Iot as a Driver of Servitization: A Thematic Analysis of the Emergent Literature

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Abstract

Internet of things (IoT) constitutes an integral part of the ongoing digital revolution. Additionally, the shift toward mass customization calls for an increasing degree of servitization.
Purpose of the paper*: This paper aims to provide the rationale for the value that the intersection of the servitization and smart connected devices can create for both businesses and consumers.*
Methodology*: A set of keywords is used to perform thorough bibliographic searches on Scopus and Web of Science to identify the available academic literature on the topic. A narrative synthesis by means of thematic and content analyses is conducted to highlight the role of IoT as one of the major drivers of servitization.*
Main Findings*: The inherent characteristics of IoT play an important role as potential enablers of value creation through servitization.*
Practical implications*: The findings of this article are useful for managers and decision-makers, organizations, and producers who want to foster their servitization dynamics.*

***Originality/value**: The role of IoT for servitization is an emerging topic and no previous attempts to treat the subject holistically have been made.*
***Type of paper**: Narrative review article*

Keywords**: **Internet of Things, servitization, value creation, thematic analysis

1 Introduction

Servitization describes a strategic transformation for which manufacturers and enterprises shift their focus from selling products to offering a combination of products and services (Baines et al., 2013; Kastalli & Van Looy, 2013). In its simplest terms, servitization refers to industries using their products to sell "outcome as a service" rather than the one-off sale. In parallel, different entities have also been increasingly pursuing digitalization. Digitalization can be defined as the contribution of digital and smart technologies to efficiently manage product and service operations and develop new value propositions. The so-called smart products, services and solutions (Bustinza et al., 2017) are emerging from this approach. One of the main enablers of digitization is the Internet of Things (IoT) (Barrett et al., 2012; Lerch & Gotsch, 2015; Lightfoot et al., 2011). The IoT could be defined as a network of items – each embedded with sensors connected to the internet. In other words, IoT is an aspect of product digitalization and ubiquitous communication technology, which together create novel and complex levels of connectivity and the ability to observe and actuate products remotely (Cagliano et al., 2019). IoT as a system of uniquely identifiable and connected products ("things") creating an internet-like structure that enables the real-time flow of data (Ng & Wakenshaw, 2017) while offering industrial firms the possibility to leverage technology to innovate their strategies, in particular in order to implement new service-oriented business models (Falkenreck & Wagner, 2017; Laudien & Daxböck, 2016).

The emerging literature emphasizes the contribution of the IoT to the servitization domain. The latter defines and analyzes the combination of products and services as an opportune business model to monetize the IoT investments (Hsu, 2007; Rymaszewska et al., 2017a). In order to further advance servitization theory and practice, it is critical to understand the processes and mechanisms that underlie the varied opportunities the IoT offers in state-of-the-art.

Using the IoT in order to facilitate servitization is not just a technical challenge but also a relational one (Schroeder et al., 2020). The importance and implications of the relations between IoT and servitization define one critical gap in the literature. The gaps involve two main questions:

- What are the main themes and topics introduced in studies related to the synergies between the Internet of Things and servitization?
- Whether available studies tend to group into different thematic clusters, and if yes, what are the main themes and approaches inside these clusters?

In order to answer the two questions, we have applied methodological qualitative-quantitative triangulation to the totality of the available literature on Scopus and Web of Science. Methodological triangulation involves using more than one kind of method to study a phenomenon. Bibliometric analysis, thematic analysis and content analysis are three different methods we used to assess scholarly documents.

2 Methodology

2.1 Preparation, search, and research process flow

To achieve the goal of this study, the analysis was divided into two phases. Initially, to detect the link between servitization and the Internet of Things, bibliometric analysis was performed to identify the evolution in time and space of the two interrelated topics and to identify areas for future research (Gutiérrez-Salcedo et al., 2018). It was considered useful for the study because, as indicated by Martinez-Sanchez et al. (2015), the bibliometric analysis contributes to assessing progress made, identifying the most reliable sources of scientific publication, laying the academic foundation for the evaluation of new developments, identifying major scientific actors, and developing bibliometric indices to assess academic output.

Secondly, we performed a content analysis and thematic analysis to detect and highlight major themes and topics in the assessed scholarly documents. Fig. 1 shows the methodological framework which we established before the collection of data. Given the topic's novelty, we evaluated quantitative content analysis as the most appropriate methodological tool for the above research questions. Indeed, content analysis is seen by many as atheoretical. While it may be seen as a negative point for the well-established domains of knowledge. Kolbe & Burnett (1991) argue that the atheoretical approach suits the most initial exploration of novel and emerging topics. Such an approach can highlight the main thematic clusters within the available literature while keeping at bay the likely biases of researchers.

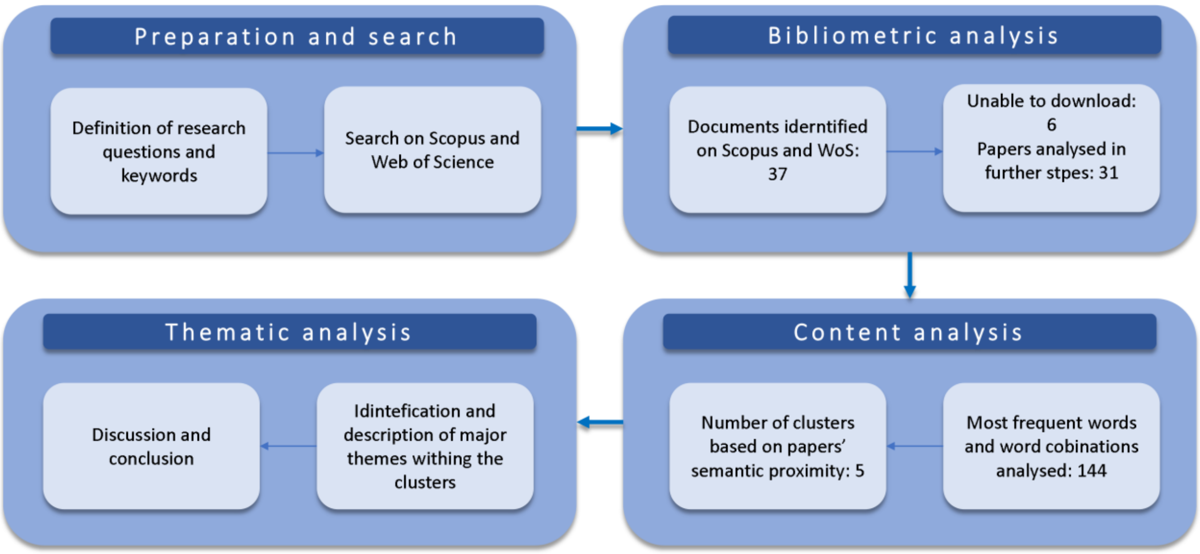

Fig. 1 Research process flow

2.2 Bibliometric analisys

We selected electronic databases as the only channels for the literature search. We have not performed forward or backward searches. Therefore, only keyword-based queries were used. We performed the searches on Scopus and Web of Science. A choice of search engines was not accidental. According to Gusenbauer & Haddaway (2020), both Scopus and Web of Science are multi-disciplinary search engines most suitable for a systematic literature search and retrieval.

