational processes that lead to a more cohesive supply chain. Hereafter, we use both terms, integration and strategic collaboration, interchangeably.

Service provision is considered to enhance product innovation capabilities for manufacturing companies (Suarez et al., 2013; Golar, 2018). Literature usually links this effect to the insights and knowledge gained through a closer relationship with customers via services (Santamaría et al., 2012). Simultaneously, supply chain integration strengthens the innovation capabilities in generating new or renewed value propositions for customers (De la Calle, 2015; Wong et al., 2013). Consequently, a synergetic effect between collaboration and innovation capabilities can be expected in servitized companies. Importantly, from the resource-based perspective (Barney, 1991), different features, such as usual intangibility, ambiguous causality, and social complexity,

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present in both innovation capabilities and collaboration within the supply chain can provide sources of more sustainable competitive advantage.

Despite its relevance to strategic management, few companies can still harness the potential of relationship management throughout the supply chain to generate greater value for the customer and improve their business results (Slone, Dittman and Mentzer, 2010). As servitization literature has largely considered, even if internal integration is a great challenge for the company (Gebauer et al., 2010), going beyond the organisation's limits involving suppliers and customers in a common strategy seems to be a more difficult challenge (Yu et al., 2013). Trying to contribute to the understanding of product-service innovation ecosystems, we delve deeper into the role of supply chain integration in the product innovation capability of servitized manufacturing companies by posing two research questions: What is the relationship between internal and external strategic collaboration according to servitization levels? What is the relationship between supply chain integration and product innovation capability depending on the extent of the incorporation of services by manufacturing companies?

This study aims to gain a more profound understanding of the role of supply chain integration in the development of competitive advantage by fostering innovation capabilities in the context of servitized companies. Considering the servitization level of different firms, we combined the innovation capabilities and internal and external (i.e., with customers and suppliers) integration levels into a single partial least squares structural equation model (PLS-SEM) that analyses data from 104 manufacturing companies in the Basque Country, Spain. The Basque Country is an industrialised region in Spain, and historically, the local government has developed cluster policies to promote collaboration among various ecosystem agents in the industrial sector (Aranguren and Navarro, 2003).

Despite their apparently clear connection, to our knowledge, no previous empirical research has considered the relationships between servitization, innovation capabilities, and internal and external supply chain integration simultaneously. Developing on the contributions of previous work not focused on servitization (De la Calle, 2015), this research attempts to shed light on this emergent problem (Baines et al., 2017) through quantitative research.

To accomplish this research objective, the paper is organized as follows. Section 2 specifies the conceptual foundations underlying servitization in manufacturing firms and its relationship with product innovation and supply chain collaboration, introducing the research hypotheses and the resultant model. Section 3 describes the data and methodological approach. Section 4 presents the data analyses and results. Finally, section 5 concludes the paper with theoretical and managerial implications, research limitations, and potential topics for further study. Interestingly, the results reveal the differences between the various dimensions of the supply chain, specifically highlighting the role of customer relationships, while confirming the importance of supply chain collaboration to generate innovation capabilities in servitized companies.

2. Literature review and hypotheses development

2.1. Servitization as a strategy for manufacturing companies

From its origination, the concept of servitization (Vandermerwe and Rada, 1988) has been related to the incorporation of services and intangibles into products as a way to create value and obtain competitive advantages. However, the difference between products and services has been blurred over time. In addition, apart from servitization, different terms are used to consider the convergence between products and services such as product-related services, product-service systems, and integrated solutions (Dachs et al., 2014); just solutions (Rabetino et al., 2018); product-service innovation (Bustinza et al., 2018); service infusion, service transformation, and service transition (Kohtamäki et al.,

2018); and even industrial services (Brax, 2005). While service applications are often studied in business-to-consumer (B2C) contexts, servitization is usually related to industrial networks and business-to-business (B2B) relationships (Kamp and Parry, 2017). Approaches also have been very different, from strategy, marketing, supply chain management to sustainability, and sectoral or territorial. Not surprisingly, the impact of servitization on a company's results and profitability can be highlighted. In this study, the focus is on supply chain relationships and their influence on product innovation capability as a means for developing a sustainable competitive advantage.

The increasing competition that manufacturing companies are confronted with as the sector matures pushes them to seek new sources of competitive advantage. Due to the struggle that many firms are facing with competitors from low-cost countries, the attraction of servitization is even greater. Servitizing is presented as a way out of commoditization and margin loss, as well as an opportunity to change the way one interacts with customers, making it more difficult for remote competitors to access the market. Therefore, servitization is not only a defensive strategy but also an innovation path to improve competitive advantage, increase customer satisfaction (Suarez et al., 2013), diversify to new service offerings, and create new markets and income sources. Moreover, new business opportunities opened by servitization for manufacturing companies can go beyond supporting the use of their products, such as when R&D and digital services are offered (Santamaría et al., 2012).

Although scholars usually relate servitization with the maturity of a firm's product business (Teece, 1986; Suarez et al., 2013), it can also take place during other lifecycle stages. For instance, in the early phase, services may overcome technology and customer needs uncertainty, as in the case of usage contracts during the introduction of business computers, when buyers were reluctant to adopt an unknown technology (Cusumano et al., 2015).

The possibilities for new services offered by manufacturing companies are wide. After a complete systematic review, Brax and Visintin (2018) identified eight value constellations going from the most basic type—products with limited support such as basic maintenance and support services—to the most complex configuration, total solutions, where the supplier operates and owns the system and payment is based on output or outcome on a long-term basis. Focusing on the effect on the product market of a firm, Cusumano et al. (2015) develop a taxonomy distinguishing, on the one hand, services that complement the company's products, and on the other hand, services that replace the purchase of the product (substituting). The first category distinguishes between those that without altering the product's functionality facilitate its use or sale (smoothing) and those that enhance, expand, or adapt the functionality of the product (adapting).

Following the product-service continuum (Oliva and Kallenberg, 2003), literature usually sees companies moving toward increasing the relative importance of services from a very low level (service as an add-on) to a very high one (tangible goods as add-ons). In that evolution, companies transition from a transactional model to a long-term-relationship-development model (Neely et al., 2011). Consequently, this requires a deep transformation of the overall business model, involving not only the adaptation of structures and development, and the acquisition of new skills and capabilities, etc., but also the necessary cultural change, including perhaps even the loss of the priority of the products in terms of the dedication of investment and management efforts. Some researchers have considered that cultural and managerial biases could be responsible for thwarting service development efforts in product-centric cultures (Oliva and Kallenberg, 2003). Just as in the past, while product orientation may have generated competitive advantages for certain manufacturing firms, the greater infusion of services favors firms with a more service-oriented culture (Gebauer et al., 2010). In addition to being complex, servitizing is a very time-consuming process (Oliva and Kallenberg, 2003) and is not always profitable, as De la Calle and Freije (2016) stated regarding Spanish

manufacturing companies. Servitization is a long-term commitment, which often requires attaining a critical mass to become profitable (Visnjic and van Looy, 2013). The difficulties in obtaining results from this strategy make up the so-called “paradox of servitization” or “service paradox”. Gebauer et al. (2016) suggest that “one reason for the service paradox is that companies underestimate the complexity of the service business”. Benedettini et al. (2015) even warn that servitization may endanger a company.

The incorporation of services usually requires profound changes in a company, which often involves moving from a product-centric organisation to a servitized one. Along with internal organisational changes, customer and supplier relationships need to be reconfigured. Core competencies and capabilities, outsourcing, and the level of integration in the supply chain need to be reconfigured. In sum, a change in the business model is required. To do this, firms should have a proper understanding of customer needs. Frequently, a certain level of integration or cooperation within the value chain is required. Elaborating on Chesbrough’s open innovation thesis, researchers are increasingly considering open business models in servitization (Visnjic et al., 2018) that allow innovation and effectiveness through leveraging the capabilities of other ecosystem agents (Chesbrough, 2007).

