

Editorial: Product-Service Innovation Systems—Opening-up Servitization-based Innovation to Manufacturing Industry

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Keywords: Product-service innovation, PSI system development, territorial servitization, manufacturing resilience, incumbent manufacturers.

1. Introduction

The objective of this special issue is to produce theoretical and empirical work that provokes and fertilizes the scholarly debate on product-service innovation (PSI) systems, that is, the adoption of externalized service-augmented strategies by manufacturing businesses (e.g., Cusumano et al., 2015; Crozet and Milet, 2017; Rabetino et al., 2018; Bustinza et al., 2019). With this end goal at the center of our priorities, we expect to advance our understanding of the connection between PSI and the innovation trajectories of manufacturers, as well as of the mechanics underlying external PSI systems in terms of their formation, evolution and performance.

This way, the collection of papers included in this special issue brings together studies that address various aspects related to PSI systems, from a business, industry, and regional levels that until now had remained largely unaddressed.

Product-service innovation has been traditionally linked to the operations of large manufacturers (e.g., Cusumano et al., 2015; Baines et al., 2017). Nevertheless, recent work on PSI systems has documented how manufacturers of all sizes are increasingly adopting competitiveness-enhancing strategies, such as the introduction of value-adding services to their value chain PSI systems (e.g., Crozet and Milet, 2017; Rabetino et al., 2018). The main line of reasoning backing this observation is that PSI systems allow resource-constrained manufacturers to access the benefits of servitization-based innovations (Bustinza et al., 2019; Lafuente et al., 2019).

This argument line is coherent with voices claiming that manufacturers' performance is more reliant on PSI systems. Notwithstanding the large stock of knowledge on PSI systems generated in

the last decade, various questions on PSI systems and how they contribute to manufacturers' innovative-led competitiveness remain unaddressed in the literature: what are the mechanisms and outcomes of product-service innovation systems, in terms of innovation management practices?; what strategic choices underpin product-service innovation systems: in-house development or collaborations among actors within the PSI system via outsourcing, strategic alliances, fusions or mergers & acquisitions? Moreover, can we argue that successful PSI is the outcome of operational specialization? The analysis of these questions is the first key cornerstone of this special issue.

In parallel to the consolidation of this 'PSI wave', scholars have recently observed that the logic of PSI processes can be extrapolated to a meso (regional) level which describes the territorial properties nurturing inter-industry collaborations, in particular between manufacturing and knowledge intensive business service (KIBS) firms (e.g., Lafuente et al., 2017; Wyrwich, 2019). This research stream dealing with territorial servitization has produced valuable theory and evidence to better grasp what drives a greater operational fit between actors within PSI systems (i.e., KIBS and manufacturers). But, as this academic field develops a number of theoretical and empirical issues need to be addressed. Examples of notable research questions that require verification include, among others: what are the pre-determinant industrial origins of PSI systems?, does manufacturers' sustained competitive advantage rely on the development of collaborations with KIBS firms within the local PSI system? The study of these and other related questions constitutes the second cornerstone of this special issue.

In this special issue we therefore encouraged contributors to produce research that challenges canonical approaches and adopts a critical angle that sheds valuable insights on PSI systems from an organizational as well as territorial perspective.

At this point, what is the positioning of this special issue within the PSI literature? In our view, this special issue advances our knowledge on PSI systems by providing clear nuances of the factors driving servitization-led innovations through hybrid value-chains connecting different economic agents. Additionally, this special issue includes studies that offer theoretically rooted models that explain how the configuration of the local industrial fabric re-defines the local PSI system and, ultimately, inter-industry collaborations with potentially positive economic repercussions.

We started this journey in 2019 with the objective to satisfy our academic curiosity on the analysis of PSI systems from multiple perspectives. This special issue received great support from scholars and policy observers working in the field. In particular, we want to thank participants in the work sessions at the 8th International Conference on Business Servitization (Basque Country, Spain, November 21st and 22nd 2019). Obviously, all our efforts simply would not have been

possible without the support and nurturing of the journal's Editor-in-Chief Wim Vanhaverbeke to whom we express our deepest gratitude.