The bibliometric analysis was carried out based on scientific contributions resulting from the search conducted on the Scopus and Web of Science using the following search criteria:

- Keywords related to the topics of "servitization" and "Internet of Things";
- No time limit in order to carry out a complete analysis associated with the evolution over time of the phenomenon under investigation, the leading scholars who have addressed the topics "servitization" and "Internet of things," and the geographical concentration of research and the universities involved;
- research category "Management" (for Web of Science) and "Business, Management and Accounting" (for Scopus);
- document types "Article, Proceedings paper, Review and Book Chapter";
- Web of Science indices: "Sci-Expanded, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI, BKCI-S, BKCI-SSH, CCR-EXPANDED, IC."

Applying the search criteria defined in the previous section, the queries provided 37 results divided into 25 articles, five conference papers, four book chapters and three reviews. From a temporal point of view, the publications are distributed over eight years from 2014 to 2021, although in a discontinuous way. For example, there are no contributions published in 2015. Subsequently, after an upward trend until 2018, the trend of published papers reversed in 2019. Significant growth of scholarly interest in the associated topics Servitization and the Internet of Things can be found in 2020. It is reasonable to expect a positive trend for the current year, which, however, is not expected to deviate significantly from 2020 (Fig. 2).

Total publications by year	
Year	Documents
2014	1
2015	0
2016	2
2017	4
2018	5
2019	4
2020	13
2021	8

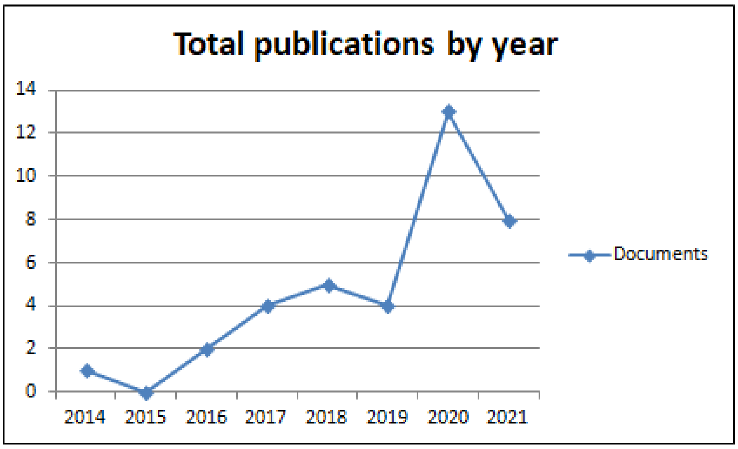

Fig. 2 Distribution of scholarly documents by year

Considering the citation analysis results, it was found that starting from 2014, the number of citations has a countertrend; in fact, after a positive trend until 2017, a constant negative trend followed (Tab. 1).

Citations	2	30	86	233	156	144	117	67
Year	2014	2015	2016	2017	2018	2019	2020	2021

Tab. 1 Total citations per year

The universities involved in studies on the link between "Servitization" and "Internet of Things" are many (63). Among the universities that have generated the largest number of studies are Vaasan Yliopisto (with six publications), Luleå Tekniska Universitet (with nine publications), National Institute of Technology NIT Sistem (with eight publications), Indian Institute of Technology IIT System (with seven publications), Fraunhofer Gesellschaft, Old Dominion University and Peter The Great St Petersburg Polytechnic University (with six publications).

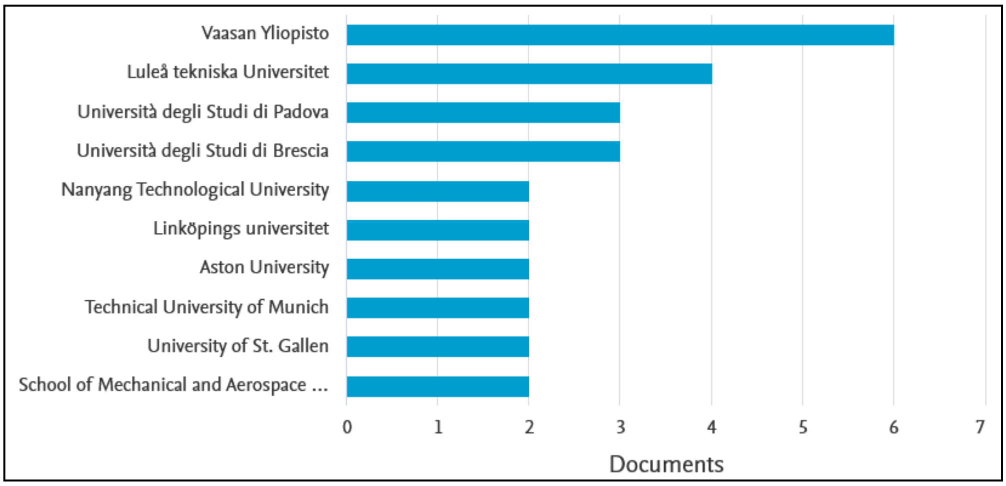

Fig. 3 Documents by affiliation

The wide diffusion of scientific interests on the subject is confirmed by the number of scholars involved (over 100). Among all the authors, those who stand out for having published more than two contributions (Fig. 4) are:

- Parida Vinit, from the Luleå University of Technology of Sweden, is particularly interested in the following research areas: servitization and advanced service innovation, business model innovation, digitalization of industrial ecosystems, circular economy and sustainable product service-system, organizational capabilities, entrepreneurial orientation and innovation in SMEs and new ventures;
- Kohtamäki, Marko, of Vaasan Yliopisto in Vaasa, Finland, is author of publications on digital servitization, product-service-software innovation, organizational change, strategic practices, business intelligence and strategic alliances.

