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Review

Logistics Service Providers and Industry 4.0: A Systematic Literature Review

Ricardo Moreira da Silva [1], Guilherme Francisco Frederico [1,*] and Jose Arturo Garza-Reyes [2]

[1] School of Management, Federal University of Paraná—UFPR, Curitiba 80210-170, Brazil
[2] Centre for Supply Chain Improvement, University of Derby, Derby DE22 1GB, UK
* Correspondence: guilherme.frederico@ufpr.br

Abstract: *Background:* Industry 4.0 is one of the topics related to manufacturing, supply chain and logistics that has received great interest from the academic community, organizations and governments in the last decade. *Problem statement:* Several published articles discuss and seek to conceptualize what the fourth industrial revolution is, but no research relates Industry 4.0 in the context of logistics service providers (LSPs) in a clear and structured way. *Objectives:* This study aims to fill this research gap, proposing a conceptual framework and addressing the challenges, barriers and organizational dimensions that need adaptation to insert LSPs in the new Industry 4.0 environment. *Methods:* This theoretical and conceptual study uses the Systematic Literature Review (SLR) as a research method to understand the Industry 4.0 phenomenon in the context of LSPs. *Contributions:* The relevant constructs identified in this research will help professionals and organizations that provide logistics services to develop strategies and encourage new research in the field of Industry 4.0 from the perspective of LSPs. *Results:* In addition, this research identified and generally consolidated six dimensions, as a result of this innovative study a conceptual framework is presented.

Keywords: logistics service providers; 3PL/4PL; Industry 4.0; Logistics 4.0; systematic literature review; Supply Chain 4.0

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1. Introduction

In the last decade, there has been a significant amount of research on Industry 4.0 [1–3], as evidenced by Ghobakhloo et al. [4], with the number of publications since 2016 doubling each year. The term "Industry 4.0" was first coined at the Hannover fair in Germany in 2011 [5–7]; it symbolizes the beginning of the fourth industrial revolution and represents, among other things, the digital transformation in the manufacturing industry [4].

The digitization of supply chains, products, services, and customer relationships [8]—through the introduction of enabling technologies such as cyber-physical systems (CPSs), Internet of Things (IoT), and cloud computing [5,6,9,10]—enables the emergence of smart factories. This trend further results in new forms of value creation and new business models [9,11] to cope with rapidly increasing and complex demands [3,12,13].

A number of studies discuss and explore the theme of Industry 4.0 from the perspectives of enabling technologies [6,14], applications in the manufacturing industry [15–17], supply chain management [2,10,14,18–20], logistics management [11,21], its implications for human resources [22], its interaction with consolidated management philosophies [23,24], and sustainability and value creation [25–28]. Authors such as Oesterreich and Teuteberg [29], Liao et al. [1], Kamble et al. [30], Frederico et al. [10], Osterrieder et al. [31], and Ghobakhloo et al. [4] have provided a comprehensive overview of the phenomenon of Industry 4.0 through literature reviews.

Research Gap

Although existing studies can help determine the state of the art, there is still little research on Industry 4.0 in the context of logistics service providers (LSPs). LSPs perform logistics outsourcing activities of transport and storage management on behalf of a shipper [32] and have become popular since their inception in the 1980s, generating an entirely new field of business [33] called third-party logistics or TPL/3PL (third-party logistics). These companies currently play a central and critical role in strategic coordination in the supply chain, creating and sustaining competitive advantages [34].

In recent decades, TPL companies have taken on a more strategic role in the supply chain [35], acting as a supply chain orchestrator and facilitating supply chain management best practices [34]. The fact is, both LSPs and the logistics area will be affected by the evolution of Industry 4.0 [36]. In their pioneering research, Hofmann and Osterwalder [36] sought to assess whether the disruptive potential of digitization could threaten the position of LSPs. However, discussions and guidance on how to develop and renew the capabilities of logistics companies remain inadequate [37]. According to Tombido et al. [8], no study has yet fully addressed the concept of Industry 4.0 and its impact on outsourced service providers.

Although LSPs have been mentioned in works describing some of their functions in the supply chain, there has not been a specific study to develop research on the implications of Industry 4.0 for LSPs. Due to the importance of the topic and the gap in the literature related to LSPs and Industry 4.0, this research performs a systematic literature review (SLR) and will theoretically seek to fill this "gap" in the literature, transcribing the challenges as well as technologies and devices that are or may be used by logistics companies to create value and gain competitive advantage. Specifically, this study addresses the following research questions:

RQ1. What are the challenges and barriers for LSPs in the context of Industry 4.0?

RQ2. What are the inter- and intra-organizational dimensions of LSPs that might be impacted by Industry 4.0?

RQ3. Which Industry 4.0 technologies can be applied by LSPs?

The objective of this research is to identify the elements that make up Industry 4.0 and the implications for logistics service providers. The main objective is to provide a robust conceptual framework that can be further validated in empirical research and to support logistics organizations in developing digitalization strategies.

This review article is structured as follows: the introductory section contextualized the research, addressed the research gap this article sought to fill, and established the main questions. Section 2 addresses the research method used, its stages as well as the generated bibliometric data. In Section 3, the results and discussions are described; Finally, Section 4 contains conclusions and directions for future research.

2. Systematic Literature Review (SLR) Method

An SLR can help understand the relationship between Industry 4.0 and LSPs, and has both theoretical and conceptual importance.

Such a review can help identify research gaps and may address an emerging topic, providing a potential theoretical foundation; however, it is not as extensive as a full review, due to the restricted body of research available [38]. Instead, it contributes to the development of knowledge [39].

In this study, we adopted the process developed by Tranfield et al. [39], consisting of three steps: planning, processing, and reporting. In the planning stage, the research protocol is developed, including the search strategy (database, keywords, and search period), to identify relevant works and define the inclusion and exclusion criteria. In the processing stage, a qualitative assessment of the studies and data synthesis are performed; in the reporting stage, the descriptive results of the analyses are presented.

2.1. Systematic Review of the Literature for LSPs and Industry 4.0

Table 1 presents the SRL method adopted in this study.

Table 1. Systematic Literature Review Method.

Stages	Results
Planning	Databases: Web of Science, Scopus, ScienceDirect, Emerald, Springer, Wiley, SAGE, and Google Scholar. Search terms: "the fourth industrial revolution" OR "the 4th industrial revolution" OR "Industry 4.0" AND 3PL OR 4PL OR LSP OR "logistics services providers" OR "third-party logistics" OR "fourth-party logistics". Research period: 2011 to Oct 2020Number of articles found: 374
Processing	Search performed based on criteria in the planning stage Screening: application of the exclusion method, reading of articles based on the theme of this research. Content that addressed concepts, capabilities, technologies, barriers, and success factors. Extraction: structuring of the concept matrix by authors x dimensions.
Reporting	Establishment of the dimensions identified in the reading and analysis of the articles. Application of the concept matrix, specification of the dimensions and sub-dimensions most cited by the authors.

2.1.1. Planning

In the planning phase, the following search terms were defined and combined: Industry 4.0 and its variations (the fourth industrial revolution and the 4th industrial revolution), third-party logistics (3PL), fourth-party logistics (4PL), and logistics service providers (LSPs).

Initially, only articles in which these terms were mentioned in the title, abstract, and keywords were considered. However, due to the low volume of results returned by the databases, it was necessary to consider the entire document, including the references.In a way, the difficulty in identifying relevant works proves the scarcity of research in this field. After this more comprehensive search, 374 articles published between 2011 and October 2020 were obtained; the period is justified by the fact that the term Industry 4.0 was first cited only in 2011. Only articles published in periodicals and written in the English language were considered.

2.1.2. Processing

To narrow the focus of the search, it was decided that the term Industry 4.0 (and its variations) should appear in the articles, along with the terms 3PL, 4PL or LSPs; moreover, the articles should address the relationship between the two.

There were some instances of article duplication since we searched for relevant articles in the two largest scientific databases—Web of Science and Scopus—in addition to publishers such as Emerald and Springer. However, this database strategy was necessary to ensure the most comprehensive coverage, to recover as many documents as possible, and to determine the saturation point. The number of duplicate articles was 39, with the article present in as many as four different databases in some cases. After eliminating duplicates, 335 articles were selected for further screening.

