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# **The moderating effect of supply chain collaboration on servitization**

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(Authors' version)

## **Abstract**

### **Purpose**

Supply chain collaboration (SCC) is an important element that contributes to enhanced performance. Nonetheless, there is still a need to understand its role in servitization implementation and outcomes. This research attempts to address this gap by looking at the impact of SCC on servitization outcomes and performance when considering different service levels (base, intermediate and advanced).

### **Design/methodology/approach**

Following a quantitative research design, data were collected from firms in the pharmaceutical sector using a questionnaire distributed online with a 29% response rate. Results were analysed using structural equation modelling.

### **Findings**

Results suggest that SCC is a crucial moderator when it comes to the influence of service levels on servitization outcomes and performance, particularly for advanced and intermediate services.

### **Originality/value**

This study contributes to the literature by providing further empirical evidence of the impact of intermediate and advanced services shedding light on the moderating role of SCC.

**Keywords:** Servitization, supply chain collaboration, performance.

## **Introduction**

The servitization literature has highlighted that firms that engage their customers in service design strategies are more successful (Fliess and Lexutt, 2019; Johansson et al., 2019; Smania et al., 2022). Given the importance of customers' feedback (e.g. retailers, supply chain buyers, etc.) and not only the feedback of the final consumers/users,

collaboration at the supply chain level is key to ensuring that the designed services fit customers' needs but also to ensure the smooth delivery of these services (Morgan-Thomas, 2016; Pilon and Hadjielias, 2017; Ruiz-Alba et al., 2019ab; Johansson et al., 2019; Brege and Daniel Kindström, 2021; Kreye and Donk, 2021). Referring to the introduction of services in manufacturing, servitization is not a new field of research but it still lacks consensus over its definitions, theoretical backgrounds, and impact (Pinillos et al., 2022). Furthermore, because most of the servitization research has been focused on the focal manufacturing firm, an examination of the servitization literature shows a limited understanding of the role of inter-firm relationships and supply chain collaboration (SCC) (Bikfalvi et al., 2013; Finne and Holmström, 2013; Xu et al., 2020; Galvani and Bocconcelli, 2022). In an attempt to shed light on this gap, this investigation focuses on the influence of SCC on servitization.

The evolution of the servitization concept (Pinillos et al., 2022) and research trends suggests a clear move from selling products to providing solutions (Gebauer et al., 2013; Huikkola and Kohtamäki, 2017) in which more than focusing on services that add value to products, companies see products almost as additional conditions of product-service offerings. This trend has occurred across industries including the pharmaceutical industry, as analysed by Ruizalba et al. (2015, 2016, 2019b). These authors applied the service levels categorisation (developed in Baines and Lightfoot, 2013) to the pharmaceutical industry, characterizing the different types of services in this industry in Spain and Portugal. They have also identified three strategic factors for pharmaceutical distributors to engage in the design and implementation of services that included: the pursuit of profitability, the pursuit of competitive advantage and the pursuit of loyalty. In this context, servitizing firms are the pharmaceutical suppliers/distributors, and the servitized firms are the pharmacy stores, both having different views on the importance, development, and usage of the created services, assuming that value is defined by and cocreated with the consumer rather than embedded in output (Vargo and Lusch, 2004).

Continuing further from this analysis by Ruizalba et al. (2015, 2016, 2019b), the present study presented in this paper focuses specifically on the role of collaboration in this servitization SC dynamic.

Servitization implies the development of processes and capabilities (Baines et al., 2009; Sousa and Silveira, 2017; Manresa et al., 2021), therefore the implementation of such a strategy will only make sense if the servitizing firms clearly understand and identify those capabilities and processes which servitized firms wish and need to develop. Hence, this definition and identification of services should be a collaborative process as previously suggested by the service innovation literature (Fliess and Lexutt, 2019; Johansson et al., 2019; Smania et al., 2022). If the servitized firms suggest that they have low levels of cooperation with suppliers, this will raise the question of whether the services provided are in fact those they actually need and if servitization strategies can be actually considered in such conditions. Therefore, we propose the following research question: *how do the different levels of services influence servitization and performance outcomes moderated by supply chain collaboration?*

As a result, this study analyses the moderating role of SCC in the implementation of different levels of services and their impact on servitization outcomes and performance. To achieve this, the remaining of the paper is structured in the following manner: first, an overview of the literature on SCC, servitization and performance is provided, followed by a suggested research framework; then methodological decisions are explained, and the

main findings are presented and discussed; finally, the paper concludes highlighting main theoretical and practical contributions and recommendations.

### **Supply chain collaboration (SCC)**

Collaboration between firms is a concept that has been studied in the context of supply chain management under many definitions (Danloup et al., 2013). Looking for partner companies to collaborate to achieve superior value is not a new concept (Corsten and Kumar, 2005). Since 1989 that Håkansson and Snehota stated that “no business is an island”. Nevertheless, although collaboration has been investigated since the late 1980’s and early 1990’s in the supply chain literature (Bowersox and Daugherty, 1987; Ellram and Cooper, 1990), not many companies engage in actual supply chain collaboration even when they acknowledge its potential, mainly due to its associated costs (Sabath and Fontanella, 2002; Fawcett and Magnan, 2004; Min et al. 2005; Chaney et al., 2022). Furthermore, a clear trend can be seen in research moving away from considering solely dimensions of inter-firm relationships such as trust, commitment, information sharing, etc (with studies such as those from Fynes et al., 2005; Fwcett et al., 2007; Panahifar et al., 2018; Baah et al., 2022; Jang and Lee, 2022), towards a focus on what constitutes SCC and the operationalization of this construct (with studies such as Cao and Zhang, 2011; Danloup et al., 2013; Kumar, 2021).