Also Federico Adrodegari and Nicola Saccani of the University of Brescia (Italy), Tim Baines, Andreas Schroeder, Parikshit Naik and Ali Ziaee Bigdeli of the Aston Business School of Birmingham (United Kingdom), Markus Böhm, Helmut Krcmar and Jörg Weking of the Technical University of Munich (Germany), C. H. Chen of the School of Mechanical and Electronic Engineering (Germany), H. Chen of the School of Mechanical and Aerospace Engineering in Singapore City, Heiko Gebauer of Linköpings Universitet (Sweden), Marco Paiola of the University of Padua (Italy), David Sjödin of the Luleå University of Technology of Sweden, Pai Zheng of Hong Kong Polytechnic University in Kowloon (Hong Kong) are also particularly interested in the topic of servitization (having published two contributions each).

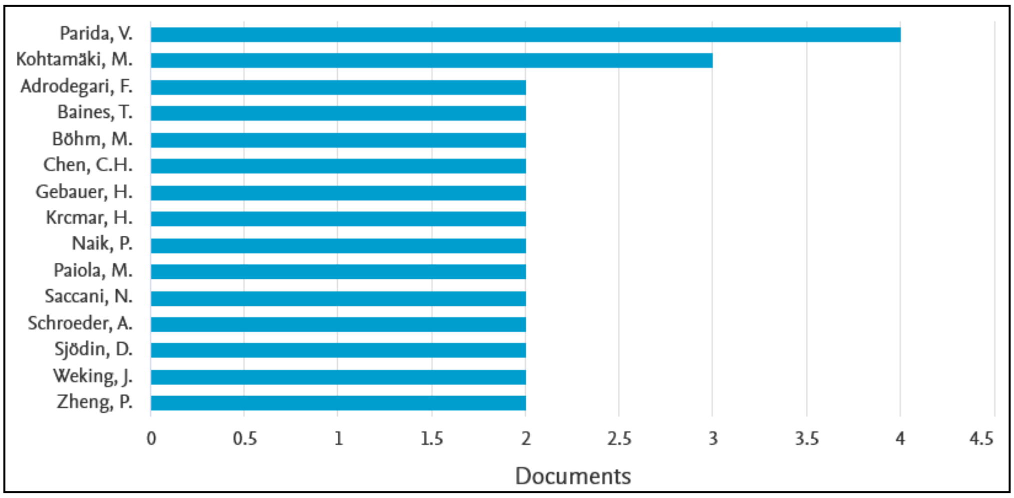

Fig. 4 Documents by author

Moreover, by examining the most productive countries, widespread interest was found at a global level. In this scenario, the most stand out Finland, Germany and United Kingdom (with seven contributions for each country), Italy (with six contributions each), Sweden (with five contributions each), Switzerland (with four contributions each), Norway and the United States (with three contributions each), China and Singapore (with two contributions each).
After combining the results from the two search engines and eliminating all duplicates, 31 scholarly documents were selected for further elaboration (6 documents were unavailable to download). The heterogeneity and complexity of the emerging topic can be easily grasped by observing the distribution of 31 selected scholarly documents by journals/proceedings and the year of publication (Tab. 2). Indeed all 31 documents were more or less evenly distributed among 21 journals and conference proceedings. The modal value of 5 documents was for Industrial Marketing Management (a journal that addresses topics to facilitate marketing decisions and strategies in global industrial and business-to-business markets). In contrast, 15 journals and proceedings contributed to the search with only one document.

Journal	**'14**	**'16**	**'17**	**'18**	**'19**	**'20**	**'21**	**Tot.**	**%**
2014 11th International Conference on Service Systems and Service Management	1							1	3.22
2019 IEEE Technology Engineering Management Conference					1			1	3.22
Advances in Manufacturing Technology		1						1	3.22
Electronic Markets					1			1	3.22
Industrial Marketing Management			1			4		5	16.13
International Journal of Lean Six Sigma						1		1	3.22
International Journal of Operations & Production Management						1	1	2	6.45
International Journal of Production Economics			2			1		3	9.67
Journal of Business & Industrial Marketing				2				2	6.45

Journal of Business Research						1	1	2	6.45
Journal of Cleaner Production				1				1	3.22
Journal of Organizational and End User Computing							1	1	3.22
Journal of Strategy and Management					1			1	3.22
LogForum				1				1	3.22
Production Planning & Control						1		1	3.22
Research-Technology Management				1				1	3.22
Science, Technology and Society							1	1	3.22
Springer International Publishing			1		1			2	6.45
Technological Forecasting and Social Change						1		1	3.22
The Routledge Companion to Management Information Systems			1					1	3.22
Transdisciplinary Engineering for Complex Socio-technical Systems					1			1	3.22
Tot.	1	1	5	5	5	10	4	31	100%

Tab. 2 Distribution of articles by journal and publication date

3 Content analysis

The 31 downloaded documents were exported in MAXQDA (release 2020.4.1) for the subsequent determination coding and analysis of the most frequent words and word combinations used by the scholars. The “Word Combinations” tool was used for this purpose. Word combinations ranging from one to three words (within sentences) were selected as the criteria for search. Moreover, all the words were lemmatized. We then proceed to automatically code all the results with a frequency of one hundred occurrences or more. One hundred forty-four codes were generated. The word cloud in Fig. 5 shows all the obtained codes, with the size proportionate to codes’ frequency in the documents. Unsurprisingly, a simple exploration of the word cloud reveals that categories related to service and IoT and generally innovative technologies are the most frequent.