We read the abstracts and introductions of the articles to identify the framing of each article and exclude research that did not clearly address the terms or combinations or lacked satisfactory depth in the themes. In some cases, we also read the article conclusions owing to the impact of the publication. It is important to emphasize that due to the low number of articles returned by the searches in the chosen databases, indicated through the following search criteria only: title, abstract, and keywords, it was necessary to cover all the content of the articles as it accessed a larger number of articles. However, most of the search terms were found in the references only. These documents were excluded in the screening process. In search of relevant information for our research, we chose to read articles from impact publications in best quartile Q1, with H-index > 100 and JCR > 3.000, in addition to the abstract, the introduction, and the conclusion. This process yielded 69 articles that were included after a more detailed reading of their content.

A few articles that only emphasized Industry 4.0 and superficially discussed LSPs were excluded. Some articles were also excluded due to their more technical approach to one or more enabling technologies or due to the date of publication and type of article. In the vast majority of excluded articles, the key words were only presented in the bibliography or in a few passages within the text, demonstrating that the theme was not the focus of these articles. Ultimately, 28 articles remained that were relevant both in terms of impact and proximity to the theme proposed in this study. Figure 1 show the detailed steps of the SLR.

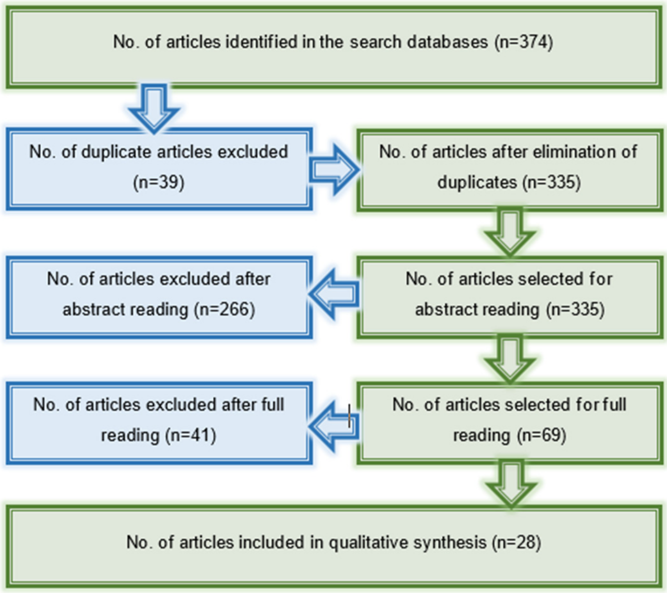

Figure 1. Flow chart of step-wise literature review process.

Figure 2 presents the number of publications per year. The year 2019, in particular, witnessed a considerable increase in the number of published articles (12 articles), which is more than double the amount of publications from previous years. This finding suggests that the theme LSPs–Industry 4.0 has gained attention in the research community.

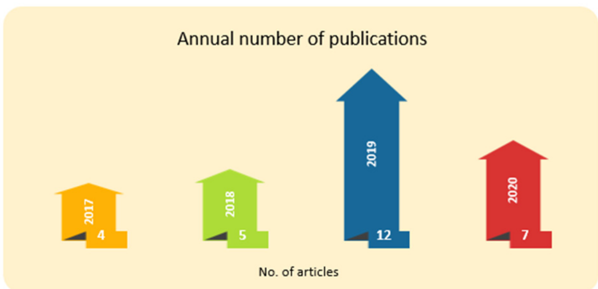

Figure 2. Annual number of publications.

Figure 3 shows the distribution of articles across databases, with 46% (13 articles) of the articles belonging to the Scopus database. It is noteworthy that articles were also identified in the databases of publishers, beyond the most popular databases such as Web of Science and Scopus; thus, articles in publisher databases, which would not have been analyzed otherwise, are also considered in this review.

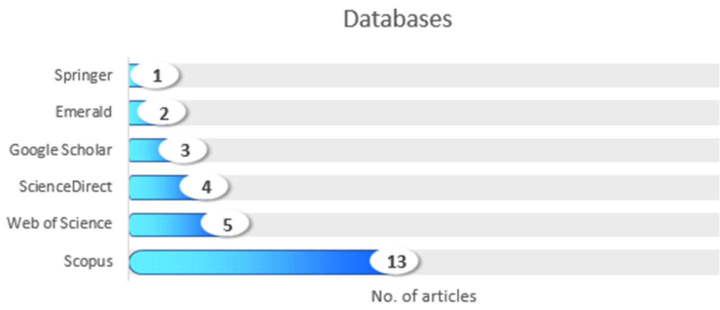

Figure 3. Articles by database.

Figure 4 displays the distribution of articles per continent/country, determined by the country of the main author. More than 46% (13 articles) of the published articles involve institutions from Europe, with institutions from Asia next, at 28% (8 articles). The top six countries that produced the most knowledge on the subject were: Germany with 14.3% (4 articles), and Switzerland, Poland, Hong Kong, Malaysia, and Turkey, all with 7.1% (2 articles) each.

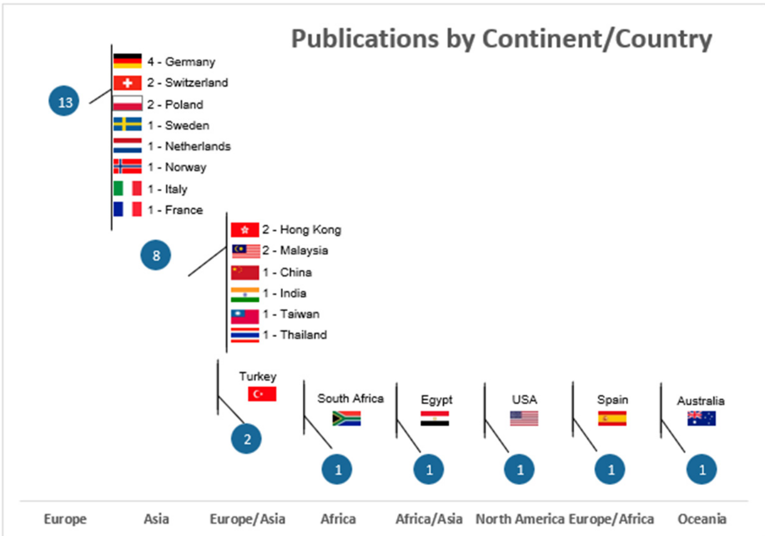

Figure 4. Number of publications by country.

Regarding the number of articles published per journal, the distribution of articles is quite dispersed, with the journals *Advanced Engineering Informatics*, *Journal of Cleaner Production*, *Processes* and *Transportation Research Part E: Logistics and Transportation Review* each accounting for two published articles. The other journals offer only one publication each, demonstrating that there is no concentration in a specific journal.

Table 2 shows the list of articles selected and included in the literature review, along with their publication details.

Table 2. List of articles included in the literature review.