2.2. Supply chain integration and servitization

To redefine a firm’s business model, understanding the configuration of other firms within the ecosystem to create a strategic fit between business models appears to be relevant. Strategies are always limited by the collaboration of other actors within the ecosystem (Kohtamäki et al., 2019). Therefore, understanding supply chain network dynamics is essential in the servitization context (Bigdeli et al., 2018).

Servitization involves diversification and consequently, defining new business models, reconsidering all their components. First, the firm must define an attractive value proposition, then organize both internally and externally in order to create and deliver the value and, finally, capture enough value (Teece, 2010). In the previous section, we noted the various opportunities that services open to complement product offerings. Considering the last component, capturing value is also necessary. As they do with their product portfolios, manufacturing firms may subsidize or give away services so as to develop their product business (Cusumano et al., 2015). Although all the components are necessary and relevant, in this work, focus is placed on the second component of the business model and, more specifically, on the reconfiguration required in relationships with customers, suppliers, and inside the organisation.

Extending the boundaries of a company, and considering collaboration with customers and suppliers, as a method to enhance final results is largely considered in the literature on supply chain management (SCM) (Stevens, 1989) and in organisational design (Jacobides and Billinger, 2006). Supply chain integration can be defined as the extent to which a firm collaborates and manages the business processes within its supply chain (Flynn et al., 2010). There is consensus in literature on the multidimensionality of SC integration (Fabbe-Costes and Jahre, 2008; Flynn et al., 2010), including internal and external integration (Swink et al., 2007; Van der Vaart et al., 2012), the latter including the relationships with customers and suppliers. The relation between internal and external integration can be examined, on the one hand, from the evolutionary theory of SCM (Frohlich and Westbrook, 2001; Morash and Clinton, 1998; Rosenzweig et al., 2003; Ross, 1998; Stevens, 1989) and, on the other, with the concept of knowledge absorptive capacity (Cohen and Levinthal, 1990). Some researchers argue that internal integration precedes external integration (Yu et al., 2013; Zhao et al., 2013). For instance, to valorize externally acquired knowledge a company needs the ability to assimilate and commercially apply it, the so-called absorptive capacity (Cohen and Levinthal, 1990). Not surprisingly, a higher absorptive capacity is related to innovation and more proactive organisations (Morais-Storz et al., 2018).

Regarding internal integration, some researchers underline that coordination capabilities are required because of the greater complexity of information processing needs and relationships that result from servitization (Benedettini et al., 2015). In addition, apart from other mentioned organisational issues, e.g., corporate structure, culture, human resources, and measurement systems (Gebauer et al., 2010), internal cooperation and alignment between organisational units involved in service development and delivery are found to be critical success factors for servitized manufacturers (Bustinza et al., 2019). Fang et al. (2008) contend that organisational conflict may damage firm value.

Referring specifically to solutions, Brady et al. (2005) argue that the development of collaboration skills in identifying, evaluating, and managing long-term risks in supply streams is required. Moreover, among only three capabilities required for companies to shift to advanced services, Visnjic et al. (2018) include the ability to understand customer needs and to work with suppliers and partners.

In the service transition, previous interactions between providers, customers, and end-users are reconfigured. Providers may bridge the buyer when interacting directly with end-users and, frequently, new actors appear to participate in the service provision (Gremyr et al., 2017). Consequently, even competition is required when simultaneously competing and cooperating with the same agents (Kim et al., 2013).

According to Baines et al. (2017), the servitization literature has taken interest in topics such as network structures/configurations, capabilities, relationships with intermediaries (e.g., distributors, agencies, and dealers), inter-organisational power in complex networks, degrees of collaboration, and triadic arrangements.

When manufacturers carry out a servitization strategy, they can develop services by themselves or lean on other companies, either related or independent third parties, or do both simultaneously (Cusumano et al., 2015). Although collaboration within ecosystems is considered relevant, service provision has been often analysed in terms of make-or-buy decisions (Bustinza et al., 2019) taking into account the effective use of resources and capacities or better matching capabilities with market needs (Jacobides and Billinger, 2006). Large manufacturers usually servitize through internal development because of their superior access to financial resources (Bustinza et al., 2015). Nevertheless, when servitization and the benefits of knowledge-intensive service provision are not fully integrated within the manufacturer’s internal value chain, there may be interesting benefits to so-called territorial servitization (Lafuente et al., 2017).

Consequently, collaborating within the supply chain, both internally and externally, is key to establishing servitization in manufacturing companies (Bigdeli et al., 2018). Since internal integration is considered to precede external integration (Yu et al., 2013), delving deeper into this relationship and distinguishing between the customer and supplier sides (Flynn et al., 2010) seems to be a valuable undertaking.

Thus, to answer our first research question: “What is the relationship between internal and external strategic collaboration according to servitization levels?”, our first hypotheses are stated as:

H1: Internal integration has a positive impact on external integration at both low and high servitization levels.

H1a. Internal integration has a positive impact on customer integration at both low and high servitization levels.

H1b. Internal integration has a positive impact on supplier integration at both low and high servitization levels.

2.3. Innovation capabilities in servitization

Some researchers have highlighted the role of strong interactions within the firm (Colombo and Rabbiosi, 2014) and between the firm and its customers and suppliers in product innovation success (Gunday et al., 2011). Cenamor et al. (2019) emphasized network capability as a dynamic capability that creates both internal and external

interdependencies that facilitate an organisation's innovation process.

Innovations in service firms must be explained from the customer side. In the innovation process, services are considered to be more pull-oriented compared to the more push-oriented products (Sundbo and Gallouj, 1998). More recent approaches argue that the distinction between innovation in services and manufacturing is becoming more difficult due to the servitization dynamic and innovation blurring (Morrar, 2014).

The relations between servitization and innovation capabilities and knowledge does not just work in one direction, that is to say, helping manufacturing companies transition from offering just products to developing new services, as has been previously stated. At the same time, services may be beneficial to product business itself. For instance, they can play an important role for manufacturing companies in generating not only a market for the product (as when the service is considered during the customer's selection of the product provider) but also increasing customer knowledge, improving the manufacturer's understanding of the customer's broader needs (Visnjic and van Looy, 2013) and, consequently, facilitating knowledge transfer and new product innovation (Golar, 2018). Cusumano et al. (2015) highlight that services can reveal information about consumption and usage that companies can leverage in technology development. Gebauer et al. (2008) contend that innovation in product-related services can be integrated into the development process of new products. In fact, Eggert et al. (2011) and Visnjic et al. (2016) show that servitization is more likely to generate better performance when it is coupled with product innovation. Dachs et al. (2014) also found from large-scale evidence that product innovation and service innovation are often complementary in the competitive strategy of highly-innovative firms.

Literature on servitization often links the superior capability to conduct product innovation with an increase in customer contacts (Brax and Jonsson, 2009; Mathieu, 2001). In addition, digital technologies are creating unprecedented innovation opportunities for manufacturing companies (Parida et al., 2015), allowing new data accumulation about customer use and needs through the Internet of Things (Parry et al., 2016). This feeds new product development and supports product innovation (Visnjic et al., 2016), reinforcing a firm's product development capability (Huang and Chu, 2010). However, collaboration becomes a key point in building trust between users and producers to facilitate data sharing (Kamp et al., 2017).

A collaborative strategy can contribute to improving the effectiveness and efficiency of an innovation strategy by facilitating access to complementary assets and knowledge, as well as by reducing the risks associated with R&D-intensive projects (Faems et al., 2005). As Jacobides and Billinger (2006, p.258) conclude: "The market can infuse the firm with information without a drastic wholesale change in compensation." Nevertheless, translating information into strategy is not straightforward (Birch-Jensen et al., 2018). The ability to successfully identify and assimilate information is highly dependent on a firm's absorptive capacity (Cohen and Levinthal, 1990).