Fig. 5 144 most frequent words and word combinations

To go beyond simple visual explanation and uncover nested thematic dynamics both within and between documents, we performed a similarity analysis using the "Document Map" tool of MAXQDA. Fig. 6 showcases the similarity of documents based on the code frequencies. The distance between single documents was obtained by calculating the sum of absolute deviations from the average code frequency for all 144 codes. Each dot in the figure represents one of the 31 analyzed articles. The size of each dot is proportionate to the absolute frequency of all codes in a document. Five clusters of studies were identified based on the distance and the disposition of documents on the map. As three out of five clusters contain only one study, they are better thought of as outliers. Consequently, most studies tended to be thematically grouped in two macro clusters (cluster 4 and cluster 5 in the documents similarity map).
To better further confirm the existence of the two thematic macro clusters, we exported codes frequencies in RStudio (version1.3.959) and performed a principal component analysis (PCA). One hundred forty-four code frequencies (as in the word cloud) have entered the analysis as active variables. The previously determined clusters were selected as supplementary variables (unrelated to the construction of PCA dimensions). The analysis resulted in 30 uncorrelated dimensions. Fig. 7 depicts the percentage of total variance for each dimension. As shown in the figure, the first dimension accounted for nearly 20 percent of the total variance. However, given the small contribution of all other dimensions (nearly 7 percent for the second dimension and lower), only the first dimension was considered to interpret the results.

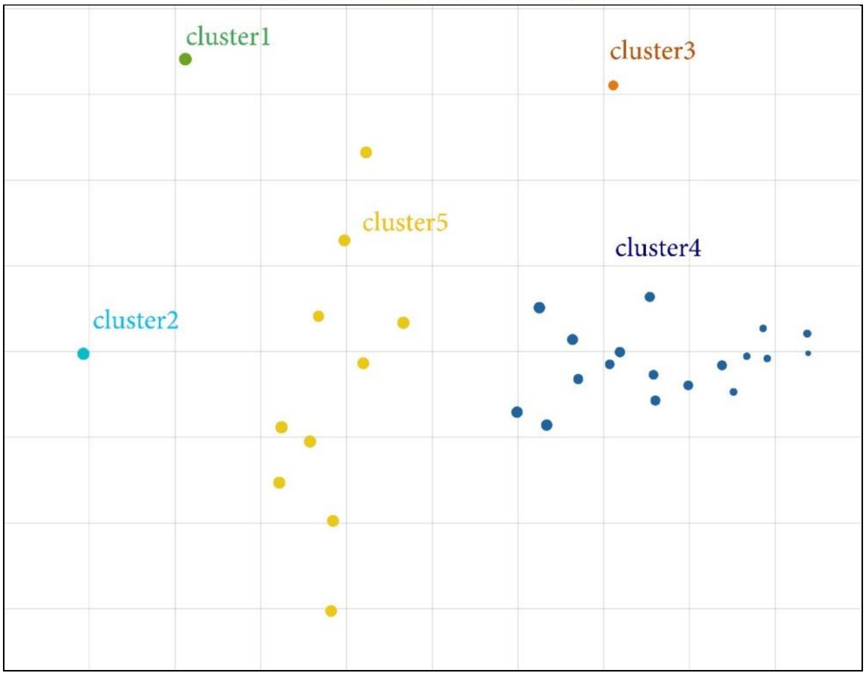

Fig. 6 Documents similarity map. Five identified clusters

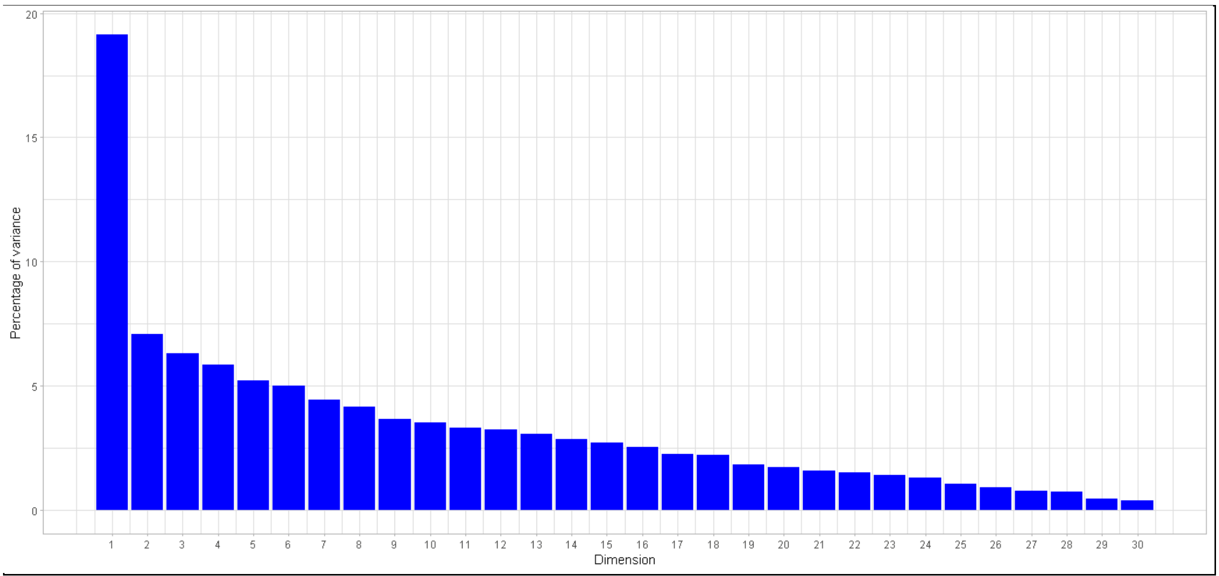

Fig. 7 PCA. the decomposition of total inertia

The visual exploration of the distribution of documents alongside the first two dimensions (Fig. 8) further confirms the existence of two thematic clusters. Indeed, the two clusters can be solely differentiated along the first dimension, with positive values identifying one cluster and negative values identifying the other. As in the case of document similarity analysis, there are three outliers with only one article belonging to each. In the next section, a qualitative thematic analysis of each cluster is performed in order to better understand the nature of studies in each cluster.