The marketing channels literature has frequently examined relationships and their efficiency through a relationship marketing perspective (Sin et al., 2005). Recent studies have highlighted the need for further research in this field, emphasising the significance of SCC to the business community (Fliess and Lexutt, 2019; Johansson et al., 2019; Smania et al., 2022). SCC is no longer an option but a requirement to successfully compete (Nguyen et al., 2019; Kumar, 2021). Organisations have moved from considering single market transactions to considering relational exchanges, where the roles of buyers and suppliers are no longer narrowly defined as a transfer of ownership of products, but also consider knowledge, trust, and other relational variables (Nguyen et al., 2019; Kreye and Donk, 2021; Liu et al., 2021; Sharma, 2022; Solem et al., 2022). These foundations apply to all types of collaboration and there are three commonly used types of collaboration: vertical collaboration, horizontal collaboration, and lateral collaboration (Danloup et al., 2013; Soosay and Hyland, 2015).

Aligned with this evolution, SCC has been defined both as a business process (e.g., Mentzer et al., 2000; Stank et al., 2001) and as a network of relationships (e.g., Bowersox et al., 2003; Golicic et al., 2003). For example, Simatupang and Sridharan (2002, p. 19) define SCC as “two or more independent companies (that) work jointly to plan and execute supply chain operations with greater success than when acting in isolation”. Fawcett et al. (2008) argue that more than efficiency, SCC implies managing relationships for innovation and continuous improvement, aiming at joint problem solving and delivering expected customer value. Whipple et al., (2010) understand SCC as a long-term relationship where participants cooperate, share information, and work together towards the improvement of joint performance. Cao and Zhang (2011, p.166) define SCC as “a partnership process where two or more autonomous firms work closely to plan and execute supply chain operations toward common goals and mutual benefits”. Danloup et al. (2013) define SCC in terms of cost-effective, timely, and reliable joint activities that generate customer satisfaction. According to Soosay and Hyland (2015:613), SCC involves multiple firms or autonomous business entities engaging in a relationship (with an appropriate level of trust, critical information sharing, joint decision

making and integrated supply chain processes) that aims to share improved outcomes and benefits. In a recent paper, Kumar (2021) argues that the main idea behind SCC is to create relational rents to build dynamic capabilities and achieve distinctive advantages. Following these definitions, SCC can be understood with two underlying major foundations: design and government of supply chain activities, and the supply chain relationships (Danloup et al., 2013; Kumar, 2021). Hence, Day et al. (2015) highlights the need for collaboration management and coordinated sourcing as important aspects of supply management capabilities, supporting their positive impact on performance.

Independently of what definition of collaboration is adopted, it is clear that SCC involves both a process and a network of relationships between different companies in supply chain operations which is how we look at it in this study. But given its broad definitions and operationalizations in the literature, further research is still required to understand the practical value of SCC, particularly regarding the link between SCC, servitization, and subsequent outcomes (Bikfalvi et al., 2013; Finne and Holmström, 2013; Xu et al, 2020; Kumar, 2021; Chaney et al., 2022; Galvani and Bocconcelli, 2022; Wang et al. 2022).

### **Supply chain collaboration (SCC) and servitization**

The concept of servitization was first defined by Vandermerwe and Rada (1988), but it remained an area of continuous interest and evolution since then. Servitization has been defined over the years differently depending on the discipline (strategic management, marketing, operations, service management, IT, etc.) and the time period (Pinillos et al., 2022). The most agreed definition sees servitization as a means to create added value to traditional offerings by developing new capabilities and improving processes (Baines et al., 2009; Baines and Lightfoot, 2013; Sousa and Silveira, 2017). Baines et al (2009) have also suggested the existence of different levels of services (base, intermediate and advanced) with different impacts on capabilities and performance (Baines, Lightfoot and Smart, 2011). According to Baines and Lightfoot (2013), base services refer to the outcomes focused on product provision and production competence (examples include product/equipment provision, spare part provision, warranty); intermediate services are the outcomes focused on maintenance of product condition (e.g., scheduled maintenance, technical help-desk, repair, overhaul, delivery to site, operator training, condition monitoring, in-field service); and advanced services are the outcomes focused on capability delivered through performance of the product (such as customer support agreement, risk and reward sharing contract, revenue through-use contact).

The literature on servitization and performance is well established with various studies showing support for the positive impact of servitization on various types of performance (e.g., Antioco et al., 2008; Fang et al., 2008; Neely, 2008; Hultén, 2012; Vendrell-Herrero, et al., 2014; Wang et al., 2018; Sjödin et al., 2019; Queiroz et al., 2020; Zhang et al., 2019; Zhou et al., 2020; Abou-foul et al., 2021; Manresa et al., 2021). For example, Wise and Baumgartner (1999) used a case study approach to suggest the influence of servitization on performance. Vendrell-Herrero, et al., (2014) suggested that servitization had a positive influence on firm performance. Wang et al. (2018) supported the positive impact of servitization and performance through a quantitative review of the servitization-performance relationship using a meta-analytic approach. Sjödin et al. (2019) identified the influence on firm performance. Queiroz et al. (2020) found a positive relationship between servitization and performance in Brazilian SMEs, including the impact of offering base services. Moreover, Zhang et al (2019) demonstrated a lack of

impact of servitization on performance. Using data from 143 servitized Chinese manufacturers, Zhou et al. (2020) investigated how a manufacturer's service supply network moderates the effect of performance on servitization. More recently, Abou-foul et al. (2021) found that digitalization and servitization had a positive impact on performance, supporting that in order to achieve superior bottom-line results, companies must integrate digital and service-specific capabilities that reinvent the nature of an offering. Aligned with this, using a dataset of 205 Spanish and Croatian manufacturing firms, Manresa et al. (2021) tested the capabilities–service–performance chain. These authors found that digital capabilities are important for the provision of all three groups of services (base, intermediate and advanced).