According to the resource-based perspective, complex bundles of idiosyncratic resources and capabilities (Barney, 1991) are the root of sustainable competitive advantages. Among these resources, innovation capabilities as well as collaboration related capabilities, whose usual intangibility, ambiguous causality, and complexity may make them more sustainable, can be considered. Eggert et al. (2014) also highlighted the socially-complex and strong tacit capabilities that are usually required to supporting clients in industrial service strategies, reinforcing sustainability. In addition, some researchers (Kowalkowski et al., 2012) have stated that service infusion often takes place incrementally, in small steps, without clearly-directed efforts. To be successful in a servitization strategy, flexibility to adapt actions continuously is required, along with the ability to seize ad hoc innovation and continuously recalibrate opportunities and intertwining goals, what is called "agile incrementalism". So, path dependence may be added to the previous list of inimitability factors.

In contrast, some researchers have noted the greater difficulty of protecting service innovations due to the complexity of defining appropriation regimes of innovation results, the need to engage customers in design and/or implementation of innovations (because the relationship with customers is a fundamental aspect of service innovations) (Santamaría et al., 2012), and the greater risk of partner or supplier opportunism or failure to coordinate activities with them due to embracing an open business model (Visnjic et al., 2018).

Growth, profit, and innovation are among the main factors described by the literature as servitization strategies; the innovation rationale is less frequently considered (Dachs et al., 2014). To supplement the extant literature in the field, in this study, we focus on product innovation capability, i.e., the capability required for the development of new or enhanced products to meet market needs (Najafi-Tavani et al., 2018). Based on this definition, in this research, product innovation capability is delineated in two dimensions, i.e., market knowledge capability and product development capability. The former is related to market knowledge management and absorptive capacity, one of the most critical dynamic capabilities according to the innovation and strategic management literature (Saeedi et al., 2014). From this dimension, it is possible to generate valuable information from which a company can create or improve its product portfolio. The latter deals with product development capability, from which it is possible to create a sustainable competitive advantage (Noke and Hughes, 2010).

Considering the primary clusters in which dynamic capabilities are divided (Teece et al., 2016), the market knowledge dimension is related to "sensing" capabilities while product development capability refers to "seizing" capabilities. In addition, we were inspired by previous research (Jansen et al., 2006; Enkel et al., 2017) to distinguish between the market and product dimensions in measuring product innovation capability. However, contrary to these previous studies, the difference between exploration (i.e., disruptive innovation) and exploitation (i.e., incremental) was not considered in our analysis, which focuses on the capability to develop both new and improved products and services.

Therefore, it can be concluded that it is interesting to study the role that supply chain integration plays in the development of product innovation capability. Lambert and Cooper (2000) state that a real source of sustainable competitive advantage over time comes from the ability of companies to get involved in processes of improvement and value creation through innovation. Although recent literature supports this relationship (Wong et al., 2013; Wu, 2013), it has not been studied according to the servitization level of companies. Furthermore, the most interesting analysis is testing whether these impacts are statistically significant between non- or lowly servitized companies and highly servitized companies. Then, to answer our second research question: "What is the relationship between supply chain integration and product innovation capability, depending on the extent of the incorporation of services by manufacturing companies?", our last but not main hypotheses are posed as follows:

H2: Supply chain integration's impact on product innovation capability is higher in companies with higher servitization levels.

H2a: Internal integration impact on product innovation capability is higher in companies with higher servitization levels.

H2b: Customer integration impact on product innovation capability is higher in companies with higher servitization levels.

H2c: Supplier integration impact on product innovation capability is higher in companies with higher servitization levels.

Fig. 1 exhibits the research model, linking the three dimensions of supply chain integration with product innovation capability, measured through its market knowledge and product development dimensions in the context of high and low levels of servitization.

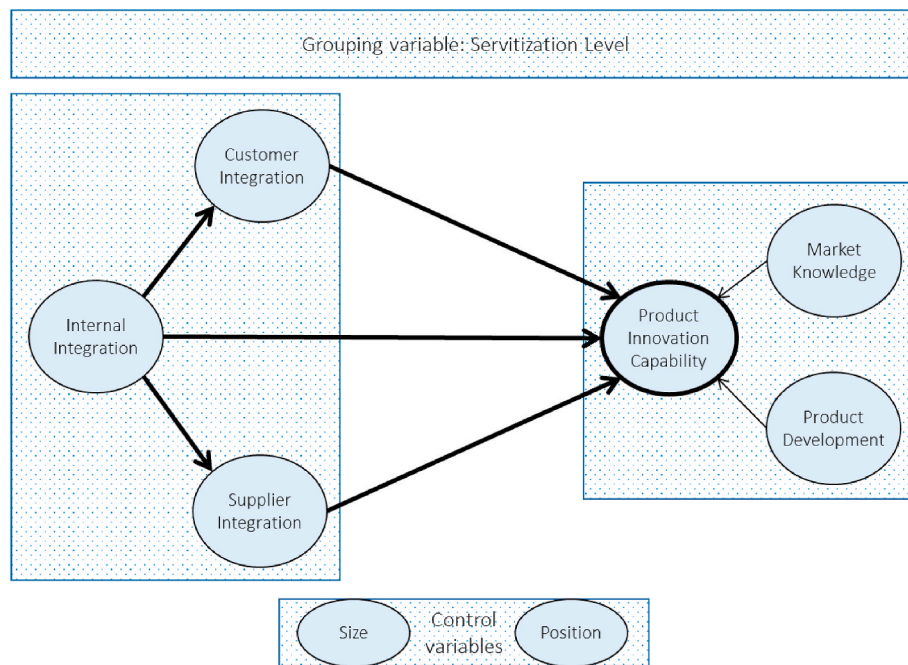


Fig. 1. Research model.

3. Method

To test our hypotheses, a questionnaire was used as an instrument of measurement. For the subsequent analysis of the collected data, a partial least squares structural equation modeling (PLS-SEM) approach was applied, which is widely used in management research (Kaufmann and Gaeckler, 2015). Given the sample size and characteristics of the model, a PLS-SEM approach was considered to be appropriate for this analysis (Henseler et al., 2016; Reinartz et al., 2009).

Statistical data analysis was executed using Smart PLS 3 (Ringle et al., 2015) software and a bootstrapping technique was used to review the significance levels of the predicted relationships. In the first phase, the model was used to extract the first-order constructs, and in the second phase, the structural model, including the second-order construct, was estimated (Hair et al., 2018). Lastly, a multigroup analysis was performed to determine the significance of the differences between two groups: non- or lowly servitized companies and highly servitized companies.

According to Cohen (1992), our sample size of 42 highly servitized companies satisfied the requirement of a minimum R² value of 25% at the 10% significance level, assuming an 80% level of statistical power.

3.1. Data collection and sample

The target population for this research was manufacturing companies (code 10 to 33 in NACE, 2009) with more than five employees located in the Basque Region, one of the most industrialised regions of Spain. According to Instituto Nacional de Estadística (Spanish Statistical Institute), in the year 2013 in the Basque Region there were 12210 manufacturing companies, but only 3877 of them had at least five employees. The questionnaire was first formulated according to the literature mentioned and then revised by a group of eleven experts from the academic and professional worlds. With the received suggestions, the questionnaire was improved. To facilitate participation in the study, the questionnaire could be answered online, by telephone, or in a personal interview. The survey design was addressed to persons integrated in the managerial team with a general knowledge of the area being studied.

Data collection was carried out between September 2012 and November 2013 and the persons interviewed were contacted through

business associations as well as personal and university relations. More than 1200 companies were requested to fulfill the questionnaire and finally 104 valid responses were collected, which is 2.7% of the total population of 3877.

The questionnaire also included some questions allowing the categorization of the company in terms of sector, position in the supply chain, and size (number of employees). In order to establish the level of servitization of the company, first the SABI database was checked to identify service incomes. The SABI database contains financial information on Spanish and Portuguese companies. In the case of presenting service incomes, company service offerings were considered so as to define the level of servitization, according to the servitization continuum (Martinez et al., 2010) and servitization categorization (Baines and Lightfoot, 2013) as explained in subsequent section.

Table 1 shows the sample characterization by sector, position in the supply chain, and size (in employees).