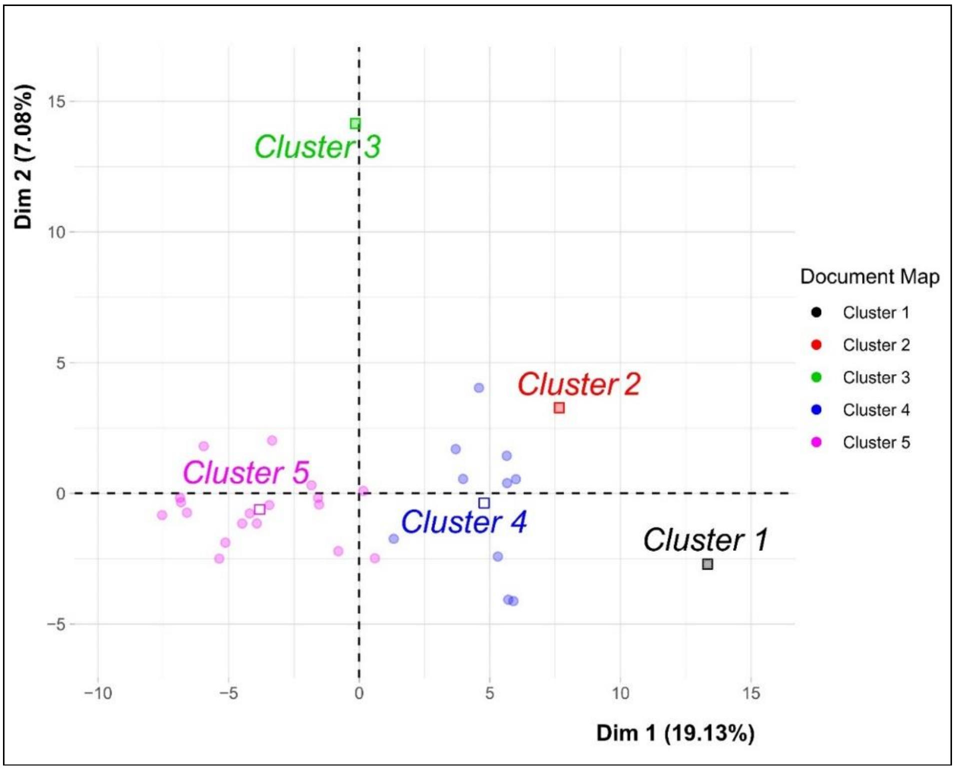

Fig. 8 PCA. Distribution of articles across the first two dimensions

4. Thematic analysis

As revealed by PCA, variables belonging to cluster 4 tended to assume the positive values for the first dimension. Vice versa, variables in cluster 5 were more likely to be negative on that dimension. Tab. 3 shows 15 of the highest-ranking variables for each macro cluster (in absolute terms). It emerges from the analysis table that articles belonging to cluster 4 were more on the managerial side, while articles in cluster 5 were centered around more technological issues.

Dim1 - positive values (cluster 4)	**Dim1 - negative values (cluster 5)**
management	environment
analysis	software
plan	smart product
qualitative	lean
economics	product service system
customer	effective
monitor	ecosystem
international	service innovation
opportunity	innovation
manufacture	Information system
create	value co-creation
production	sustainability

business	product-service
operation	network
strategy	digitization

Tab. 3 PCA. 15 active variables with majorly contributing to the two macro clusters

Tab. 4 shows the articles identified in each cluster and the significant themes that have emerged from reviewing their content. As can be seen, the main point of the divide between the two macro clusters is the focus of the researchers on either managerial (cluster 4) or more technical-oriented (cluster 5) topics.

Cluster	Articles	Major themes
1	Paiola & Gebauer, 2020	digitalization, BtoB business model, map of servitization, product-process-outcome oriented servitization
2	Chen et al., 2021	digital servitization, business model innovation, digital business model, value creation, value driver, digitalization
3	Hein et al., 2019	value co-creation, digital platforms, boundary resources, standardization
4	Boehmer et al., 2020; Green et al., 2017; Hasselblatt et al., 2018; Naik et al., 2020; Paiola et al., 2021; Paschou et al., 2020; Rymaszewska et al., 2017; Schroeder et al., 2020; Sjödin et al., 2020; Weking et al., 2020	digitalization, advanced services, digital paradox, artificial intelligence, product-service systems, new service development, affordance theory, manufacturing, digital servitization, business model innovation, sustainability, networks, digital technologies, advanced services, value creation, taxonomy and patterns, business intelligence, resource-based view, industrial internet, buyer-supplier relationships, service-dominant logic, customer co-created servitization
5	Almeida et al., 2019; Amadi-Echendu et al., 2019; Ferreira et al., 2016; Fitzgerald & Stol, 2017; Gudergan et al., 2017; Heinis et al., 2018; Kohtamäki et al., 2020; Oláh et al., 2018; Ono, 2014; Pardo et al., 2020; Rudnick et al., 2020; Spring & Araujo, 2017; Turunen et al., 2018; Wolf et al., 2019; Yun et al., 2021; Zhang et al., 2021; Zheng et al., 2018, 2019	data-driven design, smart connected products, digital twin, product-service systems, value creation, dependency graph, path traversal sequence, QoS, service composition, Top-K, business-to-business, physicality, asset, replacement models, product to-service, asset replacement decisions, resource-based view, industrial services, service infusion, lean service, servitization of manufacturing, supply chain, globalization, information technology, machine learning, metrics, ambidextrous open innovation, the 4th Industrial Revolution, product biography, circular economy, repair, product lifecycle management, cyber-physical systems, intelligence, product ecosystems, value co-creation, sociotechnical system, hybrid structure, value drivers, value capturing, digitalization, customer relationship management

Tab. 4 Significant themes in each cluster

To detect the most significant aspects of the link between "servitization" and "Internet of Things," the ten most cited publications were examined more in detail (Tab. 5).

Year	*Title*	*Authors*	*Total citations*
2017	IoT powered servitization of manufacturing – an exploratory case study	Rymaszewska A., Helo P., Gunasekaran A.	176
2018	A systematic design approach for service innovation of smart product-service systems	Zheng P., Lin T.-J., Chen C.-H., Xu X.	138
2016	Product biographies in servitization and the circular economy	Spring M., Araujo L.	75
2019	Value co-creation practices in business-to-business platform ecosystems	Hein A., Weking J., Schreieck M., Wiesche M., Böhm M., Krcmar H.	52
2020	The relationship between digitalization and servitization: The role of servitization in capturing the financial potential of digitalization	Kohtamäki M., Parida V., Patel P.C., Gebauer H.	45
2017	Two strands of servitization: A thematic analysis of traditional and customer co-created	Green M.H., Davies P., Ng ICL.	45
2020	An agile co-creation process for digital servitization: A micro-service innovation approach	Sjödin D., Parida V., Kohtamäki M., Wincent J.	41
2020	Internet of things technologies, digital servitization and business model innovation in BtoB manufacturing firms	Paiola M., Gebauer H.	32
2018	Modeling manufacturer's capabilities for the Internet of Things	Hasselblatt M., Huikkola T., Kohtamäki M., Nickell D.	30
2019	Leveraging industry 4.0 – A business model pattern framework	Weking J., Stöcker M., Kowalkiewicz M., Böhm M., Krcmar H.	30