However, most studies tend to focus on direct impacts on performance with varying measures of both servitization and performance being used. Therefore, there is still a need to explore the moderating and mediating factors involved in this relationship between servitization and performance, particularly when it comes to the relationships between companies.

When looking specifically at the literature on collaboration (and not co-creation of value or any of the other key variables commonly associated with collaboration) in the context of servitization, a few studies can also be mentioned that support further research needs (e.g., Ayala et al., 2017; Weigel and Hadwich, 2018; Grandinetti et al., 2020; Polova and Thomas, 2020; Tronvoll et al., 2020; Xu et al., 2020; Wu et al., 2021; Chaney et al., 2022; Solem et al., 2022; Wang et al., 2022). Focusing on different types of collaboration, Ayala et al. (2017) explored how manufacturing companies aiming at a servitization-driven business model innovation (BMI) integrated knowledge from service suppliers. These authors suggested a theoretical framework combining two main approaches for servitization-driven BMI (product-oriented and service-oriented product-service systems) and three main configurations of relationships (white, grey and black box configurations) with service suppliers based on traditional new product development classifications of buyer-supplier integration. Weigel and Hadwich (2018) researched the influence of key factors on performance and long-term partner retention of service networks in the context of servitization. Grandinetti et al. (2020) looked at digital servitization in B2B contexts by analysing how Industry 4.0-based servitization affected the quality of supplier–customer relationships. Examining the strategic organizational shifts that underpin digital servitization, Tronvoll et al. (2020) found that organizational identity, dematerialization, and collaboration played a key role in this digital servitization transformation. Focusing on three service strategies (after-sales service; maintenance, repair and operations) and the product-service system Xu et al. (2020) reviewed the literature and found that although SC for product-service systems depends more heavily on the implementation of the cooperation, collaboration and integration principles in operation, these principles were not evidenced in the current literature. Liu et al. (2021) examined service value chain collaboration from a systematic perspective, proposing a collaboration framework based on cloud platform for service value chain with a comprehensive consideration of coordination. Examining data collected from 175 Chinese manufacturing firms, Wu et al. (2021) also found support for the role of value chain collaboration in business model innovation. Recently, Chaney et al. (2022) research on the adoption of additive manufacturing technologies demonstrated a positive influence on servitization. Using an action research approach, Solem et al. (2022) highlighted the underlining role of service-design to enhance servitization transformation. These authors identified the drivers of the servitization transformation as: (a) customer data acquisition, (b) smart PSS collaboration through co-creation across departments, (c) smart PSS

ideation through creative forms of collaboration, and (d) effective smart PSS delivery and commercialization.

These studies evidence that currently, many of the servitization studies tend to focus on the influence of collaboration on digitalization as one of the inherent and fundamental capabilities to be developed (Galvani and Bocconcelli 2022; Vilkas et al., 2022), required by all service types (base, intermediate and advanced) (Manresa et al., 2021), but there is more to the servitization and collaboration dynamics that needs investigation. This is supported by Wang et al (2022) that used a systematic literature review to analyse contemporary research on servitization and found that the servitization research from the multi-actor collaboration perspective is an infant field, suggesting a need for further research.

Following these findings, it is argued that to implement differentiated levels of services (base, intermediate and advanced) and successful servitization strategies, SCC is an essential condition. Hence, the suggested research framework in the next section that considers the impact of different service levels (H1, H2, H3, H4, H5, H6, H7) on servitization outcomes and performance, investigating the moderating role of SCC (H8, H9).

### **Supply chain collaboration (SCC) and performance**

SCC expected outcomes include improved demand planning (McCarthy and Golicic, 2002), inventory visibility (Sabath and Fontanella, 2002; Stank et al., 2001), in brief, higher performance than operating individually (Stern and Reeve, 1980; Anderson and Narus, 1990; Lambert et al., 1999). Nonetheless, the measurement and operationalization of SCC and clarifying of its performance outcomes in a servitization context still needs attention (Lambert and Pohlen, 2001; Simatupang and Sridharan, 2004; Bikfalvi et al., 2013; Finne and Holmström, 2013; Xu et al, 2020; Galvani and Bocconcelli, 2022).

The effect of collaboration on performance has been demonstrated by many studies and a clear trend can be seen with studies moving from addressing just inter-firm relationships dimensions (e.g., Fynes et al., 2005; Sharma, 2022; Jang and Lee, 2022) to looking at SCC as a multidimensional construct (e.g., Cao and Zhang, 2011; Nguyen et al., 2019; ) and the consideration of the different tools that enable it (e.g., Rosenzweig, 2009; Liu et al., 2021; Sharma et al., 2022). Equally, when it comes to performance, a range of different performance measures have been used in these studies such as firm (e.g., Cao and Zhang, 2011; Day et al., 2015), operational (e.g., Fynes et al., 2005) and supply chain performance (e.g., Frohlich and Westbrook, 2001; Lee et al., 2007; Bae, 2020).