Due to the use of a questionnaire as a measurement instrument, in which both dependent and independent variables are asked simultaneously and in a cross-sectional manner from a single key informant in each company, common method bias (Podsakoff et al., 2003) must be checked. We carried out a Harman’s one factor test (Podsakoff and Organ, 1986) to determine the severity of the bias. The result shows that 28.6% of the variance is explained by a single factor, so common method

Table 1 Sample characterization.

Variables	Levels	Frequency (n)	Percentage (%)
Sector	Aerospace	14	13.5
	Automotive	27	26.0
	Metal	48	46.2
	Others	15	14.4
Position in supply chain	OEM	37	35.6
	Tier 1	23	22.1
	Tier 2	29	27.9
	Tier 3–4	10	9.6
	RM Supplier	5	4.8
Size (employees)	≥250	32	30.8
	50–249	37	35.6
	10–49	27	26.0
	5–9	8	7.7

bias is not a major concern in the study.

3.2. Variables

The research model has five first-order and one second-order constructs as well as two measures that act as control variables (size and position of the company in the supply chain). Constructs were operationalised with multiple items adapted from the existing literature.

3.2.1. Dependent variable: product innovation capability

Product innovation capability is a multidimensional formative construct (Raymond et al., 2013), comprised by two reflective first-order constructs: (1) market knowledge and (2) product development.

These two dimensions were operationalised with five and two items, respectively. The items were assessed using a seven-point Likert-type scale that ranged from 1 = absolutely unsatisfactory to 7 = absolutely satisfactory. The market knowledge items tried to capture the capability of the firm in understanding and taking advantage of the market. The product development items dealt with both the disruptive and incremental product innovation approaches.

Market knowledge items measured the company’s capability in updating operations, developing required quality, and using new technologies to understand the market. Product development items evaluated the company’s capability in developing new products or improving existing ones. The constructs were adopted from the literature review. See Table 2 for a more detailed description.

3.2.2. Predictor variable: supply chain integration

Supply chain integration is a multidimensional construct made up of three dimensions: a) internal integration; b) customer integration; and c) supplier integration. In the research model, each one of these three first-order constructs were operationalised in the questionnaire with five items measured using a seven-point Likert-type scale that ranges from 1

= strongly disagree to 7 = strongly agree. Thus, internal integration items consider aspects such as responsiveness, system integration, information and physical flow, and collaboration between the departments inside the company. Customer integration items evaluate if the company shares information about the market, follows the opinions of customers, involves customers in product development, and exchanges information with the customer. Finally, supplier integration items look to partnership, joint planning, and sharing information with suppliers. See Table 2 for detailed descriptions and references from the literature review.

3.2.3. Grouping variable: servitization level

In order to determine the level of servitization in a manufacturing company, two approaches were initially considered. The first was the servitization continuum with five levels developed by Martinez et al. (2010). The second was the four-level categorization described by Baines and Lightfoot (2013).

In the continuum approach, five levels are considered (Martinez et al., 2010): 1) no servitization; 2) interaction mainly transactional: some addition of peripheral services (i.e., maintenance); 3) product and service delivery; 4) customization of product and service; and 5) product and service codesigned, total solution.

In the categorization approach (Baines and Lightfoot, 2013) the four categories are: 1) no servitization; 2) base services: an outcome focused on product provision; 3) intermediate services: an outcome focused on maintenance of product condition; and 4) advanced services: an outcome focused on capability delivered through performance of the product.

We finally decided to adopt the continuum approach because this scale focuses precisely on the interaction between suppliers and customers. However, a correlation analysis between the two scales demonstrates that the relationship is highly positive and highly significant (Spearman’s rho is equal to 0.834).

Table 2
First-order constructs: Items, loadings, reliability and convergent validity.

Abbrev.	Description	Loading	t-value	α	CR	ρ_A	AVE
	Internal integration (adapted from Boon-Itt and Wong, 2011; Flynn et al., 2010; Kim, 2006; Narasimhan and Kim, 2002; Terjesen et al., 2012; Wong et al., 2011; Wong et al., 2013)			0.829	0.880	0.833	0.595
ININ1	In our company, we have a high level of responsiveness within the plant to meet other department’s needs.	0.759	13.568				
ININ2	In our company, we have an integrated system across functional areas that allows the collection of and quick access to accurate information for all departments.	0.762	14.650				
ININ3	Within our plant, we emphasize information flows among purchasing, inventory management, sales and distribution departments.	0.842	19.265				
ININ4	Within our plant, we emphasize physical flows among production, packing, warehousing and transportation departments.	0.800	13.496				
ININ5	Company managers promote collaboration between departments as a way to improve organisational performance.	0.687	10.854				
	Customer integration (adapted from Ahmad and Schroeder, 2001; Boon-Itt and Wong, 2011; Flynn et al., 2010; Huo, 2012; Narasimhan and Kim, 2002; Terjesen et al., 2012; Wong et al., 2011; Wong et al., 2013)			0.715	0.823	0.729	0.539
CUIN1	We have a high level of information sharing with regard to market information.	0.637	6.116				
CUIN2	We closely follow the comments and opinions of our main customers.	0.742	13.475				
CUIN3	We share information with our main customers through information technologies.	0.799	14.353				
CUIN4	Our customers provide us with information about their demand forecast key to our production planning.	0.749	12.411				
	Supplier integration (Ahmad and Schroeder, 2001; Boon-Itt and Wong, 2011; Flynn et al., 2010; Huo, 2012; Narasimhan and Kim, 2002; Singh and Power, 2009; Terjesen et al., 2012; Wong et al., 2011; Wong et al., 2013)			0.880	0.912	0.884	0.676
SUIN1	We share relevant information (i.e., technical, production plan, demand forecast) with our main suppliers through information technologies.	0.788	15.494				
SUIN2	We have a high degree of strategic partnership with suppliers.	0.823	20.768				
SUIN3	We have a high degree of joint planning to obtain rapid response ordering process (inbound) with suppliers.	0.880	35.106				
SUIN4	Our suppliers provide information to us about their production planning.	0.827	22.370				
SUIN5	We involved our suppliers in our product development processes.	0.790	14.529				
	Market knowledge (adapted and inspired by Jansen et al., 2006)			0.704	0.834	0.714	0.628
MKKN1	Capability for being updated with market knowledge.	0.736	11.297				
MKKN3	Capability for developing quality in products (as the market requires).	0.815	18.630				
MKKN5	Capability for using new technologies and knowledge.	0.823	28.324				
	Product development (adapted and inspired by Jansen et al., 2006)			0.707	0.872	0.707	0.773
PRDE1	Capability for developing new products.	0.876	30.882				
PRDE2	Capability for developing improvements in existing products.	0.883	37.174				

Following the servitization continuum (Martinez et al., 2010) in the sample, 15.3% of the companies do not servitize at all, 25.0% interact but mainly in a transactional way (adding peripheral services), 19.2% servitize in product and service delivery, 25.0% servitize customising product and service, and 15.4% servitize at the highest level with product and service codesigned.

When including servitization level as a grouping variable in the model, the sample size was an important limitation on the number of groups to be considered, because only two groups could be managed. Using the ANOVA technique to analyse the relations between the four levels of servitization and the variables measuring supply chain integration and product innovation capability, we decided to separate companies into two groups: a) those who do not servitize or do so with low and transactional levels (levels 1, 2 and 3 in the scale) and b) those who do servitize at high and relational levels (levels 4 and 5).

In this research model, the servitization level has been constructed as a grouping variable with only two categories: non- or lowly, and highly servitized companies. Non- or lowly servitized companies are those included in the first three levels of the scale (no servitization, interaction mainly transactional as addition of peripheral services, or product and service delivery). Highly servitized companies are only those that customise or codesign product and service, showing a higher-level interaction. In the sample, 62 companies (59.6%) have a non- or low level of servitization and 42 companies (40.4%) have a high level.

3.2.4. Control variables: size (employees) and position in the supply chain

In order to avoid confounding effects, two control variables, size and position in the supply chain, were also included in the model.