Tab. 5 Significant themes in each cluster

The analysis of the most cited papers showed the interest of researchers towards the implementation of IoT to build servitization strategies aimed at offering personalized products thanks to the addition of services that represent added value. Such a strategy fosters differentiation and the co-creation of value. To achieve this, it is essential to activate forms of cooperation and interaction with stakeholders. In fact, the study by Rymaszewska et al. (2017) focuses on how companies, which offer a product-service combination, can create value by leveraging the benefits generated by IoT. Specifically, through multiple case study, they found that servitization associated with the application of IoT-based solutions enables companies operating in different industries to formulate a value proposition that meets consumers' tastes and even goes beyond their demands, and to expand their value chain to maximize customer satisfaction and their economic performance. These scholars also pointed out that the topic of servitization associated with IoT is still underexplored in the literature.
For Zheng et al. (2018), IoT is considered the enabling technology that economically affects the development of servitization, as found in manufacturing, to increase product value and create innovative services for a segmented market from a B2B or B2C perspective.
This logic is also found in the study of Spring and Araujo (2017). They highlighted that although successful cases of servitization related to capital goods are already based on collecting and analyzing data regarding product performance, IoT promises to extend this scenario to a much more comprehensive range of products and markets. In addition, these

scholars have pointed out that the IoT itself fosters the implementation of new business models in services and supports the transition to circular business models. Moreover, IoT platforms drive a standardization process that, from a value co-creation perspective, encourages supply and demand to conform to industry standards that include servitization practices (Hein et al., 2019).
From the study by Kohtamäki et al. (2020), it emerges how servitization is linked to digital IoT technologies. The concept of digital servitization is introduced because digitization fosters the development of innovative services and new business models. This link is also highlighted in the study by (Green et al., 2017). They highlighted how the servitization knowledge domain plays a crucial role in the future of the digital economy and IoT.
The same strand of research is found in the contribution of Sjödin et al. (2020). The authors indicate how the proliferation of digital technologies generates radical changes in products, services, processes, business models and the nature of business activities in industrial ecosystems that follow the logic of digital servitization. The same scholars, referring to many other studies, defined digital servitization as the transformation of processes, capabilities, and offerings within industrial enterprises and their associated ecosystems to progressively create, deliver, and capture greater service value derived from a wide range of digital enabling technologies, such as the Internet of Things, big data, artificial intelligence, and cloud computing. Paiola and Gebauer (2020) also focused on process-oriented digital servitization, which refers to the use of IoT to provide services geared toward increasing the efficiency of products and processes for customers by assisting, controlling, and advising them in order to enable them to maximize their productivity, such as process-oriented training and consulting activities, process-oriented engineering, remote condition monitoring, and preventive maintenance.
The relevance of IoT for the development of servitization processes can also be seen in the study by Hasselblatt et al. (2018), who highlighted how, by adapting business models, manufacturing companies might differentiate their offerings because compared to carrying out activities of pure sale of goods, the services associated with it allow to generate stable levels of income, a higher marginality, more profound and long-term relationships with target customers thanks to the provision of innovative solutions that are complete and high level for the satisfaction of their needs with positive effects to achieve competitive advantages.
However, to achieve these goals, the evolutionary process of the manufacturing company towards the implementation of an innovative business model is subject to the significant commitment from higher levels of the company management, adaptation of resources and processes, and significant investments to reconfigure core functionalities.
Finally, Weking et al. (2020) highlight how servitization patterns leverage IoT devices as cyber-physical systems to support a smart factory at the customer's site. Additionally, IoT enables servitization itself with remote monitoring and predictive maintenance.

4 Discussion and concluding remarks

Our analyses reveal an increasing interest in the topics of the Internet of Things and servitization. Moreover, more and more scholars are interested in investigating the possible value of synergies between the two. The area of research is promising, with interesting implications for both scholars and managers. However, no previous attempt to study the topic systematically has been made. To our best knowledge, this study represents the first systematic and atheoretical description and evaluation of the emerging discipline. The totality of the available scholarly documents on the convergence between IoT and servitization were downloaded. After the brief bibliometric analysis, the data was then coded and quantitatively analyzed. The coding process was purely automatic and based on the occurrences of the most frequent words and word combinations in the documents. It allowed us to theorize the existence of two macro clusters of documents, which roughly translates into two sub-areas of the research within the more general topic: studies that predominantly focus on purely managerial issues and studies that focus on the more technical aspects of the convergence. Indeed, not many authors (still) study the topic holistically. Therefore, more in-depth all-encompassing studies on IoT and servitization (treated as a single domain of inquiry) are highly required. To better understand to nature of the clusters and, more in general, the connection between various themes and topics in the selected documents, a thematic analysis was performed. A consensus among the scholars was found about the positive role of the potential synergies between IoT and servitization.

The atheoretical nature of our findings represents the primary strength of this study. Indeed, not only the totality of the available literature on the topics was examined, but the potential interpretative biases were also eliminated. Consequently, our findings may be helpful for scholars and practitioners as the basis of further empirical investigations of the connections between IoT and servitization.

Finally, we want to highlight some limitations characterizing the study. Only two academic search systems were assessed. Therefore, we do not exclude that some crucial papers could have been omitted from the analysis. Similarly, we could not obtain all the papers among those found on Scopus and Web of Science. Primary keywords for the initial search were also derived subjectively. However, an array of synonyms were used to exclude any potential omission of the crucial results.

Our primary research goal was to develop the broadest up-to-date assessment of the ways IoT contributes to servitization. We achieved it by assessing the entire corpus of academic literature on the topic. Recommended procedures for the methodological triangulation were applied to reduce potential biases and increase the objectivity of the findings. We hope that the resulting taxonomy will serve a valuable purpose for researchers and practitioners to build upon their future research and innovation activities.