Therefore, the direct impacts of collaboration on performance are not new. Frohlich and Westbrook (2001) empirically demonstrated that companies that integrate both suppliers and customers into their activities had stronger associations with performance improvements than companies that integrate only suppliers or only customers. To acknowledge the multi-dimensional nature of supply chain performance these authors considered nineteen measures of marketplace (e.g., market share and profitability), productivity (e.g., labor costs and throughput), and non-productivity (e.g., quality and lead-time) success. Lee et al., (2007), explored the relationship between supply chain linkages and supply chain performance (cost containment and reliability of supply chain partners), identifying which variables were more important for each dimension of performance considered. Focusing on relationship dimensions (trust,

commitment and communication), Fynes et al. (2005) suggested that the development of closer supply chain relationships could indeed improve operational performance outcomes particularly in terms of cost and quality, arguing that the more competitive the environment, the stronger this association would be. Looking at the use of e-business technologies to promote collaboration, Sanders (2007) demonstrated empirically an indirect effect of inter-organisational collaboration on performance through the impact of intra-organisational collaboration. Organisational performance was measured in this study as a composite construct composed of multiple measures (including cost, quality, delivery, and new product introduction time - which is in fact operational performance). Rosenzweig (2009) also showed that e-collaboration was related to better operational performance (measure through extent to which B2B market space participation improved the seller's forecast accuracy, order fill rate/line item fill rate, and order fulfilment cycle time) and business performance (extent to which B2B market space participation improved their organization's customer retention rate, sales volume growth, and profitability), demonstrating that the strength of the relationship between e-collaboration and operational performance diminished as the level of environmental munificence increased. This moderating effect was not observed in the level of product complexity or market variability.

Cao and Zhang (2011) explored the nature of SCC and its impact on firm performance based on a paradigm of collaborative advantage. These authors found that SCC (considering information sharing, goal congruence, decision synchronization, incentive alignment, resource sharing, collaborative communication, joint knowledge creation) improved collaborative advantage and firm performance (measured in terms of growth of sales, return on investment, growth in return on investment, profit margin on sales). Gueimonde-Canto et al. (2011) argued the importance of industry-specific and contextual factors in the analysis of collaborative practices, encountering for their sample an effect only regarding cooperation with buyers (and not with suppliers). Wu et al. (2014) investigated four key social exchange issues (trust, commitment, reciprocity, and power) to be antecedents of information sharing, collaboration and performance. They found that those four key issues were important to determine information sharing and collaboration and both information sharing and collaboration indicated a partial mediation effect on supply chain performance (firm finance and non-finance performance). Day et al. (2015) further highlighted collaboration management measures and their impact on performance. These authors used the resource-based view to examine four routines bundles comprising ostensive and performative aspects of supply management capability (supply management integration, coordinated sourcing, collaboration management and performance assessment). They found supply management capability is formed of internally consistent routine bundles, which are significantly related to financial performance, mediated by operational performance. Kumar et al. (2016) studied collaborative culture and relationship strength roles in SCC and found that culture and relationship strengthens significantly and influenced collaborative activity. This is supported by Nguyen et al.'s (2019) findings that showed that cognitive proximity facilitated SC incentive alignment. They measure SCC focusing on information sharing, decision synchronization and incentive alignment. Panahifar et al., (2018) examined the relationships between four enablers (trust, information readiness, information accuracy and information security), perceived collaboration success, and two outcomes (sales growth and overall operational performance). Their findings suggested that three collaboration enablers including trust, information readiness and secure sharing of information improved SCC. These authors also demonstrated that effective collaboration positively and significantly influenced firm performance.



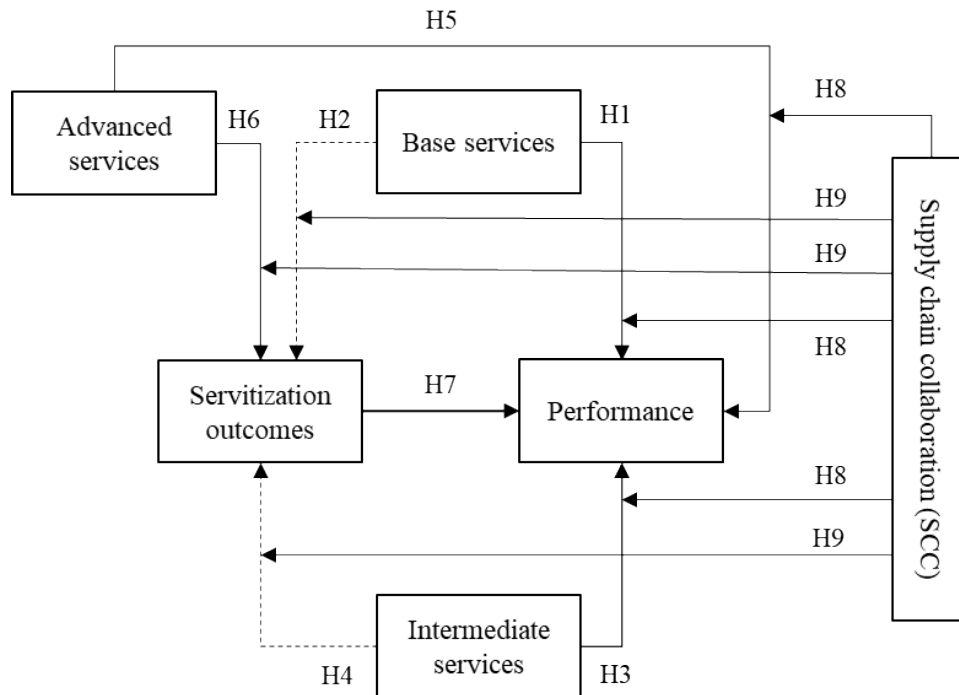
Recently, Bae (2020) has supported that collaboration (inter-departmental and with international logistics firms) for SCM has a positive effect on Supply Chain Performance (SCP), measured in terms of quality, reliability, flexibility and responsiveness, and cost performance. Looking at openness and collaboration in innovative servitization, Polova and Thomas (2020) established that higher performance (in terms of novel service development) requires real servitization maturity in terms of a shared servitization framework and market-oriented innovation. In their research, Kumar (2021) found that market-based knowledge sharing is important for SCC. Firms from the pharmaceutical, automobile and electrical/ electronic industry tended to practice higher collaboration as compared to other industries. This aligns with what is expected in the present research given that this study is conducted in the pharmaceutical industry. Baah et al (2022) found that information sharing positively and significantly influenced supply chain visibility, collaboration, agility and performance. Supply chain visibility presented significant effects on collaboration, agility and performance, while supply chain collaboration and agility had significant impact on supply chain performance (measured through flexibility and resource outcomes). Jang and Lee (2022) established that higher trust and relationship commitment with partner companies in SCM contributed to a direct influence on SCP, that is financial (growth, return on investment, return on assets and market share) and non-financial performance (such as customer service, on-time delivery, new product development and market changes).