No.	Author	Title	Database	Periodical
1	[21]	Industry 4.0 and the current status as well as future prospects on logistics	Science Direct	Computers in Industry
2	[40]	Development of an Ecosystem Model for the realization of Internet of Things (IoT) services in supply chain management	Springer	Electronic Markets
3	[11]	Logistics 4.0 and emerging sustainable business models	Scopus	Advances in Manufacturing

Table 2. *Cont.*

No.	Author	Title	Database	Periodical
4	[41]	IoT patent roadmap for smart logistic service provision in the context of Industry 4.0	Scopus	Journal of the Chinese Institute of Engineers
5	[42]	Logistics as a science—central research questions in the era of the fourth industrial revolution: Invited paper based on the position paper of the scientific advisory board of bundesvereinigung logistik (BVL) [1]	Scopus	Logistics Research
6	[43]	Knowledge resources, technology resources and competitive advantage of logistics service providers	Web of Science	Knowledge Management Research and Practice
7	[44]	Analysis of the difficulties of SMEs in Industry 4.0 applications by analytical hierarchy process and analytical network process	Scopus	Processes
8	[8]	A Systematic Review of 3PLS' entry into reverse logistics	Web of Science	South African Journal of Industrial Engineering
9	[45]	Analysis of the risk impact of implementing digital innovations for logistics management	Scopus	Processes
10	[37]	Dynamic capabilities of logistics service providers: antecedents and performance implications	Emerald	Asia Pacific Journal of Marketing and Logistics
11	[46]	Towards an autonomous Industry 4.0 warehouse: A UAV and blockchain-based system for inventory and traceability applications in big data-driven supply chain management	Web of Science	Sensors
12	[12]	An 'Internet of Things' enabled dynamic optimization method for smart vehicles and logistics tasks	Scopus	Journal of Cleaner Production
13	[47]	Technology adoption by logistics service providers	Scopus	International Journal of Physical Distribution and Logistics Management
14	[27]	Scenario and strategy planning for transformative supply chains within a sustainable economy	Scopus	Journal of Cleaner Production
15	[48]	Impacts of Internet of Things on supply chains: A framework for warehousing	Google Scholar	Social Sciences
16	[13]	Smart product-service systems in interoperable logistics: Design and implementation prospects	Scopus	Advanced Engineering Informatics
17	[49]	Digitalization and leap frogging strategy among the supply chain member: Facing GIG economy and why should logistics players care?	Scopus	International Journal of Supply Chain Management
18	[50]	Studying the sustainability of third-party logistics growth using system dynamics	Web of Science	Journal of Modelling in Management
19	[2]	The strategic role of logistics in the Industry 4.0 era	Science Direct	Transportation Research Part E: Logistics and Transportation Review
20	[51]	Pursuing supply chain sustainable development goals through the adoption of green practices and enabling technologies: A cross-country analysis of LSPs	Science Direct	Technological Forecasting and Social Change
21	[52]	Digital transformation at logistics service providers: barriers, success factors and leading practices	Scopus	International Journal of Logistics Management

Table 2. *Cont.*

No.	Author	Title	Database	Periodical
22	[53]	Smart logistics based on the Internet of Things technology: an overview	Scopus	International Journal of Logistics Research and Applications
23	[54]	An integrated online pick-to-sort order batching approach for managing frequent arrivals of B2B e-commerce orders under both fixed and variable time-window batching	Science Direct	Advanced Engineering Informatics
24	[55]	On LSP lifecycle model to re-design logistics service: Case studies of Thai LSPs	Web of Science	Sustainability
25	[3]	Logistics 4.0: a systematic review towards a new logistics system	Google Scholar	International Journal of Production Research
26	[56]	An IoT-enabled real-time logistics system for a third-party company: a case study	Google Scholar	Procedia Manufacturing
27	[57]	Analyzing enablers of knowledge management in improving logistics capabilities of Indian organizations: a TISM approach	Emerald	Journal of Knowledge Management
28	[7]	Logistics centers in the new industrial era: A proposed framework for logistics center 4.0	Scopus	Transportation Research Part E: Logistics and Transportation Review

3. Results and Discussions

An analysis was performed on each article listed in Table 2, whereby the categories, sub-categories, and components were extracted following the concept-centered approach of Webster and Watson [38]. Table 3 presents the categories, or so-called dimensions extracted and consolidated from the articles.

Table 3. Concept categories extracted from the literature.

Author(s)	Staff	Technology	Infra Structure	Relationship	Services	Organizational	Challenges	Barriers	Threats	Performance Requirements
[21]		X					X	X		X
[40]		X		X		X		X		X
[11]		X			X	X	X			X
[41]		X					X			X
[42]	X	X		X	X	X			X	X
[43]	X	X				X				X
[44]	X	X					X	X		X
[8]		X				X	X			X
[45]		X		X		X		X		
[37]	X	X			X	X	X		X	X
[46]		X			X		X			X
[12]		X			X	X	X		X	X
[47]	X	X		X	X	X	X	X	X	X
[27]		X				X				X
[48]		X	X	X	X		X			X
[13]		X		X	X	X	X	X	X	X
[49]		X				X	X			X
[50]	X	X		X	X	X	X		X	
[2]		X					X		X	X
[51]		X				X				X
[52]	X	X	X	X	X	X	X	X	X	X
[53]		X	X		X		X		X	X

Table 3. *Cont.*

Author(s)	Staff	Technology	Infra Structure	Relationship	Services	Organizational	Challenges	Barriers	Threats	Performance Requirements
[54]		X	X	X	X	X	X	X	X	X
[55]		X			X		X			X
[3]	X	X				X	X	X		X
[56]		X				X	X			X
[57]	X	X		X		X	X	X		X
[7]		X	X	X		X	X			X
No. of items considered	**9**	**28**	**5**	**11**	**13**	**20**	**22**	**10**	**10**	**26**

A clear and distinct classification trend is evident, based on category and sub-category. Ten categories were identified in the analysis, and the following three were the most cited: Technology (28), Performance Requirements (26), and Challenges (22). This reveals there is still a gap and lack of consensus in explaining the structure of a Logistics Service Provider 4.0.

From the main categories (technology, performance requirements, and challenges) identified in the analysis, sub-categories were derived.

Table 4 presents the set of sub-categories under the technology category—the sub-categories IoT (22), cloud computing (14), big data (14), RFID (13), blockchain (13), and autonomous entities (9) were the most frequently discussed.

Table 4. Sub-categories for technology.

Author(s)	IoT	IoS	RFID	WSN	CPS	Cloud Computing	BigData	Blockchain	3D Printing	Drones	Augmented Reality	Autonomous Entities	Social Media
[21]	X	X	X		X	X	X	X	X	X		X	
[40]	X		X										
[11]	X		X		X	X	X		X	X	X	X	
[41]	X		X	X	X	X	X						
[42]	X											X	
[43]			X										
[44]	X				X								
[8]	X					X							
[45]	X					X	X	X	X	X	X		
[37]	X						X			X		X	
[46]	X		X		X	X	X	X	X	X	X		
[12]	X		X										
[47]													
[27]							X	X	X	X		X	
[48]	X	X			X	X			X				
[13]	X							X				X	
[49]	X					X	X	X					X
[50]	X							X					
[2]	X							X		X		X	
[51]						X							X
[52]							X	X					
[53]	X		X	X		X	X	X					
[54]						X							
[55]	X	X	X		X		X						
[3]	X		X	X	X	X	X	X	X		X	X	X
[56]	X		X			X	X						
[57]	X		X				X	X					
[7]	X		X			X		X		X	X	X	
No. of items considered	**22**	**3**	**13**	**3**	**8**	**14**	**14**	**13**	**7**	**8**	**5**	**9**	**3**

Table 5 displays the sub-categories under performance requirements, with the most popular sub-categories being efficiency (19), responsiveness (15), agility (15), collaboration (15), and flexibility (12).

Table 5. Sub-categories for performance requirements.

Author(s)	Efficiency	Visibility	Reliability	Responsiveness	Assertiveness	Agility	Flexibility	Collaboration
[21]	X	X	X	X			X	
[40]								X
[11]	X	X		X				X
[41]	X	X		X	X	X		
[42]	X		X		X	X	X	X
[43]	X			X	X		X	
[44]	X							
[8]	X	X						
[45]								
[37]	X			X			X	X
[46]	X		X			X		
[12]	X	X		X	X	X		X
[47]								X
[27]							X	X
[48]	X	X	X	X		X	X	
[13]	X					X	X	X
[49]				X	X	X		
[50]								
[2]			X			X		
[51]								X
[52]	X	X		X		X	X	X
[53]	X	X	X	X	X	X	X	X
[54]	X		X	X	X	X	X	X
[55]				X		X	X	X
[3]	X	X		X	X			
[56]	X	X			X	X		
[57]	X			X		X		X
[7]	X		X	X		X	X	X
No. of items considered	**19**	**10**	**8**	**15**	**9**	**15**	**12**	**15**

Table 6 lists the sub-categories under the organizational category, in which the sub-categories of differentiation (16), sustainability (8), and digitalization (7) were the most frequent.

Table 6. Sub-categories for organizational.