5 References

1. Almeida, T. D., Costa Avalone, M., & Fettermann, D. C. (2019). Building blocks for the development of an IoT business model. *Journal of Strategy and Management*, *13*(1), 15–32. https://doi.org/10.1108/JSMA-07-2019-0130
2. Amadi-Echendu, J., Dakada, M., Ramlal, R., & Englebrecht, F. (2019). Asset replacement in the context of Servitization. *2019 IEEE Technology Engineering Management Conference (TEMSCON)*, 1–7. https://doi.org/10.1109/TEMSCON.2019.8813622
3. Baines, T., Lightfoot, H., Smart, P., & Fletcher, S. (2013). Servitization of manufacture: Exploring the deployment and skills of people critical to the delivery of advanced services. *Journal of Manufacturing Technology Management*, *24*(4), 637–646. https://doi.org/10.1108/17410381311327431
4. Barrett, M., Davidson, E., Fayard, A.-L., Vargo, S. L., & Yoo, Y. (2012). Being Innovative About Service Innovation: Service, Design and Digitalization. *ICIS*.

5. Boehmer, J. H., Shukla, M., Kapletia, D., & Tiwari, M. K. (2020). The impact of the Internet of Things (IoT) on servitization: An exploration of changing supply relationships. *Production Planning & Control*, *31*(2–3), 203–219. https://doi.org/10.1080/09537287.2019.1631465
6. Bustinza, O. F., Vendrell-Herrero, F., & Baines, T. (2017). Service implementation in manufacturing: An organisational transformation perspective. *International Journal of Production Economics*, *192*, 1–8. https://doi.org/10.1016/j.ijpe.2017.08.017
7. Cagliano, R., Canterino, F., Longoni, A., & Bartezzaghi, E. (2019). The interplay between smart manufacturing technologies and work organization: The role of technological complexity. *International Journal of Operations & Production Management*, *39*(6/7/8), 913–934. https://doi.org/10.1108/IJOPM-01-2019-0093
8. Chen, Y., Visnjic, I., Parida, V., & Zhang, Z. (2021). On the road to digital servitization – The (dis)continuous interplay between business model and digital technology. *International Journal of Operations & Production Management*, *ahead-of-print* (ahead-of-print). https://doi.org/10.1108/IJOPM-08-2020-0544
9. Falkenreck, C., & Wagner, R. (2017). Falkenreck, C., Wagner R. (2017) The Internet of Things – Chance and challenge in industrial business relationships, Industrial Marketing Management 66C pp. 181-195. *Industrial Marketing Management*, *66*, 181–195. https://doi.org/10.1016/j.indmarman.2017.08.007
10. Ferreira, F., Faria, J., Azevedo, A., rico, Marques, A. L., & sa. (2016). Product Lifecycle Management Enabled by Industry 4.0 Technology. *Product Lifecycle Management Enabled by Industry 4.0 Technology*, 349–354. https://doi.org/10.3233/978-1-61499-668-2-349
11. Fitzgerald, B., & Stol, K.-J. (2017). The future of software development methods. *The Routledge Companion to Management Information Systems*, 125–137.
12. Green, M. H., Davies, P., & Ng, I. C. L. (2017). Two strands of servitization: A thematic analysis of traditional and customer co-created servitization and future research directions. *International Journal of Production Economics*, *192*, 40–53. https://doi.org/10.1016/j.ijpe.2017.01.009
13. Gudergan, G., Buschmeyer, A., Feige, B. A., Krechting, D., Bradenbrink, S., & Mutschler, R. (2017). Value of Lifecycle Information to Transform the Manufacturing Industry. In G. Oswald & M. Kleinemeier (Eds.), *Shaping the Digital Enterprise: Trends and Use Cases in Digital Innovation and Transformation* (pp. 173–194). Springer International Publishing. https://doi.org/10.1007/978-3-319-40967-2_9
14. Gusenbauer, M., & Haddaway, N. R. (2020). Which academic search systems are suitable for systematic reviews or meta-analyses? Evaluating retrieval qualities of Google Scholar, PubMed, and 26 other resources. *Research Synthesis Methods*, *11*(2), 181–217. https://doi.org/10.1002/jrsm.1378
15. Gutiérrez-Salcedo, M., Martínez, M. Á., Moral-Munoz, J. A., Herrera-Viedma, E., & Cobo, M. J. (2018). Some bibliometric procedures for analyzing and evaluating research fields. *Applied Intelligence*, *48*(5), 1275–1287. https://doi.org/10.1007/s10489-017-1105-y
16. Hasselblatt, M., Huikkola, T., Kohtamäki, M., & Nickell, D. (2018). Modeling manufacturer's capabilities for the Internet of Things. *Journal of Business & Industrial Marketing*, *33*(6), 822–836. https://doi.org/10.1108/JBIM-11-2015-0225
17. Hein, A., Weking, J., Schreieck, M., Wiesche, M., Böhm, M., & Krcmar, H. (2019). Value co-creation practices in business-to-business platform ecosystems. *Electronic Markets*, *29*(3), 503–518. https://doi.org/10.1007/s12525-019-00337-y
18. Heinis, T. B., Loy, C. L., & Meboldt, M. (2018). Improving Usage Metrics for Pay-per-Use Pricing with IoT Technology and Machine Learning. *Research-Technology Management*, *61*(5), 32–40. https://doi.org/10.1080/08956308.2018.1495964
19. Hsu, C. (2007). Scaling with digital connection: Services innovation. *2007 IEEE International Conference on Systems, Man and Cybernetics*, 4057–4061. https://doi.org/10.1109/ICSMC.2007.4414260