Effective SSC demands strategic management and coordination of relationships developed with partners (Day et al., 2015). However, collaboration should not be seen as a panacea for all evils and SCC does not always produce the desired benefits leaving space for criticism and ambiguity (Sabath and Fontanella, 2002; Fawcett and Magnan, 2002; Daugherty et al., 2006; Sanchez Rodrigues, Harris and Mason, 2015; Kumar, 2021). Thus, research on its impact on performance has produced mixed results (Stank et al., 2001; Sinkovics and Roath, 2004; Corsten and Felde, 2005; Ruiz-Alba et al., 2019a; Ruzo-Sanmartín et al., 2022). Moreover, in all these studies there is limited consensus in what constitutes definite measures of SCP and the concept itself has been a target of criticism particularly when the unit of analysis includes only the firm and not the views of several firms in the same supply chain. As a result, in this study a focus on firm performance was adopted instead of SCP, focusing particularly on commonly agreed measures of firm performance since the aim was not to contest the typically achieved outcomes of SCC on performance, but instead to focus on its influence through servitization outcomes.

## **Research Framework & Hypotheses**

This brief overview of the literature suggests a lack of research on the role of SCC on servitization and their impact on performance (e.g., Xu et al., 2020; Solem et al., 2022; Wang et al., 2022), hence the present study and the suggested research framework detailed in Figure 1. For clarity, the adopted definitions from the literature for each construct are summarized in Appendix A.

Figure 1: Suggested research framework and hypotheses.



In this framework we propose that SCC serves a moderator in the relationship between the adoption of different types of services (as defined by Baines et al., 2009) and servitization outcomes as well as those outcomes and performance. This is summarized by the suggested hypotheses below:

- H1: Base services have a positive impact on performance.
- H2: Base services have no relationship with servitization outcomes.
- H3: Intermediate services have a positive impact on performance.
- H4: Intermediate services have no relationship with servitization outcomes.
- H5: Advanced services have a positive impact on performance.
- H6: Advanced services have a positive impact on servitization outcomes.
- H7: Servitization outcomes have a positive impact on performance.
- H8: Supply chain collaboration (SCC) moderates the impact of base, intermediate and advanced on performance.
- H9: Supply chain collaboration (SCC) moderates the impact of base, intermediate and advanced on servitization outcomes.

## Methodology

In order to investigate this, a quantitative research methodology was implemented. A model was developed and tested empirically in the pharmaceutical industry in Spain. The data collection instrument was divided in four main sections that included the measurement of SCC, the relationships between the use of different levels of services (base, intermediate and advanced) as well as their impact on servitization outcomes (i.e., improvement of process and capabilities – following Baines et al. (2009) understanding of servitization) and performance (financial and market performance). Commonly agreed

measures of firm performance were adopted because the aim was not to contest the typically achieved outcomes of SCC on performance, but instead to focus on its influence through servitization outcomes.

We used an online survey instrument that was sent by email to 755 pharmacy stores with the support of main pharmaceutical distributors in Spain. Finally, a total of 219 pharmacy stores returned valid questionnaires (response rate 29%) and the data analysis included both exploratory and confirmatory factor analysis as well as multiple regression analyses. Constructs and definitions can be found in Appendix. SCC was measured based on the measures available in Cao and Zhang (2011) and Day et al. (2015) papers. The different levels of services (base, intermediate and advanced) were measured based on the categorization of Baines and Lightfoot (2013) applied to the Spanish pharmaceutical industry by Ruizalba et al. (2015, 2016). In turn, servitization outcomes (i.e., improvement of process and capabilities) and performance measures followed Ruizalba et al (2019b) and were measured following respectively the Baines et al. (2009) servitization definition and Fang et al., (2008), Hultén (2012) and Vendrell-Herrero, et al., (2014). The items considered for each construct are provided in the results tables in the following section.

Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) was used to validate the scales using the libraries *psych* and *lavaan* for R. EFA was used to test if services used by pharmacy stores were grouped according to the classification proposed by Baines and Lightfoot (2013) and Ruizalba et al. (2015; 2016; 2019b). The presence of three factors was confirmed with eigenvalues higher than one that explained 58% of the variance. Factor loadings analysis allowed the interpretation of those factors into base, intermediate and advanced services. After this analysis, CFA was performed to analyse whether the scales used were valid and reliable. Robust Maximum Likelihood was the method of estimation as the sample did not followed multivariate normal distribution ( $b1p = 206.99$ ;  $Z = 22.50$ ;  $p = 0.00$ ;  $b2p = 1060.81$ ;  $Z = 11.19$ ;  $p = 0.00$ ; omnibus =  $631.72$ ;  $p = 0.00$ ) (see Bollen, 1989; 415-424). The proposed model showed adequate global fit indicators ( $\chi^2_{SB} = 542.71$ ;  $df = 388$ ;  $p\text{-value} = 0.00$ ;  $GFI = 0.96$ ;  $AGFI = 0.95$ ;  $CFI = 0.95$ ;  $NNFI = 0.94$ ;  $TLI = 0.94$ ;  $RMSEA = 0.04$ ). Reliability was measured through Cronbach's Alpha and the coefficient of compound reliability showed values over 0.70 for all constructs. The average extracted variance (AVE) was above 0.50 in all cases except for SCC which was 0.40. Nonetheless, the elimination of the item with the lowest individual reliability did not result in a significant increase of neither compound reliability nor AVE. Following the recommendations of Hair et al. (2014, pp. 103-104), this item was preserved not affecting content validity.