As a result of our efforts, throughout this editorial note we address the two subjects outlined above and provide an overview of the collection of papers included in this special issue.

2. The contributions of this special issue to the literature on product-service innovation (PSI) systems

After an exhaustive peer review process, this special issue includes nine articles that contribute significantly to advance the analysis of the antecedents and outcomes of PSI systems.

By analyzing the approaches adopted by the selected papers, we observe that PSI systems can be researched from multiple angles, and that the unit of analysis varies from top executives (2 studies), organizations in manufacturing, biopharmaceutical and textile industries (6 studies), to NUTS-2 regions (1 study). Note that part of the value of the papers included in this special issue is the capacity to bring together theoretical premises from different fields, including organizational approaches as well as arguments closer to economic geography. The richness of these papers also becomes evident in their methodological diversity—which spans from qualitative and case study approaches (5 studies) to quantitative studies using different estimation methods (4 studies)—and in the geographic variety of the analyzed settings, covering different European countries (5 studies), China (2 studies), and businesses from multiple countries (2 studies). By using multiple analytical methods on cross-sectional (7 studies) and longitudinal (2 studies) data sets, the selected papers contribute to identify the different patterns that characterize PSI systems as well as their outcomes at organizational and territorial level.

The diversity of the selected papers is consistent with and further reinforces the logic underlying this special issue which emphasizes the need to analyze the antecedents and impacts of PSI systems from multiple perspectives.

Overall, the collection of studies presented within this special issue dedicated to product-service innovation systems delivers valuable insights on how manufacturing businesses capitalize on service-augmented products within a PSI system context from an innovation management perspective. As such, their contributions confirm that the economic outcomes of PSI systems go beyond service-augmented product portfolios (Tongur and Engwall, 2014; Rabetino et al., 2018). Also, the presence of strong cross-industry collaborations throughout the hybrid value chain is associated with superior servitization-based innovations for manufacturers (Lafuente et al., 2017).

Table 1 offers a brief summary of the contributions of the different articles composing the special issue.

Table 1. Summary of contributions to the special issue

Authors	Title	Highlights	Sample / method	Keywords
A1 Y. Vaillant, E. Lafuente & F. Vendrell-Herrero	Product-Service Innovation Systems: Conceptualization and Assessment of Industrial Pre-determinants	The study proposes a conceptual framework to explain the development of regional PSI systems. The empirical results point to the roots of regional PSI systems: PSI systems have their greatest impact over manufacturing employment in regions with an established incumbent manufacturing base.	Data: Multi-sourced panel dataset of the 17 Spanish Autonomous regions during 2006-2012 Method: Fixed-effects regression model	Product-service innovation, PSI system development, territorial servitization, manufacturing resilience, incumbent manufacturers.
A2 O. Bustinza, M. Opazo-Basáez & S. Tarba	Exploring the interplay between Smart Manufacturing and KIBS firms in configuring product-service innovation performance	Results returned three superior manufacturing performance scenarios. One involved pure manufacturers that did not develop PSI and relied entirely on traditional supportive manufacturing technologies. The other two strategies involved servitized manufacturers that developed PSI with or without KIBS firms and benefitted from access to larger manufacturing technologies. The study offers novel evidence on the importance of choosing the right technology for manufacturers that embrace service infusion. The study also reaffirms the role of KIBS firms in supporting PSI.	Data: Sample of 366 Spanish manufacturing firms. Method: Fuzzy-set qualitative comparative analysis (fsQCA)	Product-service innovation, innovation management, KIBS firms, smart manufacturing, performance.
A3 I. Freije, A. De la Calle & J. V. Ugarte	Role of Supply Chain Integration in the Product Innovation Capability of Servitized Manufacturing Companies	This study reveals significant differences between manufacturing companies with low- and high-level of services regarding the impact of customer integration on product innovation capability.	Data: Sample of 104 Basque manufacturing companies Method: Partial least squares structural equation modeling (PLS-SEM)	Servitization, manufacturing companies, supply chain collaboration, product innovation capability, customer integration.
A4 K. Kapoor, A. Bigdeli, A. Shroeder & T. Baines	A Platform Ecosystem View of Servitization in Manufacturing	Platform ecosystem lens clarifies servitization-related organizational transformation. Socio-technical components explain functional dynamics of service platform ecosystems. Manufacturers use their products as platforms for achieving their servitization goals.	Data: Collective experiences of 14 senior executives from seven global manufacturing companies from Japan, USA, Sweden, France, and UK Method: Multiple case study approach	Advanced services, platform ecosystems, servitization.
A5 J. Tian, W. Coreynen, P. Matthysens & L. Shen	Platform-based servitization and business model adaptation by established manufacturers	By proposing a framework for explaining platform-based servitization, three service destinations were identified: non-digital, digital and smart servitization. Platform leverage logics can be applied in the organizational front- and back-end. Also, companies follow a sequential and simultaneous business model adaptation path.	Data: Four large Chinese textile and apparel manufacturing companies Method: Multiple case study approach (longitudinal and interpretive research method)	Servitization, digitization, smartization, product-service innovation, platform leverage logics, business model adaptation.