In the questionnaire, company size was measured by an ordinal scale with four levels: 1) between 5 and 9 employees; 2) between 10 and 49; 3) between 50 and 249; and 4) 250 or more employees. Table 1 shows the proportion of companies in the sample for each level of size. Analysing the relation between size and servitization level (with the continuum five-level scale), we decided to include the number of employees as a dichotomous variable where 0 means small size (between 5 and 249 employees) and 1 means large size (250 or more employees). In the sample, 69.2% of the companies are small and 30.8% are large.

In the survey, the position of the company in the supply chain was measured with a five-level ordinal scale: 1) OEM; 2) Tier 1; 3) Tier 2; 4) Tier 3–4; and 5) Raw Material Supplier. Table 1 shows the proportion of companies in the sample in each of these five positions. After analysing the relation with the servitization level, we decided to maintain the measure in the model as a single variable with values from 1 to 5, where larger values mean that the firm is further away from the final consumer.

As mentioned before, the target population of the study was manufacturing companies (code 10 to 33 in NACE, 2009) with more than five employees located in the Basque Region. The questionnaire delivered allowed the classification of manufacturing companies within sectors, but given the limitation of the sample size and the characteristics of the companies in the Basque Region, it was very difficult to adopt a reasonable classification related to servitization level. So, although Table 1 includes a description with four categories, no sector indicator was ultimately included in the model.

In the sample of the 62 companies that were not servitized or lowly servitized, 19.4% were large (250 or more employees), whereas of the 42 companies that were highly servitized, 47.6% were large. This means that servitization level had a significant positive relation with size.

Non- or lowly servitized companies' distribution with respect to supply chain position was as follows: 21.2% OEM, 9.6% Tier 1, 17.3% Tier 2, and 11.5% Tier 3–4 or RM supplier. In highly servitized companies the distribution was as follows: 14.4% OEM, 12.5% Tier 1, 10.6% Tier 2, and 2.9% Tier 3–4 or RM supplier.

3.3. Measurement model evaluation

The measurement model analysis had been developed through three

main criteria: scale, reliability, and validity of the first- and the second-order constructs. For the five first-order latent constructs, items with loadings of 0.707 or more were accepted and items with loadings between 0.5 and 0.707 were analysed. Three indicators were removed (CUIN5 Involving customers in product development, MKKN2 capability of developing our brand, and MKKN6 capability of innovation in marketing and sales). Consequently, 19 items were maintained: 14 related to supply chain integration (five for internal integration, four for customer integration and five for supplier integration) and five related to product innovation capability (three for market knowledge and two for product development). Table 2 presents the accepted items with their factor loadings and significance levels, as well as the reliability and convergent validity of the first-order constructs. The five first-order reflective constructs of the model have Cronbach's alpha (α) and composite reliability (CR) values higher than 0.7, indicating the reliability of the set of indicators (Hair et al., 2017). In addition, the convergent validity was assessed by examining the average variance extracted (AVE) and composite reliability with Dijkstra–Henseler's rho (ρ_A). In all of the latent first-order constructs, the AVE is above 0.5 (Fornell and Larcker, 1981) and the ρ_A is greater than 0.707 (Dijkstra and Henseler, 2015), confirming both convergent and composite validity.

Additionally, in the model, there is also one second-order formative construct, product innovation capability, which is composed of market knowledge and product development first-order constructs. This molar construct was evaluated in terms of indicator outer weights and their significance and in terms of collinearity. The outer weights are 0.605 with market knowledge dimension and 0.541 with product development dimension, both being significant. There were no collinearity issues because the maximum variance inflation factor was 1.374, much lower than the suggested threshold of 3.3 (Petter et al., 2007).

Lastly, discriminant validity was assessed by looking at the cross loadings and applying the Fornell and Larcker criterion. At item level, it is verified that each item loads higher to its own construct than with any other construct. At construct level, the square root of AVE for each construct is greater than the correlations involving the construct (Fornell and Larcker, 1981), confirming discriminant validity. Table 3 presents these results.

Previous results and analyses of the measurement model evaluation were computed with all the companies in the sample. Similar studies were carried out separately for companies in the two groups of servitization: non- or lowly servitized and highly servitized companies. These two analyses and tables are omitted so as not to extend the explanations.

4. Results

This section presents the results for the statistical and structural model analyses performed for the model research. The structural model was assessed by examining the path significance and effect of each hypothesised relationship and its explanatory power.

4.1. Differences between highly servitized and non- or lowly servitized companies

To analyse the possible existing differences between the results for low and high servitization level groups in supply chain integration as well as in product innovation capability, comparisons of the scores obtained in the latent variables were performed with nonparametric tests.

Mean parametric tests are not appropriate when using ordinal data (Nunnally and Berstein, 1994) or when data is skewed (Pallant, 2013). We used a nonparametric Wilcoxon test to compare highly servitized versus non- or lowly servitized companies. Results are presented in Table 4a and Table 4b. The first shows comparisons of items and the last shows comparisons of constructs with standardized scores in latent variables.

At item level all the differences are positive, with a larger value in highly servitized companies, but they are not always significant. For

Table 3
Discriminant validity.

Abbr.	Int.Int.	Cus.Int.	Sup.Int	Mk.knw	Prd.dev.	PIC	Size	Position
Int.Int.	(0.772)							
Cus.Int.	0.477	(0.734)						
Sup.Int.	0.324	0.470	(0.822)					
Mk.knw.	0.302	0.407	0.283	(0.792)				
Prod.dev.	0.343	0.313	0.356	0.521	(0.879)			
PIC	0.369	0.421	0.362	0.901	0.840	NA		
Size	0.086	0.062	0.149	0.072	-0.023	0.035	(1.000)	
Position	-0.048	0.106	-0.119	0.196	0.117	0.184	-0.218	(1.000)

Off diagonal shows correlations. Diagonal in parentheses shows square root of AVE.

Table 4a
Differences between highly servitized and non- or lowly servitized companies: Items (1–7 scale).

Item	Highly servitized		Non- or lowly servitized		Mean Difference HS – LS	z	p-value
	Mean	Std. Dev.	Mean	Std. Dev.			
ININ1	5.833	0.961	5.532	1.155	0.301	1.145	0.252
ININ2	5.857	1.201	5.435	1.421	0.422	1.515	0.130
ININ3	6.190	0.943	5.597	1.234	0.594*	2.580	0.010
ININ4	5.976	1.000	5.435	1.111	0.541**	2.667	0.008
ININ5	6.190	0.833	5.677	1.252	0.513	1.963	0.050
CUIN1	5.500	1.153	4.500	1.328	1.000***	3.748	<0.001
CUIN2	5.738	1.149	5.161	1.148	0.577**	2.660	0.008
CUIN3	5.357	1.376	4.387	1.475	0.970**	3.255	0.001
CUIN4	5.333	1.476	4.613	1.712	0.720*	2.033	0.042
SUIN1	5.024	1.370	4.306	1.636	0.717*	2.190	0.029
SUIN2	5.405	1.466	4.306	1.752	1.098**	3.187	0.001
SUIN3	5.262	1.449	4.403	1.644	0.859**	2.673	0.008
SUIN4	4.810	1.642	4.048	1.769	0.761*	2.154	0.031
SUIN5	4.786	1.788	4.194	1.735	0.592	1.713	0.087
MKKN1	5.048	1.035	4.613	1.061	0.435	1.949	0.051
MKKN3	5.643	1.032	5.387	1.030	0.256	1.326	0.185
MKKN5	5.548	1.017	4.645	1.010	0.902***	4.220	<0.001
PRDE1	5.190	1.194	4.855	1.129	0.336	1.202	0.229
PRDE2	5.286	1.088	4.774	1.015	0.512*	2.393	0.017

p-values for two tailed tests. *p < 0.05, **p < 0.01, ***p < 0.001.

example, in product development dimension item 1 (Capability for developing new products) the difference is positive but not significant even at the 10% level. Nevertheless, at construct level (with standardized scores), all the differences are positive and significant at the 5% level.

As expected, we discovered higher values in supply chain integration and product innovation capability for highly servitized companies. Companies that customized or co-designed products and services have higher internal, customer, and supplier integration than companies that do not servitize at all or servitize only transactionally or upon delivery. Furthermore, highly servitized companies have higher capabilities in market knowledge and product development, and innovation as a whole than non- or lowly servitized companies.