The constructs have convergent validity (see Table 1). Discriminant validity was tested with the heterotrait-monotrait ratio of correlations (HTMT) (see Henseler, Ringle and Sarstedt, 2015) showing a value below to 0.90. All constructs have discriminant validity. Once demonstrated both the convergent and discriminant validity of the scales, seven new variables were calculated using the average of items adopted to measure each latent variable.

*Table 1. Reliability and Averaged Extracted Variance (AVE)*

<b>Construct</b>	<b>Cronbach's alpha</b>	<b>Compound Reliability</b>	<b>AVE</b>
Base services	0.81	0.81	0.52
Intermediate services	0.91	0.91	0.63
Advanced services	0.88	0.88	0.56

Servitization outcomes	0.84	0.85	0.74
Financial performance	0.82	0.83	0.61
Market performance	0.78	0.78	0.54
Degree of co-creation	0.79	0.79	0.40
Performance	-	0.89	0.80

## Results

In order to test the suggested hypotheses to address the influence of *different levels of services on servitization and performance outcomes moderated by supply chain collaboration*, a specified model was created with two dependent variables: performance and servitization outcomes. To explain performance, the following independent variables and interaction effects were used: base, intermediate and advanced services, servitization outcomes, SCC, base by SCC, intermediate by SCC, advanced by SCC and servitization outcomes by SCC. Similarly, to explain the servitization outcomes variable, the following variables and interaction effects were used: base, intermediate and advanced services, base by SCC, intermediate by SCC, and advanced by SCC. All variables were centred on the mean to avoid collinearity effects on the estimated coefficients. The standard errors were estimated using the robust variant Eicker-Huber-White (Stock and Watson, 2012, p. 164). Finally, it was verified that the residuals followed a normal distribution. All our analyses were carried out with the *lavaan* library for R due to its flexibility and ease of programming.

When using performance as the dependent variable, three main effects appear as significant (see Table 2): intermediate services, advanced services, and servitization outcomes. None of the other effects exhibited significant results. The intermediate and advanced services had a positive impact on performance ( $\beta_{\text{interm}} = 0.29$ ;  $p = 0.00$ ;  $\beta_{\text{advanc}} = 0.18$ ;  $p = 0.01$ ), therefore H3 and H5 should not be rejected. By the same token, servitization outcomes positively impact on performance ( $\beta_{\text{servit}} = 0.15$ ;  $p = 0.00$ ), hence H7 also receives empirical support. Nonetheless, base services showed no significant influence neither on performance (H1 should be rejected), nor in any of the moderating effects proposed (H8 should also be rejected). The adjusted  $R^2$  was 0.30.

Table 2. Estimated coefficients in the performance equation.

	<b>Coeff</b>	<b>Std. err</b>	<b>t-stat</b>	<b>p-value</b>	<b>vif</b>
<b>Intercept</b>	3.98	0.05	79.34	0.00	
<b>Base services (BS)</b>	-0.02	0.05	-0.48	0.64	1.00
<b>Intermediate services (IS)</b>	0.29	0.04	6.68	0.00	1.08
<b>Advanced services (AS)</b>	0.18	0.05	3.31	0.00	1.84
<b>Servitization outcomes (SC)</b>	0.15	0.05	3.29	0.00	1.79
<b>Supply chain</b>	0.00	0.05	0.01	0.99	1.17

<b>collaboration (SCC)</b>					
<b>BS x SCC</b>	-0.06	0.04	-1.51	0.13	1.14
<b>IS x SCC</b>	-0.03	0.04	-0.86	0.39	1.09
<b>AS x SCC</b>	0.07	0.04	1.61	0.11	1.47
<b>SC x SCC</b>	-0.02	0.03	-0.67	0.50	1.44

When the analysis looks into servitization outcomes, a main effect and two interaction effects emerge (Table 3). As expected, the relationship between base and intermediate services is not significant ( $\beta_{\text{base}} = 0.06$ ;  $p = 0.42$ ;  $\beta_{\text{interm}} = 0.03$ ;  $p = 0.63$ ), so H2 and H4 should not be rejected. In turn, there is a positive and significant relationship between advanced services and servitization outcomes ( $\beta_{\text{advanc}} = 0.67$ ;  $p = 0.00$ ) (H6 receives empirical support).

Finally, two interaction effects exhibited significant results (IS x SCC and AS x SCC). On one hand, intermediate services, results showed that intermediate services significantly influence servitization outcomes but only when the degree of collaboration is high ( $\beta_{\text{IS\_HSCC}} = 0.25$ ;  $p = 0.00$  vs  $\beta_{\text{IS\_LSCC}} = 0.06$ ;  $p = 0.42$ ). On the other hand, advanced services significantly influence servitization outcomes, and this influence is higher when the degree of collaboration is high ( $\beta_{\text{AS\_HSCC}} = 0.80$ ;  $p = 0.00$  vs  $\beta_{\text{AS\_LSCC}} = 0.67$ ;  $p = 0.00$ ). From the results, it can be said that H9 only gets partial support since the interaction between base services and SCC was not significant ( $\beta_{\text{BS\_SCC}} = 0.07$ ;  $p = 0.17$ ). The adjusted  $R^2$  was 0.42 in this case. These results allow us to empirically address our main research question which considered the influence of *different levels of services on servitization and performance outcomes moderated by supply chain collaboration*.