Author(s)	Sustainability	Digitalization	Differentiation	Leadership	Agile Management
[21]					
[40]			X		
[11]	X				
[41]					
[42]				X	
[43]		X	X		
[44]			X		
[8]	X		X		X

Table 6. *Cont.*

Author(s)	Sustainability	Digitalization	Differentiation	Leadership	Agile Management
[45]		X			X
[37]			X		
[46]					
[12]	X		X		
[47]			X		
[27]	X	X	X		
[48]			X		
[13]			X		
[49]		X	X		
[50]			X		
[2]					
[51]	X				
[52]		X	X	X	X
[53]		X	X		
[54]			X		
[55]			X		
[3]	X				X
[56]	X				
[57]				X	
[7]	X	X			X
No. of items considered	**8**	**7**	**16**	**3**	**5**

Table 7 discusses the sub-categories under the challenges category, in which the predominant sub-categories were cost reduction (12), rapid changes in demand (9), information security (8), resource management, and lack of skilled professionals (7).

Table 7. Sub-categories for challenges.

Author(s)	Quick Changes in Demand	Process Complexity	Cost Reduction	Resource Management	Shortage of Skilled Labor	Technology Adoption	System Interoperability	Information Security
[21]		X			X			X
[40]								
[11]	X							
[41]		X					X	
[42]								
[43]					X			
[44]			X					
[8]			X					
[45]								
[37]	X			X				
[46]	X		X	X				X
[12]	X		X	X				
[47]					X	X	X	
[27]	X							
[48]			X				X	X

Table 7. *Cont.*

Author(s)	Quick Changes in Demand	Process Complexity	Cost Reduction	Resource Management	Shortage of Skilled Labor	Technology Adoption	System Interoperability	Information Security
[13]			X	X	X		X	
[49]			X		X			
[50]			X		X			
[2]			X					X
[51]								
[52]	X	X			X	X		X
[53]			X	X			X	X
[54]	X		X	X				
[55]								
[3]	X	X	X			X		X
[56]	X					X		
[57]				X				
[7]								X
No. of items considered	**9**	**4**	**12**	**7**	**7**	**4**	**5**	**8**

The number of categories per author is shown in Figure 5. Authors such as Cichosz et al. [52], Leung et al. [54], Mathauer and Hofmann [47], and Pan et al. [13] employed more than seven of the categorized dimensions in their research; however, only Cichosz et al. [52] covered all ten categories listed in the concept matrix.

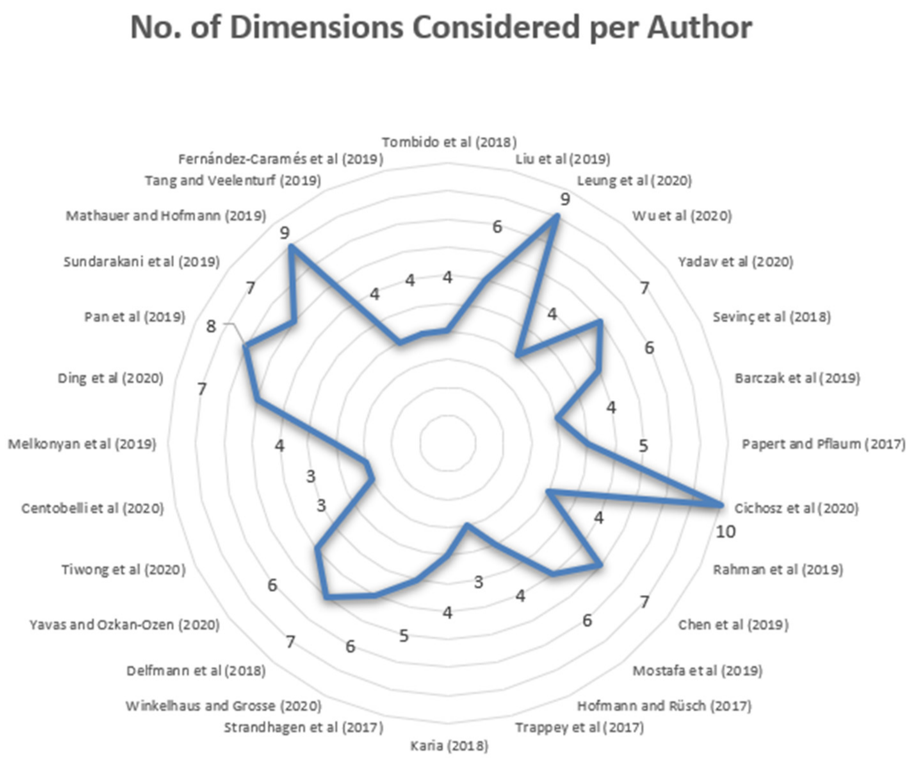

Figure 5. Number of categories per publication/author. [2,3,7,8,11–13,21,27,37,40–57].

3.1. Conceptual Map for Logistics Service Provider 4.0

In this subsection, a conceptual structure is proposed and constructed in an inductive way through the analyses performed in the articles. The categories, sub-categories, and their interactions are arranged in Figure 6.

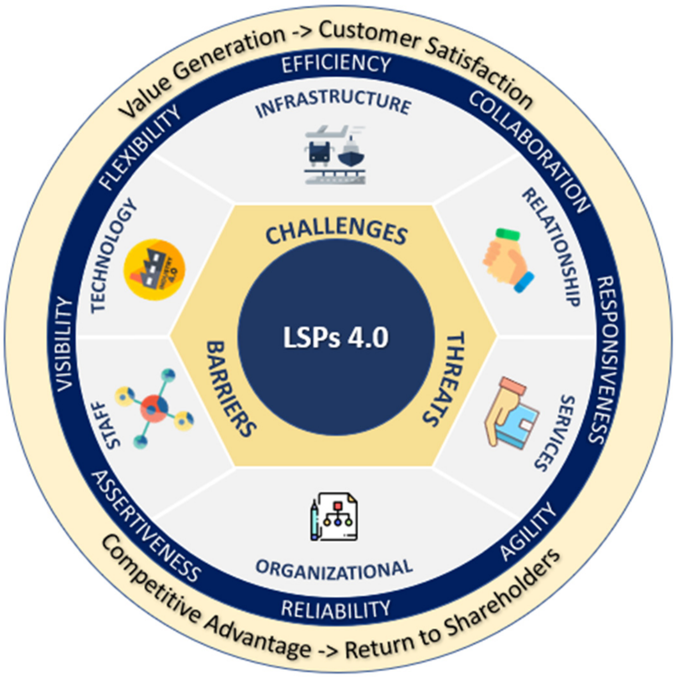

Figure 6. Conceptual map for the logistics service provider 4.0.

Although, as mentioned, there is no consensus among authors on a clear categorization of the dimensions, it is evident that there is some consensus in relation to the categories of technology and performance requirements, as presented in Table 3. The majority of the authors consider these categories, demonstrating that they are key categories in the proposed structure.

Due to the complexity of this structure, it is necessary to discuss more clearly the importance of each category, its sub-categories, and interactions to understand and clarify the relationships between them.

3.1.1. Challenges

This category includes elements from the external and internal environments of organizations, referring to complex situations that need to be overcome. They encourage and drive companies to continue developing both in terms of technology and innovation, while remaining competitive in an increasingly globalized market.

In the new industrial era, some challenges deserve special attention for LSPs to remain competitive:

- Rapid changes in demand: New customer requirements, a greater variety of products and services, high demand combined with an increasingly individualized demand, or uncertain or imprecise demand.
- Complexity of processes: The coordination of several logistics networks, composed of processes between senders, intermediaries, and recipients of different sizes, segments, and geographic location frequently requires customization of services, making it difficult to standardize processes and technological infrastructure.
- Cost reduction: While cost reduction remains the main reason why shippers hire LSPs, the extremely competitive and commoditized environment creates pressure to reduce costs; consequently, LSPs face frequent contract reviews and increasingly tight profit margins.
- Resource management: Failures and mismanagement of resources also cause an increase in logistics costs, due to the waste and idleness generated. Therefore, optimal allocation is the key to maximize the use of logistics resources, be competitive, and

reduce costs. However, the lack of reliable information and the dependence on human experience to determine a complex allocation of resources are major impediments.