Table 4b
Differences between highly servitized and non- or lowly servitized companies: Constructs (standardized).

Construct	Highly servitized		Non- or lowly servitized		Mean Difference HS – LS	z	p-value
	Mean	Std.Dev.	Mean	Std.Dev.			
Internal integr.	0.316	0.789	-0.214	1.083	0.529*	2.376	0.018
Customer integr.	0.461	0.863	-0.313	0.979	0.774***	3.813	<0.001
Supplier integr.	0.349	0.875	-0.236	1.025	0.585**	3.108	0.002
Market knowledge	0.378	1.024	-0.256	0.914	0.634**	3.283	0.001
Prod. development	0.262	1.012	-0.178	0.968	0.440*	2.105	0.044
Prod. innov. capab.	0.377	1.065	-0.256	0.882	0.633**	3.280	0.001

p-values for two tailed tests. *p < 0.05, **p < 0.01, ***p < 0.001.

4.2. Structural model evaluation

In order to test the hypotheses posed in the research model, PLS-SEM analysis with bootstrapping (5000 samples) was carried out, and path coefficients (betas) with their statistical significance as well as the variance explained (R²) for the dependent variables were obtained. This analysis was performed first with all the companies in the sample and afterwards separately for each of the two groups: non- or lowly servitized (LS) and highly servitized (HS) companies. Results are summarized in Fig. 2.

The model fit is acceptable as the standardized root mean square residual (SRMR) is less than the threshold of 0.08 proposed by Hu and Bentler (1998) for the whole model (0.069) and for the non- or lowly servitized model (0.068). For the highly servitized model, the SRMR is 0.085 slightly above the threshold.

Full details about the path coefficients (betas), with their significance and variance explained (R²) for each dependent variable in the model, are reported in Tables 5a, 5b, and 5c. The first was computed with all the companies in the sample, and the last two were only computed with highly servitized companies and with non- or lowly servitized companies, respectively. When the dependent variable is product innovation capability total effects (Tot.Eff.), it is also indicated for those predictors that include indirect effects.

The empirical results demonstrate that internal integration precedes external integration for the whole model. Product innovation capability has an R² value of 0.276, which means that the model explains a good amount of its variance, and two path coefficients indicate that internal integration and supplier integration positively and significantly impact product innovation capability.

Regarding the control variables, with all the companies, size seems not to have significant influence on supply chain integration or product innovation capability, but position positively relates with product innovation capability, indicating that the further the company is from the final customer the higher is its product innovation capability. However, to draw generalised conclusions, a deeper analysis is required as the companies classified as raw materials providers in the sample make up a small number of firms with a highly customized product.

Considering only highly servitized companies, product innovation capability has an R² value of 0.417, showing that an important amount of variance is explained, but only one path coefficient is significant pointing out that customer integration has a strong positive influence on

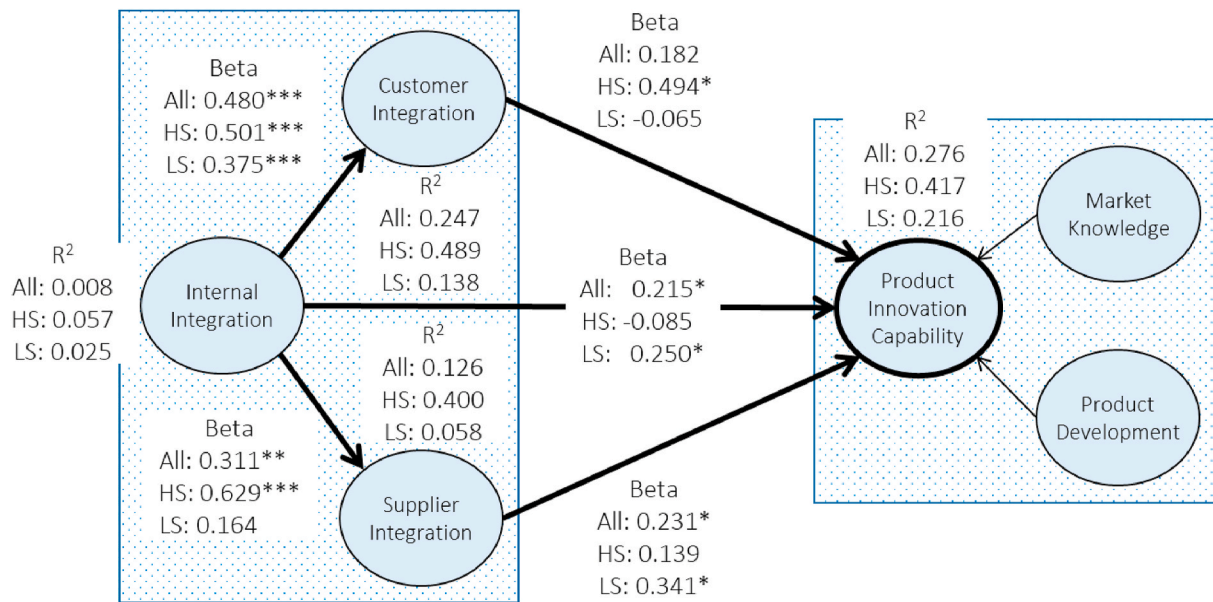


Fig. 2. Result of the structural model.

Table 5a
Path coefficients and variance explained: All companies.

Structural paths	Beta	t-value	p-value
Predictor variables			
Direct effects			
Internal integr. → Customer integr.	0.480***	5.698	<0.001
Internal integr. → Supplier integr.	0.311**	3.195	0.001
Internal integr. → Prod. innov. capab.	0.215*	2.075	0.019
Customer integr. → Prod. innov. capab.	0.182	1.366	0.086
Supplier integr. → Prod. innov. capab.	0.231*	1.822	0.035
Total effects			
Internal integr. → → Prod. innov. capab.	0.374***	4.396	<0.001
Control variables			
Direct effects			
Size → Internal integr.	0.079	0.870	0.192
Position → Internal integr.	-0.031	0.351	0.363
Size → Customer integr.	0.051	0.593	0.277
Position → Customer integr.	0.141	1.573	0.058
Size → Supplier integr.	0.105	1.196	0.116
Position → Supplier integr.	-0.081	0.965	0.167
Size → Prod. innov. capab.	0.011	0.095	0.462
Position → Prod. innov. capab.	0.203*	2.210	0.014
Total effects			
Size → → Prod. innov. capab.	0.075	0.563	0.287
Position → → Prod. innov. capab.	0.198*	1.834	0.034
Structural model fit			
Internal integr. R ² = 0.008			
Customer integr. R ² = 0.247			
Supplier integr. R ² = 0.126			
Prod. innov. capab. R ² = 0.276			

p-values for one tailed tests. *p < 0.05, **p < 0.01, ***p < 0.001.

product innovation capability. Nevertheless, unlike in the whole model, internal and supplier integration do not have significant effect on innovation. In this sense, as well as in the whole model, internal integration precedes external integration. However, the direct effect of servitization on product innovation capability, unless it is not significant, is sufficiently negative to cause its total effect on product innovation capability to become not significant. This somewhat counterintuitive finding requires further research and an increase in the sample size to better understand this behavior.

When only non- or lowly servitized companies are analysed, product innovation capability has a good value of 0.216 in R², and just as in the

Table 5b
Path coefficients and variance explained: Highly servitized companies.