Table 1. Continued.

Authors	Title	Highlights	Sample / method	Keywords
A6 M.Jovanovic, D. Sjödin, & V. Parida	Co-evolution of platform architecture, platform services, and platform governance: Expanding the platform value of industrial digital platforms	The study examines the evolution of three industrial digital platform archetypes: product platform, supply chain platform, and platform ecosystem. The authors argue that each archetype involves co-evolution of platform architecture, platform services and platform governance, which mirror each other. Findings indicate that each platform archetype is characterized by specific innovation mechanisms that contribute to platform service discovery and expand platform value.	Data: Four in-depth cases of British and Swedish incumbent manufacturers developing industrial digital platforms. Method: Qualitative study with a grounded theory building approach.	Digital servitization, industrial digital platforms, platform architecture, platform service, platform ecosystem, platform value.
A7 T. Huikkola, M. Kohtamäki, R. Rabetino, H. Makkonen & P. Holtkamp	Overcoming the Challenges of Smart Solution Development: Co-alignment of Processes, Routines, and Practices to Manage Product, Service, and Software Integration Successfully	The results identify three innovative routines, namely: collaborative, customer-focused, and decision-making oriented. The study highlights the co-alignment of innovative processes, routines and practices to achieve improved outcomes from smart solution development (SSD).	Data: Interviews to 12 senior managers of a large Finish solution provider. Method: In-depth single-case study methodology	Product-service innovation, smart solution development, new service development digital servitization, product-service systems, organizational routines.
A8 S. Tahı, W. Khlif, K. Belghoul & V. Casadella,	Public-Private Innovation Networks in Services: Revisiting PPPs with Servitization	The results confirm the centrality of public actors in structuring and diffusing knowledge within a PPINS; as well as the role of structural holes in controlling and filtering transferred knowledge, the main beneficiaries of which are private actors.	Data: Biopharmaceutical industry in the Ile-de-France region (France). Data covers the period 2005-2016 Method: Structural holes and personal network efficiency methodology.	Public-private partnerships, innovation, servitization, biopharmaceutical sector, structural holes.
A9 Y. Wang, J. Gao, & Z. Wei	The double-edged sword of servitization in radical product innovation: The role of latent needs identification	Servitization has an inverted U-shaped relationship with radical product innovation performance. Servitization negatively moderates the relationship between latent needs identification and radical product innovation, whereas latent needs identification positively mediates the relationship between servitization and radical product innovation performance.	Data: Sample of 208 Chinese servitized manufacturing firms. Method: OLS regression analysis	Servitization, latent needs identification, radical product innovation, organizational knowledge creation, embeddedness.