Table 3. Estimated coefficients in servitization outcomes equation.

	<b>Coeff</b>	<b>Std. err</b>	<b>t-stat</b>	<b>p-value</b>	<b>Vif</b>
<b>Intercept</b>	4.62	0.08	61.60	0.00	
<b>Base services (BS)</b>	0.06	0.07	0.81	0.42	1.00
<b>Intermediate services (IS)</b>	0.03	0.06	0.48	0.63	1.05
<b>Advanced services (AS)</b>	0.67	0.07	10.03	0.00	1.23
<b>Supply chain collaboration (SCC)</b>	0.08	0.07	1.19	0.24	1.16
<b>BS x SCC</b>	0.07	0.05	1.36	0.18	1.12
<b>IS x SCC</b>	0.19	0.06	3.32	0.00	1.04
<b>AS x SCC</b>	0.13	0.06	2.20	0.03	1.16

## Discussion

The main research question concerned *how do the different levels of services influence servitization and performance outcomes moderated by supply chain collaboration?* Main findings show SCC emerging as a clear differentiating factor of

performance for servitizing firms aligning with Kumar's (2021) definition of SCC highlighting the need to create relational rents to build dynamic capabilities and achieve distinctive advantages. As suggested by the literature (Sjödin et al., 2019; Zhang et al., 2019; Zhou et al., 2020; Manresa et al., 2021), different outcomes were obtained in terms of SCC levels and their impact on services levels. Thus, the degree of collaboration exhibits a moderating effect for intermediate and advanced levels of services.

This study found a statistically significant relationship between advanced services and servitization outcomes which is consistent with the literature so far discussed. Accordingly, servitization outcomes also show a statistically significant effect on performance, supporting Baines et al. (2009) definition and the literature that supports the impact of servitization on performance (e.g., Fang et al., 2008; Neely, 2008; Hultén, 2012; Vendrell-Herrero, et al., 2014; Wang et al., 2018; Sjödin et al., 2019; Queiroz et al., 2020; Zhang et al., 2019; Zhou et al., 2020; Abou-foul et al., 2021; Manresa et al., 2021). But more importantly, this study allows us to discuss and empirically support that these effects are increased through collaboration.

As mentioned previously, the direct impacts of collaboration on performance are not new. The literature showed a clear trend with studies moving from addressing just inter-firm relationships dimensions (e.g., Fynes et al., 2005; Sharma, 2022; Jang and Lee, 2022) to looking at SCC as a multidimensional construct (e.g., Cao and Zhang, 2011; Nguyen et al., 2019) and the consideration of the different tools (e.g. digital) that enable it (e.g., Rosenzweig, 2009; Liu et al., 2021; Sharma et al., 2022). Equally, a range of different performance measures have been used in these studies such as firm (e.g., Cao and Zhang, 2011; Day et al., 2015), operational (e.g., Fynes et al., 2005) and supply chain performance (e.g., Frohlich and Westbrook, 2001; Lee et al., 2007; Bae, 2020; Baah et al., 2022). Hence, we are not trying to claim that direct impacts on performance are new or unique effects to our study, but instead we are trying to empirically demonstrate the importance of SCC as a moderator in the development of servitization outcomes and performance through the implementation of different service levels.

Regarding the moderating role of SCC, results showed that this effect is particularly relevant for the implementation of advanced and intermediate services. Advanced services and servitization outcomes always have an impact on performance as previous literature seems to suggest (Queiroz et al., 2020; Manresa et al., 2021). Advanced services also exhibit an effect on servitization outcomes, but this effect is moderated by collaboration, that is, the effect of advanced services on servitization outcomes is higher when the degree of collaboration is higher. This means that, although advanced services always lead to the improvement of processes and capabilities (as per the servitization definition of Baines et al., 2009), this effect will increase for the customers in the presence of higher levels of collaboration.

In turn, unless there is a high degree of collaboration, intermediate services do not influence directly servitization outcomes, but they still influence performance. This means that intermediate services will only contribute to the improvement of processes and capabilities when there is a high degree of SCC. This might be explained by the fact that when collaboration levels between servitizing and servitized firms is higher, this seems to enable the provision of personalized and adjusted services focusing on the needs of that specific customer which can then help in the development of their processes and capabilities (Polova and Thomas, 2020; Tronvoll et al., 2020; Chaney et al., 2022). This is an important insight into the relationships between manufacturers and their customers as it indicates ways in which customers can better take advantage of the services offered by their manufacturers. Otherwise, the application of generalised solutions may actually hinder the organisation.