- Lack of skilled professionals: The lack of workforce skills; shortage of professionals with digital skills, technology skills, and operations knowledge, coupled with low levels of education are all challenges confronting LSPs.
- Technology adoption: Factors such as information technology (IT) experience, top management support, competitive pressure, competitive conditions, requirement and alignment with customers and business partners, security issues, and perceived benefits, are as important to technology adoption as choosing the right technology at the right time—it is the organizational strategy that will drive digital transformation and ensure a successful integration for LSPs.
- Interoperability between systems: The constantly evolving and wide range of digital devices and technologies necessitates greater integration between systems, which must necessarily have the capacity to communicate, integrate with each other in an effective manner, and operate seamlessly regardless of the technology platform and supplier. Interoperability between systems is one of the biggest challenges of Industry 4.0.
- Information security: The large number of connected devices and the high volume of confidential data traffic over the network, often deposited in cloud solutions, mean that data protection and information security are critical issues. Moreover, there is a growing need among customers to obtain information in real-time, anytime and anywhere, placing greater pressure on access security to nullify attempted breaches or unauthorized access and cyber-attacks.

3.1.2. Barriers

Different from challenges, which are motivators, the category of barriers refers to obstacles that hinder or make it difficult for LSPs to experience the benefits of the 4.0 environment. Some of these barriers are listed below:

- High cost of technologies: Initial investment in advanced IT in the logistics sector is often high. It not only includes the cost of acquiring the technology (purchase or development) but also costs related to its implementation, including transition costs, where these new technologies are integrated into the company, maintenance costs, and costs related to technical support and training.
- Distrust of benefits: In addition to the high cost of investment, the indifference in relation to the return also prevents companies from investing in new technologies. Many firms question whether these technologies can really bring competitive advantage and assist in winning new contracts. Organizations are not always convinced of the return on investment, which remains difficult to estimate or doubtful, generating distrust of its benefits.
- Lack of technological know-how: The lack of technological know-how and a digital culture is an obstacle. Logistics providers are generally not seen as innovative companies but strive to acquire technological know-how through collaboration with partners and clients. However, obtaining such knowledge through interaction may not lead to innovation, thus hurting the company's attempts to establish leadership in innovation or differentiation from the competition. Moreover, without genuine digital transformation, the potential of a technology may not be fully exploited, and any competitive advantage derived might not be sustained.

3.1.3. Threats

This category considers threats from the external environment, and is limited to competition, new entrants, and substitutes.

Logistics companies are facing great pressure from customers, employees, partners, and competitors to undergo digital transformation. Meanwhile, entirely new companies are emerging that research, analyze, and question current processes and value creation, adding to the opportunities offered by digitalization and interconnectivity. These new innovative competitors, such as startups, are gaining market share from consolidated logistics operators and challenging current business practices. They benefit from digitalization, which is leading to ever shorter technology innovation cycles, and are opening up new opportunities through business models based on new technologies and digital platforms. This demonstrates that centralized and unilateral logistics services can be replaced by a dynamic and more collaborative optimization strategy. However, driven by the recent evolution of e-commerce and Industry 4.0, companies are starting to invest in new logistics technologies to offer their own delivery services, which are faster and sometimes free of charge, instead of relying on LSPs.

3.1.4. People Resources

The people dimension is key in this structure, since advanced technologies require high levels of knowledge and competencies at different levels for companies to benefit from better performance. This is because resources related to knowledge allow the technology resources to generate competitiveness; without them, the technology resources alone would not be able to generate sustained results. However, knowledge is a rare and difficult-to-imitate capability; therefore, it becomes an important competitive advantage, since it is people who create, use, and share knowledge in an organization.

Thus, organizations need people specialized in new digital technologies, with technology-oriented skills and talents, so they can create and define digital transformation strategies and participate in decisions to acquire or reject technologies. This is an important factor for the successful implementation of change.

3.1.5. Technology Resources

Technology resources are vital to achieve a higher level of LSPs performance, as they can raise logistics competitiveness, increase innovation capacity, reduce costs, and improve service levels. Such resources are acquired through investment in advanced equipment and devices, as well as information and communication technologies (ICTs); moreover, unlike knowledge, they are easy to imitate and transfer, that is, competitors can easily absorb them, although it is necessary to have these resources in place to achieve a higher level of performance.

The new era of industrialization has ushered several new technologies such as IoT, CPS, cloud computing, big data, radio-frequency identification (RFID), blockchain, and autonomous technologies, which when combined can drive better performance results for logistics companies.

3.1.6. Infrastructure Resources

This dimension is significant in logistics and plays an important role in local and global operations. It is related to the structure of the organization in tangible terms, such as assets, real estate, sheds, vehicles, handling equipment, and storage structures. Usually, companies either employ their own resources, acquired through investments, or lease resources from third parties.

In fact, logistics operations are composed of various basic assets, including structures and equipment that allow the storage, movement, and transportation of products. These structures and equipment are a great opportunity to incorporate technological components that enable connectivity and support operations in a network environment, thereby making the operation more efficient and intelligent.

3.1.7. Relationship Resources

Relationships are indispensable in establishing long-term alliances and contracts, and long-term relationships can help foster the cooperative networks or commercial alliances necessary to create innovative logistics solutions that often require considerable investment.

A long-term relationship can arouse the client's interest in transferring responsibility for other stages of the supply chain to the logistics partner, thereby increasing its participation in the business and creating a collaborative and trusting environment between the parties, in which information sharing, transparency, and delivery of agreed service levels are fundamental.

In the 4.0 environment, the relationship is not restricted only to shipper clients. It is important to consider all the actors and stakeholders that participate directly or indirectly in the supply chain, such as other suppliers, competitors, technology developers, innovation ecosystems, government organizations, and society in general.

A relationship between competitors—such as sharing goods and services—although debatable, can also bring an advantage over others through better management of the capabilities and resources of both. This collaborative business model between competitors is even more interesting in a decentralized, collaborative, and dynamic environment.

3.1.8. Service Resources

Service resources are the core business of LSPs. They are composed of the companies' know-how, expertise, and help to generate value for the client and the consumer. Innovation plays an important role in this competence, as it elevates the level of service delivered to the client through significant improvements in performance.

Historically, LSPs have been driven by operational demands and have passively evolved in response to clients' specific needs, continuously adjusting their service portfolio and improving their established operations.

New business models can now be developed with the addition of digital technologies, improving and making available innovative services that will benefit LSPs and their customers. This has caused LSPs to seek a more active and proactive stance in developing services, using advanced technologies to meet new customer demands and requirements.

Recent advances in Industry 4.0 technologies have enabled their application in several relevant logistics areas such as planning, inventory management, storage management, transportation management, and information and material flow management.

3.1.9. Organizational Resources

Managing organizational resources is important for organizations in the new era of digitalization, which comprises agile systems, processes, strategies, culture, and values. These elements are directly related to organizational guidelines, routines and contribute to overall performance.

Organizations must reorganize the management structure so that they can quickly absorb digital technologies, develop capabilities and skills to use digital innovation, and face any changes based on a cooperative and customer-relationship approach. This reorganization suggests a radical change in companies to employ modern technologies, with a direct impact on current strategies, cultures, and business models.

Advanced technologies can improve the competitive position of LSPs by innovating services, improving existing logistics solutions, and adding value to the services provided. Therefore, strategies, policies, and processes need to be rethought so that business goals and strategies are aligned and supported by IT strategies.

3.1.10. Performance Requirements

The previously described dimensions, individually or through interaction between them, must meet performance requirements at a level that will ensure customer satisfaction through value generation and satisfy organizations' shareholders through competitive advantage and sustainable financial results.

The performance requirements are listed below:

- Efficiency: Processes that deliver high performance rates, reduced costs, failure-free or minimal error rates, and no waste.
- Visibility: Availability and processing of real-time information of events and recorded conditions of processes and equipment.