Structural paths	Beta	t-value	p-value
Predictor variables			
Direct effects			
Internal integr. → Customer integr.	0.501***	4.341	<0.001
Internal integr. → Supplier integr.	0.629***	6.509	<0.001
Internal integr. → Prod. innov. capab.	-0.085	0.286	0.387
Customer integr. → Prod. innov. capab.	0.494*	1.901	0.029
Supplier integr. → Prod. innov. capab.	0.139	0.699	0.242
Total effects			
Internal integr. → → Prod. innov. capab.	0.251	1.150	0.125
Control variables			
Direct effects			
Size → Internal integr.	0.152	0.955	0.170
Position → Internal integr.	0.200	1.319	0.094
Size → Customer integr.	-0.154	1.294	0.098
Position → Customer integr.	0.388**	3.222	0.001
Size → Supplier integr.	-0.187	1.517	0.065
Position → Supplier integr.	-0.271**	2.822	0.002
Size → Prod. innov. capab.	0.076	0.538	0.296
Position → Prod. innov. capab.	0.232	0.880	0.190
Total effects			
Size → → Prod. innov. capab.	0.012	0.080	0.468
Position → → Prod. innov. capab.	0.436*	2.344	0.010
Structural model fit			
Internal integr. R ² = 0.057			
Customer integr. R ² = 0.489			
Supplier integr. R ² = 0.400			
Prod. innov. capab. R ² = 0.417			

p-values for one tailed tests. *p < 0.05, **p < 0.01, ***p < 0.001.

whole model, path coefficients indicate that internal integration and supplier integration positively and significantly impact product innovation capability. In summary, nevertheless, although internal integration maintains its positive effect on customer integration for the non- or lowly servitized companies, its influence on supplier integration is positive but ceases to be significant. Thus, hypothesis H1a is supported and H1b is partially supported.

Before proceeding to analyse whether the differences between low and high servitization levels are statistically significant, it is interesting to highlight that the impact of supply chain integration on product innovation capability has been verified in some cases. Any one of the

Table 5c
Path coefficients and variance explained: Non- or lowly servitized companies.

Structural paths	Beta	t-value	p-value
Predictor variables			
Direct effects			
Internal integr. → Customer integr.	0.375**	3.136	0.001
Internal integr. → Supplier integr.	0.164	1.260	0.104
Internal integr. → Prod. innov. capab.	0.250*	1.905	0.029
Customer integr. → Prod. innov. capab.	-0.065	0.388	0.349
Supplier integr. → Prod. innov. capab.	0.341*	1.915	0.028
Total effects			
Internal integr. → → Prod. innov. capab.	0.281*	2.143	0.016
Control variables			
Direct effects			
Size → Internal integr.	-0.109	0.866	0.194
Position → Internal integr.	-0.149	1.281	0.100
Size → Customer integr.	0.021	0.189	0.425
Position → Customer integr.	0.019	0.164	0.435
Size → Supplier integr.	0.188*	1.666	0.048
Position → Supplier integr.	-0.001	0.007	0.497
Size → Prod. innov. capab.	-0.147	0.864	0.194
Position → Prod. innov. capab.	0.176	1.282	0.100
Total effects			
Size → → Prod. innov. capab.	-0.115	0.675	0.250
Position → → Prod. innov. capab.	0.132	0.960	0.169
Structural model fit			
Internal integr. R ² = 0.025			
Customer integr. R ² = 0.138			
Supplier integr. R ² = 0.058			
Prod. innov. capab. R ² = 0.216			

p-values for one tailed tests. *p < 0.05, **p < 0.01, ***p < 0.001.

three types of integration has a positive effect on product innovation capability. In the whole sample and in non- or lowly servitized companies, both internal integration and supplier integration positively and significantly affect product innovation capability. Conversely, in highly servitized companies, customer integration is the only variable that has a significant positive influence on product innovation capability.

4.3. Model differences between highly servitized and non- or lowly servitized companies

To gain further insight into the differences between companies that have a high level of servitization and those with a low level, multigroup bootstrapping was executed in order to determine if the differences between the path coefficients of the models for highly and non- or lowly servitized were statistically significant. Table 6 presents these differences (i.e., highly servitized – non- or lowly servitized) with the t-values and p-values of the Welch–Satterwhite test.

Regarding the intensity of the impact of supply chain integration on product innovation capability, only the influence of customer integration on innovation shows a significant difference. The impact is stronger when companies are highly servitized than it is when they are non- or lowly servitized.

Thus, hypothesis H2 regarding higher integration’s positive impact on highly servitized companies has only been significantly verified for the impact of customer integration on product innovation capability. Consequently, H2b is supported and H2a and H2c are rejected.

In sum, the structural model support three (one of them partially), and reject two hypotheses as shown in Table 7.

5. Conclusion, limitations of the analysis, and areas for further research

This research addresses the role of supply chain collaboration in developing a sustainable competitive advantage by fostering product innovation capability in the context of servitized and non- or lowly servitized companies. Based on the literature review, we argued that a

Table 6
Differences in path coefficients.

Structural paths	Be Diff H-L	t-value	p-value
Predictor variables			
Direct effects			
Internal integr. → Customer integr.	0.127	0.750	0.228
Internal integr. → Supplier integr.	0.465**	2.748	0.004
Internal integr. → Prod. innov. capab.	-0.334	1.136	0.129
Customer integr. → Prod. innov. capab.	0.559*	1.851	0.034
Supplier integr. → Prod. innov. capab.	-0.202	0.790	0.216
Total effects			
Internal integr. → → Prod. innov. capab.	0.031	0.121	0.462
Control variables			
Direct effects			
Size → Internal integr.	0.262	1.346	0.091
Position → Internal integr.	0.350*	1.951	0.027
Size → Customer integr.	-0.176	1.063	0.145
Position → Customer integr.	0.369*	2.145	0.017
Size → Supplier integr.	-0.375*	2.219	0.014
Position → Supplier integr.	-0.270	1.542	0.063
Size → Prod. innov. capab.	0.224	0.990	0.162
Position → Prod. innov. capab.	0.057	0.198	0.422
Total effects			
Size → → Prod. innov. capab.	0.127	0.562	0.288
Position → → Prod. innov. capab.	0.304	1.261	0.107

p-values for one tailed tests. *p < 0.05, **p < 0.01, ***p < 0.001.

Table 7
Hypotheses testing results.

	t-value	p-value	Hypothesis
H1a: Internal integr. impact on Customer integr.			Supported
Beta Highly servitized	0.501***	4.341	<0.001
Beta Non- or lowly servitized	0.375**	3.136	0.001
H1b: Internal integr. impact on Supplier integr.			Partially supported
Beta Highly servitized	0.629***	6.509	<0.001
Beta Non- or lowly servitized	0.164	1.260	0.104
H2a: Internal integr. impact on Product innov. capability is higher with higher servitization levels			Rejected
Beta Diff H-L (Direct effect)	-0.334	1.136	0.129
Beta Diff H-L (Total effect)	0.031	0.121	0.462
H2b: Customer integr. impact on Product innov. capability is higher with higher servitization levels			Supported
Beta Diff H-L	0.559*	1.851	0.034
H2c: Supplier integr. impact on Product innov. capability is higher with higher servitization levels			Rejected
Beta Diff H-L	-0.202	0.790	0.216

synergetic effect between collaboration and innovation capabilities can be expected in servitized companies. Thus, using a sample of 104 manufacturing companies from the Basque Country, we investigated two main aspects that were formulated as research questions in the context of a comparison between non- or lowly servitized and highly servitized companies.

The first question tackles the relationship between supply chain integration dimensions considering non- or lowly servitized and highly servitized companies. Servitization literature emphasizes the difficulties for companies to develop the required business model transformation, giving a prominent role to value chain relationships when servitizing (Bigdeli et al., 2018). Thus, we investigate both internal and external integration, considering supplier and customer relationships in the latter. We found that internal integration has relevant importance in developing higher levels of external integration, which positively and significantly impacts external integration as a whole. Moreover, in the case of high-level servitization, separately affects both customer

integration and supplier integration. This result aligned with that of Yu et al. (2013), who showed that internal integration is an enabler of external integration.