From the literature dealing with product-service innovation systems (e.g., Baines et al., 2017; Rabetino et al., 2018) an evident gap is highlighted; that of the industrial pre-determinants of PSI systems. This gap motivated the study by **Vaillant, Lafuente and Vendrell-Herrero** (A1 in Table 1) who evaluate the origins of value-adding PSI systems. The authors propose a conceptual framework to better understand the role that active hybrid value-chain collaboration plays in re-defining value creation through the development of local PSI systems. The study empirically tests the proposed framework, and results give evidence as to the roots of regional PSI systems and the value-adding processes that they engender. By employing fixed-effects regression models, the study delivers empirical evidence that PSI systems have their greatest impact over manufacturing employment growth in regions with an established incumbent manufacturing sector.

The transaction-level PSI system is divided in back-end and front-end processes (Vendrell-Herrero, Bustinza et al., 2021). The study by **Bustinza, Opazo-Basález and Tarba** (A2 in Table 1) centers on the back-end interplay amongst firms within this level's PSI system. These authors analyzed the relationship configurations between Smart Manufacturing and KIBS firms that produced greatest PSI performance. This study highlights the importance of choosing the right set of technologies for manufacturers that embrace service infusion and reaffirms the role of KIBS firms in supporting value-adding PSI systems, especially as enablers of the potential benefits that can come from the adoption of Smart Manufacturing technologies.

At a similar level, **Freije, de la Calle and Ugarte** (A3 in Table 1) expand the study of the key front-end interrelations within effective PSI systems by specifically analyzing the “Role of Supply Chain Integration in the Production Innovation Capability of Servitized Manufacturing Companies”. These authors use partial least squares structural equation modeling (PLS-SEM) on a sample of Basque manufacturing companies to reveal that the impact of customer integration on product innovation capability significantly differs as a result of the servitization intensity implemented by the supplying manufacturers.

Moving to the ecosystem-level PSI system, three studies analyze PSI systems from a platform-based and eco-systemic perspective. First, **Kapoor, Bigdeli, Shroeder and Baines** (A4 in Table 1) apply a platform ecosystem lens when analyzing the collective experience of Senior Executives of manufacturing companies from five countries to highlight the fact that socio-technical components often explain the functional dynamics of the servitization trajectory for manufacturers within PSI systems. **Tian, Coreynen, Matthysens and Shen** (A5 in Table 1) apply a somewhat similar lens to explore how manufacturers leverage the use of platforms for servitization. Their study concludes as a result of its longitudinal and interpretive research methods into the servitization pathways of four Chinese textile and apparel manufacturing companies, that manufacturers follow a sequential

and simultaneous business model adaptation path towards smart servitization. In their qualitative study on the co-evolution of PSI platform architecture, **Jovanovic, Sjödin and Parida** (A6 in Table 1) demarcate three platform archetypes: product platform, supply chain platform and platform ecosystem and find that each platform archetype is characterized by specific innovation mechanisms that contributes to PSI delivery and expanding system value.

Huikola, Kohtamäki, Rabetino and Holtkamp (A7 in Table 1) make an important contribution to the literature and to this special issue by offering a better understand of the linkages between the ecosystem and the transaction level processes in relation to PSI, smart servitization and smart solution development. Their process-based qualitative case-study research highlights the importance of the co-alignment of PSI processes, routines, and practices to achieve improved outcomes for smart solution development.

The study by **Tahi, Khlif, Belghoul and Casadella** (A8 in Table 1) takes a wider meso-level perspective of the PSI system. Their research brings a new component to the PSI system analysis beyond the usual limits of the hybrid value-chain that has characterized the literature until now by adding the role of the public administration into the system. Through the in-depth longitudinal analysis of the case of the biopharmaceutical industry in the Ile-de-France region of north-central France, and building on structural holes and personal network efficiency methodology, their results confirm the centrality of public actors for the effective function of PSI systems.