- Reliability: Reliable and safe processes and services that function properly at an acceptable level of service quality.
- Responsiveness: Appropriate response to changes in the environment and demand, without prejudice to the level of service.
- Assertiveness: Proactivity in the constant reassessment and monitoring of processes and services, with assertive decision-making and solutions.
- Agility: Prompt reaction and the ability to quickly and effectively adapt to constantly changing environments.
- Flexibility: Assume, absorb, and adapt when internal or external changes occur, observing cost, quality, and time constraints.
- Collaboration: Relationship of coordination, cooperation, and communication between internal and external entities in order to achieve common goals.

3.2. Theoretical Foundation of the Conceptual Framework

The proposed model presents robust constructs extracted through an SLR, after consolidating the categories and sub-categories in the reviewed articles.

3.2.1. Challenges

The conceptual framework initially proposes challenges that LSPs might face due to the transformation brought about by the 4.0 environment. According to Leung et al. [54] and Liu et al. [12], these challenges will result in rapid change and increased demand, stimulated mainly by the growth of e-commerce. Chen et al. [37] suggest that to meet customers' needs, LSPs must rapidly recognize these changes and reconfigure, integrate, and invest in resources to enhance and develop new services.

This often dispersed and uncontrolled increase in demand results in many problems in the logistics sector. Liu et al. [12] state that the increase in logistics costs is the main problem for LSPs, especially given the cost reduction pressures in the sector, as revealed by Leung et al. [54]. Many executives still view logistics as a cost to be managed [2]. Melkonyan et al. [27] state that, with the aid of digital technologies, the dynamic behavior of supply chains may be anticipated and analyzed, thereby reducing costs arising from a sudden oscillation in demand. Tang and Veelenturf [2] suggest that the high cost of acquiring digital technology can be overcome by reducing logistics costs.

Cichosz et al. [52] and Hofmann and Rüsch [21] indicate that this challenge is even greater for providers due to the complexity of logistics processes, as they usually deal with a logistics network and coordinate processes between intermediaries, shippers, and customers of different sizes and geographic locations, which makes it difficult for them to standardize processes and infrastructure. Nonetheless, they are often forced to customize to meet a particular customer need. Trappey et al. [41] and Winkelhaus and Grosse [3] reinforce that the lack of technological standardization is an even more important challenge as it has become essential in Industry 4.0.

Additionally, Liu et al. [12] explain that another impact factor that results in increased logistics costs is related to the issue of resource management, where the challenge is optimal allocation. However, allocation is hampered by the lack of real-time and reliable information. Therefore, implementing management with visibility and seeking optimal allocation is the key to maximizing the use of logistics resources.

Leung et al. [54] state that the traditional process of handling products in some distribution centers, which still rely on human experience to determine the allocation of resources, can create inefficiency.

Cichosz et al. [52] highlight that the lack of technological knowledge and qualified resources is also a challenge, combined with the shortage of employees with digital skills and the low educational levels of the workforce identified by Cichosz et al. [52]. Qualified employees are essential for the successful integration of new technologies.

Technology adoption itself becomes a challenge for LSPs in terms of making the right choice at the right time. According Cichosz et al. [52], it is not technology but strategy that drives digital transformation. Winkelhaus and Grosse [3] describe some important influences for technology adoption: IT experience, top management support, competitive pressure, security issues, as well as perceived benefits. Mathauer and Hofmann [47] find that the modes of access to technology can hinder success in integrating new technologies, because in LSPs there is a relationship between mode of access (make, buy, or alliance) and the successful integration process.

Another important challenge of Industry 4.0 for global supply chain and logistics operations, according to Frederico et al. [10], is interoperability between systems. Yavas and Ozkan-Ozen [7] state that a range of digital devices and technologies already exist and will continue to emerge; these must—in line with Noura et al. [58]—necessarily have the ability to communicate, integrate with each other effectively, and operate seamlessly regardless of the type of technology.

Finally, according to Mostafa et al. [48] and Cichosz et al. [52], a challenge that has been gaining increasing importance is data protection and information security, owing to the large number of connected devices and the high volume of confidential data traffic over the network, often deposited in cloud solutions.

Hofmann and Rüsch [21] point out that data security is a critical issue, especially when there is an increasing demand from customers for real-time information that is accessible anytime and anywhere. Cichosz et al. [52] reveal that this puts greater pressure on access security. According to Fernández-Caramés et al. [46] and Tang and Veelenturf [2], organizations must seek to nullify attempted breaches or unauthorized access and cyber-attacks. Ding et al. [53] reiterate that access control and the guarantee of user privacy must be ensured, while Yavas and Ozkan-Ozen [7] argue that security in data management is a success factor in the implementation of new technologies.

3.2.2. Barriers

In addition to the challenges, there exist some barriers in adapting to the 4.0 environment. Winkelhaus and Grosse [3] highlight the high initial investment cost, especially of advanced information technologies applied to the logistics sector [12]. According to Papert and Pflaum [40], besides the complexity and high cost of implementation, there are other significant costs relating to transition when new technologies are integrated into the company, including maintenance, technical support, and training, as highlighted by Sevinç et al. [44].

Sevinç et al. [44] also reveal that managerial indifference regarding the return is another factor that prevents companies from investing, because top management is not convinced of the return on investment, coupled with the fact that the return on investment is difficult to estimate or even doubtful. According to Winkelhaus and Grosse [3], this is one of the important barriers in implementing these technologies. Thus, the adoption of a new technology is impacted by the relationship between costs and benefits, according Mathauer and Hofmann [47].

However, the lack of technology challenges the efficiency of logistics services [12], because technological innovations facilitate better use of resources, information exchange, and integration between supply chain partners; moreover, they make LSPs more dynamic and adaptable to change, according to Cichosz et al. [52].

According to Wagner [59], logistics providers usually acquire technological know-how through collaboration between partners and clients. However, these types of interactions may not lead to innovation, jeopardizing the company's efforts to establish leadership in innovation and create differentiation from competition. The author further states that, without professional acquisition of know-how, the potential of these technologies may not be fully exploited.

3.2.3. Threats

Although the challenges and barriers discussed thus far encourage LSPs to seek active participation and adapt to this new environment, another factor that requires attention is in relation to external threats, primarily with traditional competition and new entrants. Cichosz et al. [52] provide the example of express delivery companies that compete for employees with Uber and other last mile delivery companies.

Leung et al. [54] explain that increasingly innovative and cutting-edge initiatives are solving society's problems, facilitating exchanges between the customer and supplier, and completely changing not only the value proposition but also organizations' business models.

In this regard, Chen et al. [37] report that the recent evolution of e-commerce and Industry 4.0 have led companies such as Amazon, Alibaba, and SF Express to invest in new logistics technologies with the aim of significantly reducing delivery times. Mathauer and Hofmann [47] reinforce that digitalization is leading to ever shorter technology innovation cycles and opening up opportunities for new competitors. Ding et al. [53] note that new competitors are gaining market share in consolidated logistics operators' markets through business models based on new technologies, exemplified by the case of Uber Freight, whose platform connects transportation providers with the most appropriate goods available, creating an on-demand logistics network through its app.

Indeed, new technology solutions bring innovations in both services as well as new business models. Pan et al. [13] cite the example of Fulfilment by Amazon, under which Amazon stores third-party products in its distribution centers and sorts, packs, ships, and provides customer service for these products. Similarly, cubyn.com provides on-demand logistics services; uship.com and anyvan.com are online freight platforms.

Additionally, Tang and Veelenturf [2] attest to the growing importance of logistics from the customer's perspective, causing e-tailing companies such as Amazon and Alibaba to invest heavily in logistics technologies to offer faster and sometimes free delivery services, rather than relying on LSPs.

3.2.4. People Resources

To face the challenges, overcome the barriers, and combat the threats presented, companies that provide logistics services must rethink their capabilities in the people, technology, infrastructure, relationships, services, and organizational dimensions.

One of the main capabilities of organizations and an important pillar of this conceptual framework is the people dimension. It is related to the knowledge developed by employees over time. According to Karia [43], it comprises intangible elements that accumulate within a company through information, knowledge, skills, attitudes, training, and education.