This study supports the role of a collaborative culture and relationship strength in the pursuit of performance as identified for example by Kumar et al. (2016) and Nguyen et al. (2019). Still, the literature has produced contradicting results when it comes to the impact of collaboration on performance and alert us to the fact that collaboration does not solve all problems (e.g., Sabath and Fontanella, 2002; Fawcett and Magnan, 2002; Daugherty et al., 2006; Kumar, 2021; Ruiz-Alba et al., 2019a; Ruzo-Sanmartín et al., 2022). Moreover, although previous studies (e.g., Bikfalvi et al., 2013; Nguyen et al., 2019; Grandinetti et al. 2020; Kumar, 2021; Kreye and Donk, 2021; Solem et al., 2022) have supported the requirement for inter-firm collaboration when implementing servitization, companies tend to not engage in actual collaboration even when they acknowledge its potential mainly due to its associated costs (Sabath and Fontanella, 2002; Fawcett and Magnan, 2004; Min et al. 2005; Chaney et al., 2022). However, according to Kumar (2021), firms from the pharmaceutical industry (along with automobile and electrical/ electronic companies) tend to practice higher collaboration than companies in other industries. Gueimonde-Canto et al. (2011) also argued the importance of industry-specific and contextual factors in the analysis of collaborative practices. Therefore, it is not surprising that in this study, collaboration reveals to be key to increase the effect of advanced and intermediate services. Still, empirical research is still needed to establish the conditions of these relationships and as argued by Sjödin et al. (2019), Xu et al (2020) and Wang et al (2022) to establish the multiple paths to achieving superior outcomes. We argue, however, that these outcomes must go beyond financial performance and focus on relational rents (Kumar, 2021) and servitization outcomes to clarify the role of SCC both as a business process (as defined by Mentzer et al., 2000; Stank et al., 2001) and as a network of relationships (as defined by Bowersox et al., 2003; Golicic et al., 2003; Danloup et al., 2013).

## **Implications**

This paper contributes with some implications for theory and practice. Two main contributions can be pointed: (1) empirically considering SCC in the servitization debate; and (2) clarification of SCC outcomes. More specifically, the impact of service levels and servitization outcomes on performance through increased collaboration. A first theoretical implication is the support of the importance of collaboration in the influence of service types on servitization outcomes and on performance, aligned with recent research calls (Queiroz et al., 2020; Xu et al., 2020; Manresa et al., 2021; Solem et al., 2022; Wang et al., 2022). Advanced services and servitization outcomes always have an impact on performance, but this is increased with higher collaboration levels. And a similar effect was found with intermediate services but showing that unless SCC was high then servitization outcomes would not be influenced by intermediate services. These research findings are relevant for scholars and for practitioners when implementing servitization in the pharmaceutical industry.

Implications for practice can also be found in this study. A first implication for practitioners who want to implement servitization strategies is that they should collaborate with the customers in B2B contexts. A second managerial implication is that servitization outcomes have a positive influence on performance, in particular in financial and market performance. Therefore, working on servitization strategies can have a positive impact on performance. A third managerial recommendation is that when the level of collaboration with other actors in the supply chain is higher, then the influence on servitization performance is higher and also intermediate services have a positive impact on servitization outcomes when collaboration is higher. Therefore, enhancing

collaboration would enhance the impact of intermediate services on servitization and advanced services on performance. This gives managers an indication of how and where to invest their resources, and the types of services that complement their performance. Finally, managers should work jointly with their business partners to plan and implement supply chain operations (Simatupang and Sridharan, 2002).

## Conclusion

In conclusion, due to Baines et al. (2009) definition and subsequent research it is commonly assumed that advanced services will lead to the development of processes and capabilities and increased overall performance. This research addresses specifically how different levels of services influence servitization and performance outcomes moderated by supply chain collaboration. This research has shed light on this question with the empirical evidence of how intermediate and advanced services impact on performance but not base services. Furthermore, when the level of supply chain collaboration is higher, then intermediate services have an impact on performance and the effect of advanced services is increased. Similarly, advanced services have a positive influence on servitization outcomes, however, this effect is significantly higher if the level of supply chain collaboration is high. Moreover, it is also important to establish how intermediate services effects can be heightened. Accordingly, to the findings of the present paper the answer to these questions is the need to increase SCC.

Main findings clearly show the moderating role of SCC on the superior effects of advanced and intermediate services on servitization outcomes and subsequently on performance. Hence, this paper argues that intermediate services should not be ignored or set aside as less important in the servitization processes since their effect on servitization outcomes through performance later reflects on performance improvements, which is also consistent with Baines et al (2009) definition of servitization effects adopted in this research. Finally, it can be concluded that collaboration is a crucial element in the successful implementation of intermediate and advanced services.

As with all research projects, this study is not without its limitations. We acknowledge that we take a limited snapshot of the B2B relationships considered due to the methodological approach selected. Nonetheless, given the difficulties in accessing such a specific sector we have explored the moderating effect of SCC in these constructs from a novel perspective which adds to the literature as it stands. Still, future research should focus further on understanding: (1) the effects of different inter-firm relationships on servitization; (2) in different SC contexts (beyond the pharmaceutical domain and considering different intermediaries), (3) internal marketing orientation and the capabilities required to servitize at different levels of the SC and (3) look at servitization impacts including a range of different measures (including market, financial, operational) to encompass supply chain performance.

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## APPENDIX

### Appendix A: Constructs and definitions

Construct	Definition
Base services	An outcome focused on product provision (Baines and Lightfoot, 2013)
Intermediate services	An outcome focused on maintenance of product condition (Baines and Lightfoot, 2013)
Advanced services	An outcome focused on capability delivered through performance of the product (Baines and Lightfoot, 2013)
Supply chain collaboration (SCC)	SCC refers to both a process and a network of relationships between multiple companies (Danloup et al., 2013; Soosay and Hyland, 2015; Kumar, 2021) engaged in collaborative management and collaborative sourcing (Day et al., 2015) in their supply chain operations. To this end, companies are expected to develop an appropriate level of trust, critical information sharing, joint decision making and integrate supply chain processes (Soosay and Hyland, 2015).
Servitization outcomes	Following Baines et al. (2009) servitization explanation, expected outcomes of servitization are the improvement of processes and capabilities. Therefore, servitization outcomes were defined as the improvement of processes and capabilities.
Performance	This refers to how the company has performed in terms of market and financial measures.