20. Kastalli, I. V., & Van Looy, B. (2013). Servitization: Disentangling the impact of service business model innovation on manufacturing firm performance. *Journal of Operations Management*, *31*(4), 169–180. https://doi.org/10.1016/j.jom.2013.02.001
21. Kohtamäki, M., Parida, V., Patel, P. C., & Gebauer, H. (2020). The relationship between digitalization and servitization: The role of servitization in capturing the financial potential of digitalization. *Technological Forecasting and Social Change*, *151*, 119804. https://doi.org/10.1016/j.techfore.2019.119804
22. Kolbe, R. H., & Burnett, M. S. (1991). Content-Analysis Research: An Examination of Applications with Directives for Improving Research Reliability and Objectivity. *Journal of Consumer Research*, *18*(2), 243–250. https://doi.org/10.1086/209256
23. Laudien, S. M., & Daxböck, B. (2016). Understanding Determinants of Business Model Design in the Context of Product-Service Transition. *Academy of Management Proceedings*, *2016*(1), 16718. https://doi.org/10.5465/ambpp.2016.16718abstract
24. Lerch, C., & Gotsch, M. (2015). How digitalization can accelerate the transformation from manufacturer to service provider. *Servitization: The Theory and Impact*, 76–82.
25. Lightfoot, H. W., Baines, T., & Smart, P. (2011). Examining the information and communication technologies enabling servitized manufacture. *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture*, *225*(10), 1964–1968. https://doi.org/10.1177/0954405411399019
26. Martínez, M. A., Cobo, M. J., Herrera, M., & Herrera-Viedma, E. (2015). Analyzing the scientific evolution of social work using science mapping. *Research on social work practice*, *25*(2), 257-277.
27. Naik, P., Schroeder, A., Kapoor, K. K., Ziaee Bigdeli, A., & Baines, T. (2020). Behind the scenes of digital servitization: Actualising IoT-enabled affordances. *Industrial Marketing Management*, *89*, 232–244. https://doi.org/10.1016/j.indmarman.2020.03.010
28. Ng, I. C. L., & Wakenshaw, S. Y. L. (2017). The Internet-of-Things: Review and research directions. *International Journal of Research in Marketing*, *34*(1), 3–21. https://doi.org/10.1016/j.ijresmar.2016.11.003
29. Oláh, J., Zéman, Z., Balogh, I., & Popp, J. (2018). Future challenges and areas of development for supply chain management. *LogForum*, *Vol. 14*(1). https://doi.org/10.17270/J.LOG.2018.238
30. Ono, M. (2014). Service science in top IT vendors. *2014 11th International Conference on Service Systems and Service Management (ICSSSM)*, 1–6. https://doi.org/10.1109/ICSSSM.2014.6874115
31. Paiola, M., & Gebauer, H. (2020). Internet of things technologies, digital servitization and business model innovation in BtoB manufacturing firms. *Industrial Marketing Management*, *89*, 245–264. https://doi.org/10.1016/j.indmarman.2020.03.009
32. Paiola, M., Schiavone, F., Grandinetti, R., & Chen, J. (2021). Digital servitization and sustainability through networking: Some evidences from IoT-based business models. *Journal of Business Research*, *132*, 507–516. https://doi.org/10.1016/j.jbusres.2021.04.047
33. Pardo, C., Ivens, B. S., & Pagani, M. (2020). Are products striking back? The rise of smart products in business markets. *Industrial Marketing Management*, *90*, 205–220. https://doi.org/10.1016/j.indmarman.2020.06.011
34. Paschou, T., Rapaccini, M., Adrodegari, F., & Saccani, N. (2020). Digital servitization in manufacturing: A systematic literature review and research agenda. *Industrial Marketing Management*, *89*, 278–292. https://doi.org/10.1016/j.indmarman.2020.02.012
35. Rudnick, M., Riezebos, J., Powell, D. J., & Hauptvogel, A. (2020). Effective after-sales services through the lean servitization canvas. *International Journal of Lean Six Sigma*, *11*(5), 929–942. https://doi.org/10.1108/IJLSS-07-2017-0082
36. Rymaszewska, A., Helo, P., & Gunasekaran, A. (2017a). IoT powered servitization of manufacturing – an exploratory case study. *International Journal of Production Economics*, *192*, 92–105. https://doi.org/10.1016/j.ijpe.2017.02.016

37. Rymaszewska, A., Helo, P., & Gunasekaran, A. (2017b). IoT powered servitization of manufacturing – an exploratory case study. *International Journal of Production Economics*, *192*, 92–105. https://doi.org/10.1016/j.ijpe.2017.02.016
38. Schroeder, A., Naik, P., Ziaee Bigdeli, A., & Baines, T. (2020). Digitally enabled advanced services: A socio-technical perspective on the role of the internet of things (IoT). *International Journal of Operations & Production Management*, *40*(7/8), 1243–1268. https://doi.org/10.1108/IJOPM-03-2020-0131
39. Sjödin, D., Parida, V., Kohtamäki, M., & Wincent, J. (2020). An agile co-creation process for digital servitization: A micro-service innovation approach. *Journal of Business Research*, *112*, 478–491. https://doi.org/10.1016/j.jbusres.2020.01.009
40. Spring, M., & Araujo, L. (2017). Product biographies in servitization and the circular economy. *Industrial Marketing Management*, *60*, 126–137. https://doi.org/10.1016/j.indmarman.2016.07.001
41. Turunen, T., Eloranta, V., & Hakanen, E. (2018). Contemporary perspectives on the strategic role of information in internet of things-driven industrial services. *Journal of Business & Industrial Marketing*, *33*(6), 837–845. https://doi.org/10.1108/JBIM-06-2017-0153
42. Weking, J., Stöcker, M., Kowalkiewicz, M., Böhm, M., & Krcmar, H. (2020). Leveraging industry 4.0 – A business model pattern framework. *International Journal of Production Economics*, *225*, 107588. https://doi.org/10.1016/j.ijpe.2019.107588
43. Wolf, V., Stumpf-Wollersheim, J., & Schott, L. (2019). The Internet of Things in a Business Context: Implications with Respect to Value Creation, Value Drivers, and Value Capturing. In R. Baierl, J. Behrens, & A. Brem (Eds.), *Digital Entrepreneurship: Interfaces Between Digital Technologies and Entrepreneurship* (pp. 185–197). Springer International Publishing. https://doi.org/10.1007/978-3-030-20138-8_8
44. Yun, J. J., Liu, Z., & Zhao, X. (2021). Introduction: Ambidextrous Open Innovation in the 4th Industrial Revolution. *Science, Technology and Society*, *26*(2), 183–200. https://doi.org/10.1177/09717218211006969
45. Zhang, B., Wen, K., Lu, J., & Zhong, M. (2021). A Top-K QoS-Optimal Service Composition Approach Based on Service Dependency Graph. *Journal of Organizational and End User Computing (JOEUC)*, *33*(3), 50–68. https://doi.org/10.4018/JOEUC.20210501.oa4
46. Zheng, P., Lin, T.-J., Chen, C.-H., & Xu, X. (2018). A systematic design approach for service innovation of smart product-service systems. *Journal of Cleaner Production*, *201*, 657–667. https://doi.org/10.1016/j.jclepro.2018.08.101
47. Zheng, P., Wang, Z., & Chen, C.-H. (2019). Smart Product-Service Systems: A Novel Transdisciplinary Sociotechnical Paradigm. *Transdisciplinary Engineering for Complex Socio-Technical Systems*, 234–241. https://doi.org/10.3233/ATDE190128