Nonetheless, this capability is difficult to imitate. Hence, it becomes an important competitive advantage. According to Yadav et al. [57], knowledge is the main sustainable competitive advantage for LSPs; the authors highlight that it is people who create, use, and share knowledge. The authors further state that in this case, the advanced application of information and communication systems is appropriate for knowledge management, being an enabler to improve decision making and management efficiency.

Cichosz et al. [52] state that people are crucial for digital transformation in the logistics services sector, but there is a resistance to change among employees in the adoption of technology. Nonetheless, for LSPs, this is far from being the most significant barrier and can be overcome by stimulating people through a collaborative environment of support, trust, and empowerment. Consequently, the engagement of employees will become a success factor. The authors also warn that commitment toward this process must start with top management.

According to Cichosz et al. [52], digital skills development is one of the prerequisites for employees' engagement in a digital business environment. Therefore, companies should invest in training and capacity building, thus remedying the shortage of qualified professionals. Rahman et al. [49] state that employees must have knowledge, cyber skills, and technology-oriented talent, which can be acquired by training and certifications; another way to acquire knowledge, as mentioned by Chen et al. [37], is knowledge sharing, supported by a culture open to learning and experimentation, in which employees are encouraged to do things differently.

3.2.5. Technology Resources

The adoption of technology by firms in pursuit of greater automation can certainly reduce the reliance on people, according to Sevinç et al. [44]; however, it is important to understand what is expected. According to Hofmann and Rüsch [21], employees should have more responsibility and act as decision makers, assuming coordination functions instead of performing purely operational services. In this way, human interaction will be limited to control and monitoring mainly at the operative level.

Karia [43] empirically demonstrated that technologies are positively related to knowledge resources, the latter being the most important source for technology investment. Conversely, knowledge depends on technology to generate competitive cost advantages. Thus, LSPs should acquire advanced technology when they have high levels of knowledge to benefit from cost advantages. Rahman et al. [49] emphasize that knowledge and technology resources are important forces for LSPs to remain competitive in the market.

Moreover, Karia [43] highlights that technology resources are vital to achieve a higher level of performance in LSPs, because they can raise logistics competitiveness, increase innovation capacity, reduce costs, and improve service levels.

Cichosz et al. [52] state that technological innovations support logistics resources, enabling measurements, adequate use of resources, information exchange, integration with other actors in the supply chain, and better customer service. Thus, technologies help the LSPs become more dynamic and adaptable to changes in the environment. Therefore, advanced technologies are key to increasing productivity, according to Rahman et al. [49]. However, Cichosz et al. [52] state it is important to select solutions that are relevant and aligned with the purpose and objectives of the organization.

For Karia [43], technology resources are acquired through investment in advanced equipment and devices, as well as ICT aimed at cost reduction, agility in response time, and differentiation in services provided. However, unlike knowledge, the technological infrastructure is easy to imitate and transfer; therefore, competitors can easily absorb them.

Indeed, the employment of technologies can help organizations deal with many of the challenges described thus far; for example, changes in environment and demand require rapid decision making, which can be achieved—according to Trappey et al. [41] —by cloud computing platforms, which store and retrieve a huge amount of data [53] captured by IoT devices such as sensors, actuators, RFID, 4G communication devices, location (GPS) [3,7,11,53]. These devices, installed on physical objects such as goods, trucks, and containers, allow these objects to be identified, located, and monitored at different stages of the logistics process [7,41]; they also provide information regarding brightness, humidity, temperature, and pressure, which are crucial for certain types of products [40]. According to Ding et al. [53], the data captured by these devices and stored in the cloud can be modeled and analyzed, using big data technology to predict future situations and prevent disruptions.

In summary, the main technologies of Industry 4.0 according to Hofmann and Rüsch [21]; Strandhagen et al. [60]; Trappey et al. [41]; Liu et al. [12]; Mostafa et al. [48] and Wu et al. [56] are IoT, CPS, cloud computing, big data, augmented reality, additive manufacturing (3D printing), unmanned vehicles, and blockchain. These technologies can provide information in real-time about any object, whether a product or information [40,56].

3.2.6. Infrastructure Resources

The introduction of these technologies also suggests a change in the way LSPs logistics facilities are thought of and configured [54]. As previously mentioned, vehicles, forklifts, and conveyors can be equipped with devices that make them smart [52]. The warehouse, as stated by Mostafa et al. [48], is a basic component of the supply chain for the storage of products; according to Yavas and Ozkan-Ozen [7], from the technological perspective, distribution centers can integrate technologies into their activities, increasing efficiency in cost and process, and reducing errors and delays.

However, Leung et al. [54] state that high investments in technology can be very risky. Moreover, Trappey et al. [41] and Frederico et al. [10] argue that interoperability and standardization are important, because in addition to ensuring connectivity, they can be replicated or customized for other processes and customers with some ease.

3.2.7. Relationship Resources

One solution that seems appropriate in addressing this barrier is the establishment of long-term relationships, supported by information sharing and transparency. The relationship suggested by Papert and Pflaum [40] involves the development of cooperative networks and business alliances to drive innovative products and services, especially in dynamic business environments. This environment includes, for example, suppliers, customers, stakeholders, unions, trade associations, government organizations, and competitors.

Establishing relationships with competitors by sharing resources, to gain advantages over other competitors by better managing capabilities and resources, is a good example of the benefits of collaboration.

While Chen et al. [37] suggests that the LSPs should proactively interact and negotiate with supply chain members to determine its value-add in the industry, Yadav et al. [57] suggest that managing information along the supply chain requires a certain set of protocols, agreements, and ultimately, collaboration. According to the authors, collaboration occurs at two levels within the organization: between individuals and between the organization and its network of partners.

According to Mostafa et al. [48], the main thing is to focus on making partners and customers more cooperative and strengthen integration by performing tasks together so that the relationship is based on trust. Sundarakani et al. [50] add that this perspective arouses customer interest in outsourcing a wider range of logistics services, paving the way for a long-lasting relationships.

Delfmann et al. [42] explain that innovative logistics services are often developed in collaboration with pilot customers as value added services, while Mathauer and Hofmann [47] mention that these collaborative developments also depend on the customer's strategic relevance and trust. This is because, sometimes, LSPs make considerable investments in assets usually based on the demands and requirements of a specific customer. Therefore, contract durations often differ depending on the amortization of specific investments.

Ding et al. [53] state that, in a collaborative relationship, the data and information are shared and visualized. This promotes interaction between suppliers and customers, making the process transparent and traceable, improving satisfaction in a mutual way, and promoting decentralized decision making and quick responses to any incidents that may occur.

3.2.8. Service Resources

According to Strandhagen et al. [60], recent advances in technology provide many opportunities related to logistics services. Liu et al. [12] mention the enhancement in routing optimization, seamless loading services, and opportunity to create more sustainable logistics service. Chen et al. [37] likewise argue that new technologies can also help continuously adjust the mix and improve the overall service level. Tiwong et al. [55] state that improving the logistics service is paramount in meeting customer needs. Thus, the greater the innovation in this regard, the higher the level of service delivered to the customer.

Service is the core business of logistics providers, composed of the know-how and expertise of these companies, which generate value for the client and for the final consumer. Mostafa et al. [48] and Yavas and Ozkan-Ozen [7] also state that advanced technologies can actually improve logistics services in the following contexts: in the planning stages, through improved demand forecasts; in process management, by providing greater visibility of each step and more accurate predictive actions and decision making; in inventory management, through more accurate inventory, and leaner, automated, and real-time monitoring; in storage management, through communication between products and shelves, and autonomous handling systems that enable decentralized management; in transport management, through improved collaboration between shipper, carrier, and customer, expediting the service, reducing risks and accidents, and providing real-time information.

Conversely, Cichosz et al. [52] argue that new business models can be developed by LSPs, serving, for example, as architects of further flow developments within Industry 4.0; presenting new services based on customer information regarding demand, available capacity, and end-to-end supply chain visibility; or even developing platform business models for customers and suppliers as a shared economy with common access to data by business partners.

Delfmann et al. [42] draw attention to the classic processes of product and service development, which, according to the authors, are misaligned with respect to the characteristics of 4.0 solutions, necessitating a redesign of these processes; without which, they will have no prospect of success in their market introduction.