Finally, **Wang, Gao and Wei** (A9 in Table 1) close Techovation's special issue on "Product-Service Innovation System" by presenting a study that offers a word of caution associated with the radical implementation of product-service innovation. The results of their quantitative study of Chinese manufacturing firms emphasizes the importance of latent needs identification, but whereas they play a positive mediating role over the relationship between servitization and radical product innovation performance, product-service innovation is itself responsible for negatively mediating the relationship between latent needs identification and radical product innovation performance. They therefore warn PSI manufacturers of "The double-edged sword of servitization in radical product innovation". In our view, this result is consistent with the relational view of servitization (Kamalaldin et al., 2020). PSI systems needs long-term provider-customer relationships (Vendrell-Herrero, Vaillant et al., 2021) that incentivize incremental improvements of products, in the detriment of radical product changes that can distort these long-term relations.

3. Toward future research

To conclude, building on the review of the nine studies included in this special issue we believe that the authors' research efforts have contributed to untangle and articulate the boundary

conditions of PSI systems. Moving forward, the debate is open and there are still promising topics that should be added to scholars' research agenda.

First, studies that examine the interdependencies and divergences between business-led (e.g. Kohtamäki et al., 2019) PSI ecosystems are relatively scarce. This is extensive to the study of the microfoundations (e.g. Barney and Felin, 2013) involved in PSI implementation and development. We hope to see in the future high-quality studies addressing research question on these topics. For example, at different stages of the innovation process, are different types of organizations or people required to be able to exploit a similar knowledge stock to guarantee a successful PSI process? Moreover, given the disparity in the contribution to the hybrid value chain of the agents taking part of the PSI process, how does the imbalance between the actors involved in the PSI system affect innovation processes? Does this value-adding imbalance affect the properties of the resulting service-augmented product and the distribution of the extra rents generated by the PSI system?

Second, studies spanning multiple levels of analysis and settings that examine the challenges associated with developing a regionally-based PSI ecosystem (e.g. Araya-Solano, 2019; Lafuente et al., 2019) are also scarce. In this introductory editorial, we highlighted the importance of identifying the precursors and the dynamics of regional PSI systems. Future work can help to fill this gap by addressing research questions such as the following: what interconnections exist between constituents and agents involved in local hybrid value chains or territorial servitization? Also, the regional PSI ecosystem approach is in many ways coherent with smart specialization postulates (e.g., Capello and Kroll, 2016) so; therefore, can policy observers optimize the local hybrid value chain by promoting actions targeting specific ecosystem elements? Finally, if geographic proximity is no longer a pre-requisite for developments in the local hybrid value chains process to take hold in knowledge-based economies (Wyrwich, 2019), does this imply that regions with an underdeveloped manufacturing base can engage in regional PSI processes by investing in other aspects of their local hybrid value chain? Finally, what is the role of geographic proximity in the development of regional PSI systems? Recent work challenges the role of geographic proximity in knowledge-based economies for territorial servitization processes (Opazo-Basáez et al., 2020). Thus, can regions with an underdeveloped manufacturing base take advantage of digital infrastructures and digitalization processes for promoting the development of their local hybrid value chain?

We are hopeful that this special issue will advance our understanding of PSI systems and will add an impulse to increase theoretical and empirical research on this topic. Such research is relevant and necessary if academics are to learn how organizations, with different degrees of complexity, can introduce, adapt and learn from PSI process in order to enhance their competitive edge in the long term.

Acknowledgements: The guest editors thank the Editor-in-Chief Wim Vanhaverbeke for his support and guidance during the editorial process of this special issue. The guest editors are also thankful to the army of anonymous referees whose most valuable revisions contributed to significantly improve the manuscripts included in the special issue. For their ideas and comments the guest editors are grateful to participants at the 8th International Conference on Business Servitization in San Sebastian (Basque Country, Spain, November 21st and 22nd 2019).

Funding: Esteban Lafuente acknowledges financial support from the Spanish Ministry of Science and Innovation (Ministerio de Ciencia e Innovación, Agencia Estatal de Investigación) (grant: PID2020-115018RB-C32).

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