The second question faces the relationship between supply chain integration and innovation capabilities in the servitization context. Our results demonstrate higher values of the dimensions of supply chain integration and product innovation capability for highly servitized companies. These results confirm the arguments of previous studies that separately examined supply chain integration and servitization (Bustinza et al., 2019) and product innovation and servitization (Visnjic et al., 2016). On the one hand, servitization implies diversification, thus moving to a relational model in which the capability to understand the supply chain network dynamics (Bigdeli et al., 2018) and work with suppliers and partners (Visnjic et al., 2018) might become essential. On the other hand, the combination of servitization and product innovation is considered to provide additional opportunity for enhanced firm performance (Eggert et al., 2011; Visnjic et al., 2016). In this study we analyse the combined effect of the two elements (specifically: supply chain integration and product innovation capability) on manufacturing companies' servitization. In this sense, the results provide evidence on the asymmetrical impact of each dimension of supply chain integration on product innovation capability considering the servitization level. This clarifies the role of internal and external integration in the development of product innovation capability in both high- and non- or low servitization levels. Our results demonstrate that for highly servitized companies, internal integration alone cannot directly explain product innovation capability but external integration can do so indirectly. This result is aligned with Wong et al. (2013), who analysed the relationship between internal and external integration and product innovation enhancement in the Thai automotive industry. However, our study's results reveal a positive and significant impact of internal integration on product innovation capability for non- or lowly servitized companies. Regarding the impact of external integration as a whole and of customer integration on product innovation capability, the research findings indicate that a significant difference exists depending on the servitization level. Nevertheless, this impact was not observed with the other dimension: supplier integration. Thus, even supplier integration can play an important role in product innovation success (Un et al., 2010), but there is no evidence of its dependence on the firm's servitization level.

5.1. Theoretical implications

This study introduces an emergent yet insufficiently covered field (Kohtamäki et al., 2019)—the role of supply chain integration and product innovation capability in servitization. In a recent article on state-of-the-art research priorities, Baines et al. (2017) described supply chain integration and product innovation capability as emergent topics. Therefore, the present analysis provides several theoretical contributions that extend knowledge in the servitization field.

First, this study addresses a gap in the servitization literature, delving deeper into the relationship between supply chain integration, both internal and external, and product innovation capability to develop a sustainable competitive advantage. Previous servitization research has considered supply chain collaboration (Bigdeli et al., 2018), the ability to understand customer needs and work with suppliers and partners (Visnjic et al., 2018), and enhanced coordination capabilities to address the complexities of information processing and relationships (Benedettini et al., 2015) required by servitization. Although supply chain integration is considered relevant, the provision of services has often been analysed only partially, for example, from the perspective of make-or-buy (Bustinza et al., 2019) or just considering the customer side of the supply chain dimensions (Visnjic and van Looy, 2013). Simultaneously, the interrelationships within and outside an organisation are considered as facilitators of product innovation (Cenamor et al., 2019; Lambert and Cooper, 2000; Wong et al., 2013). Nevertheless, we are

unaware of any previous studies that have linked both value chain integration and innovation capability with the servitization level.

Second, a gap related to the exploitation of relationship management in the supply chain framework also exists. This study contributes with a better understanding of, first, the relationship between supply chain integration dimensions, identifying the prominent role of internal integration. Although servitization literature has largely argued about the difficulties faced while transforming the required business model, further considering their connections with an external relationship and distinguishing between customer and supplier sides are necessary. In this vein, this study established the importance of disaggregate supply chains in three dimensions. Moreover, this study enabled measurements of the direct and indirect effects of each dimension on the development of competitive advantage based on product innovation capabilities in the servitization framework. This approach was mentioned by Flynn et al. (2010), who defined supply chain integration as a multidimensional construct not related to servitization. Thus, from the quantitative perspective, these findings reinforce the prominent role of customer relationships in the servitization context, and more specifically, in the more advanced stages of the service continuum. The second contribution to fill this gap is the analysis of the impact of each dimension on product innovation capability. Although servitization has been considered an enabler for product innovation (Visnjic et al., 2016) and supply chain integration has been argued to be a facilitator for product innovation (Cenamor et al., 2019), both elements must be linked. We provide empirical evidence to demonstrate the relationship between supply chain integration dimensions, product innovation capabilities, and servitization. This approach is especially interesting because of the clear differences in managing the various dimensions of the supply chain and the prominence traditionally given to customers in this field.

Besides, the literature on servitization research is dominated by conceptual articles and qualitative studies (Rabetino et al., 2018). This study addresses the problem with a quantitative approach by considering a sample of more than 100 Basque manufacturing companies.

Moreover, most servitization studies focus on large and multinational companies but they fail to address the importance of small and medium-sized enterprises-SMEs (Kowalkowski et al., 2012), which comprise the majority of companies in Europe, particularly in Spain and more specifically in the Basque Country. SMEs usually lack the resources and capabilities to perform demanding processes such as servitization; thus, the extension of their capacities by forging relationships with other agents becomes a special and often essential tool of interest (Cenamor et al., 2019). Consequently, these findings are especially relevant in enhancing our understanding of how to address those obstacles.

5.2. Managerial and policy implications

This research also provides useful insights for business managers at manufacturing companies. Apart from the potential offered by product-service innovation and its sustainability, there is a clear need for reflection on the need for supply chain integration in achieving high-level servitization. First, companies should understand that efforts toward internal integration are prior to external collaboration. Secondly, in external integration, customers are the main actor to collaborate with when conducting high-level servitization.

In addition, practitioners must remember that despite many efforts, service infusion is a long and difficult process that requires determination and a long-term approach to be profitable and sustainable (Visnjic et al., 2016). Capabilities are always key to any strategy, and the complexity arising from the links between supply chain integration and innovation capabilities can become a source of sustainable competitive advantages (Barney, 1991). Interestingly, the underestimation of servitization's complexity is one reason why companies have difficulty profiting from the process (Gebauer et al., 2016).

Regarding SMEs specifically, customer integration can be more convenient as their lack of certain resources and capabilities may push

them to search for these in other agents (Kowalkowski et al., 2012). In doing this, capabilities for interaction become essential.

Policy makers can also take interesting insights from this research, mainly in regions with a sound industrial base where servitization can open new business opportunities as well as reinforce present manufacturing ones. The present situation, with predominantly low levels of integration, demonstrates that there is a wide margin for improvement. Provided that both supply chain integration and innovation capabilities are higher in firms with more advanced services, regional policies should include new efforts to boost collaboration within the ecosystem so as to seize on territorial servitization (Lafuente et al., 2017). Apart from boosting external collaboration, for example, within cluster policy, the research emphasizes the importance of internal integration capabilities, which is perhaps less widely-considered in policy agendas.

In addition, as SMEs constitute the majority in the sample and in the universe of firms in the Basque economy as well as the Spanish and European economies, collaboration capabilities within the supply chain may extend companies' boundaries, leveraging other capacities to enhance innovation capabilities and transit the path to servitization. In addition to financial or collaborative support, promoting awareness could be also very beneficial.

Furthermore, both managers and policymakers will take an interest in the fact that the servitization of manufacturing companies may not only serve as a way to defend firms and employment in very competitive markets (Crozet and Milet, 2017), but also to generate new business models and innovate (Cusumano et al., 2015) by creating blue ocean strategies (Kim and Mauborgne, 2005).

5.3. Limitations and future research

Future research projects can address the limitations of this study. First, if the number of respondents is increased, more solid and generalizable statistical results and new analyses would become possible, such as determining sectoral-level differences. Second, further research could explore in more depth why, contrary to customer integration, both supplier and internal integration only impact product innovation capability in low-level servitization. Third, no consensus yet exists in the literature on the relevant innovation capabilities for servitization strategy, so investigation in this area might provide a useful contribution. Lastly, this analysis utilized cross-sectional rather than longitudinal data. It would be interesting to analyse the evolution of these capabilities and their impact on the servitization level in the Basque manufacturing industry and/or conduct a comparison with other regions. Because supply chain integration is a progressive process, the stages of integration should be considered to set simpler and more concrete goals during the initial phase of the relationship.

Furthermore, delving deeper into cases concerning the level and particularities of both value chain integration and product innovation capability in highly servitized companies might be quite fruitful. By developing case studies to understand the particularities of these relationships according to specific supply chain conditions, industry and other specific characteristics might be determined. From such research very interesting insights might be gained for companies, researchers, and policymakers.

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