3.2.9. Organizational Resources

According to Cichosz et al. [52], digitization is not about a single technology, but about major changes in the organization based on a combination of information, computing, communication, and connectivity technologies—in other words, a fusion of advanced technologies that connect physical and digital systems. Strandhagen et al. [60] claim that digitization enables organizations to be more collaborative and efficient.

According to Barczak et al. [45], it is necessary to reorganize management so that the company can easily and quickly absorb emerging digital technologies arising from digitalization. Therefore, a corporate innovation strategy focusing on the capacity and ability to use digital innovations is desirable.

Nonetheless, Papert and Pflaum [40] view digital transformation as a radical change within an organization and a source of differentiation. It is supported by the use of modern technologies to achieve greater business efficiencies. However, changes in process management are likely to result from the introduction of technologies, as well as changes in the approach to cooperation with customers and suppliers. Therefore, LSPs must evolve their strategies, cultures, and business models [52].

According to Yadav et al. [57], organizational culture is even more important in the new era of digitalization. Analogously, Cichosz et al. [52] state that developing a digitalization-friendly organizational culture is another key success factor, as organizational culture defines how a company operates and how it introduces change. They are in essence a set of norms, values, and attitudes that are clearly communicated and shared among all stakeholders, and further comprise agile systems, processes, and strategies which are directly related to organizational guidelines and routines and contribute to improved operational performance.

Leadership has an important and active role in this change. According to Chen et al. [37], the ideal leader in this regard must be closely involved in communicating the company's technological vision, undertake constant monitoring of market trends, translate them into business opportunities, orchestrate changes, and be able to inspire and motivate people to be part of this organizational change.

Sevinç et al. [44] mention that it is important for companies to keep up with technological advances to remain competitive. Cichosz et al. [52] reveal that, in the future, LSPs will no longer be considered simply logistics companies, but will be recognized as technology companies that offer logistics services.

According to Sundarakani et al. [50], the factors that currently drive the growth of LSPs are expected to change in the coming years, mainly due to the rapid evolution of the 3PL industry due to the adoption of advanced technologies. As a differentiation factor, Pan et al. [13] use the following argument: With the increase in the number and complexity of demands, organizations will move toward collaboration, intelligence, and service orientation, whereby collaborative business—including coopetition, which consists of sharing goods or logistics services between competitors from a business-to-business (B2B) network—will be prominent.

Mathauer and Hofmann [47] argue that technologies can help improve the competitive position of a LSPs by assisting in service innovations or improving existing logistics solutions with value addition.

4. Conclusions

Industry 4.0 is equated with the fourth industrial revolution, given that it has significant implications for the entire manufacturing industry. Accordingly, LSPs must develop strategies to adapt to this new environment. Although studies in this area are nascent, considering that all the articles on this subject were published in the last 10 years, this article undertook a systematic review of the literature covering both Industry 4.0 and LSPs. The objective was to propose a conceptual structure of LSPs in the future, following the consolidation of Industry 4.0. In doing so, the study not only fills an existing gap in the literature but can also guide scholars and professionals in further research.

Three research questions were proposed to guide this study. In response to Q1, the SLR revealed eight major challenges: rapid changes in demand, process complexity, cost reduction, resource management, lack of qualified professionals, technology adoption, interoperability between systems, and information security. Three main barriers were also noted: high cost of technologies, lack of confidence in the benefits, and lack of technological know-how. Some threats were also highlighted, such as competition, new entrants, and substitutes. These dimensions are part of the proposed conceptual model.

Regarding Q2, six dimensions were identified and grouped: people, technology, infrastructure, relationship, services, and organizational. These dimensions are related to the aforementioned challenges, barriers, and threats. Accordingly, these inter- and intra-organizational dimensions need to be emphasized as organizations prepare to absorb the impacts of Industry 4.0.

Regarding Q3, the technology dimension was the most frequently discussed in the articles in this SLR; in fact, all the studies analyzed address the advanced technologies of industry 4.0, in the following order of frequency: IoT, Internet of Services (IoS), RFID, and WSN technologies, CPS, cloud computing, big data, blockchain, 3D printing, drones and autonomous entities, augmented reality, and social media.

All these technologies have the potential for application in logistics processes, which are usually performed by LSPs when these processes are outsourced.

This research identified and consolidated six dimensions that can be used as research themes to be further explored: the development and the role of people (1) in this transformation; the types of technology (2) and their applications in the processes; the facilities and infrastructure (3) in general connected through devices; the role and the relationship (4) with customers, suppliers, and competitors; the development of new services (5) and business models; and finally, the change in the structure and organizational culture (6) of companies. Thus, it is undeniable that there is much to be explored by researchers, since this research did not aim to comprehensively cover the subject, but rather to provoke, foster, and stimulate new research related to the theme. However, the structuring and definition of topics is the starting point to stimulate scholars, academics, professionals, and policy makers, to study the issues raised in greater depth.

New research is fundamental to developing the initially proposed framework, especially for practical advances.

Thus, this research has both theoretical and practical implications. From a practical perspective, the proposed framework can be used to support professionals in organizations that provide logistics services, by providing theoretical support to initiate strategic changes and adaptations to become LSPs 4.0. As companies are increasingly required to adapt to smart industries, consultancy may be of interest to support the transformation process. This may provide an opportunity to further explore the concepts presented herein and develop a model with practical validity.

As for theoretical implications, this study contributes to the academic community. It is unique and introduces an original model. However, further empirical studies are required to validate the conceptual framework.

Research Limitations and Directions for Future Research

Despite admitting the richness of this study, we cannot claim that it fully covers the dimensions and implications of Industry 4.0's impact on organizations providing logistics services, because we are talking about a new industrial revolution in evolution.

Therefore, we recognize that this research has its limitations, first in methodological terms, because it has characteristics of qualitative and exploratory research, where empirical and quantitative research can improve, qualify, and confirm the findings, validating or even refuting the proposed theoretical model. The second limitation is related to the period in which this work was carried out, which is the result of a master's thesis developed in 2020, and considering the mass of articles that have been published in recent years, for example, research conducted by Nica, E., et al. [61], Andronie, M., et al. [62] and Lăzăroiu, G., et al. [63], which address intelligent process planning assisted by deep learning, real-time production logistics based on the Internet of Things, and cyber-physical process monitoring systems. These topics, which were not explored in depth in this research, demonstrate that a new review is necessary in order to update and validate the constructs.

However, as it is an innovative study and brings relevant constructs to LSPs, it does not lose its relevance for organizations and the academic community, and contributes to new reviews due to the process by which the review was conducted, which allows for repeatability and replicability of the study.

The previous sections presented and discussed the categorized dimensions that resulted from an SLR, to set up a conceptual structure for LSPs 4.0. However, the proposed structure requires empirical validation.

Some of the identified dimensions and sub-categories have received more attention by researchers, as demonstrated in Tables 3–7. This shows that there is a clear need for further research.

Therefore, other research questions were identified, which should be of interest to researchers in the field of supply chain management, logistics, and logistics outsourcing.

- What, in shippers' view, are the necessary elements to create LSPs 4.0?
- What benefits do shippers perceive from LSPs 4.0 in their supply chain?
- How can LSPs 4.0 support customers in deploying Industry 4.0?
- What professional profiles and skills are required to implement LSPs 4.0?
- Which logistics processes should be prioritized to receive investments and achieve technological innovation?
- What are the financial impacts of LSPs 4.0 implementation on LSPs?
- How and which processes should be measured when introducing disruptive technologies?
- What IT infrastructure is needed to deploy LSPs 4.0?
- How should the performance of logistics processes be measured through digital technologies?
- What is the best way for LSPs to acquire disruptive technologies?
- How can LSPs 4.0 measure customer satisfaction?
- What levels of competitive advantage can the transformation to LSPs 4.0 deliver for traditional service providers?
- How can the barriers of high technology cost, lack of know-how, and firm-level misgivings of the benefits, be mitigated?
- How can disruptive technologies support LSPs 4.0 in making logistics processes more sustainable?
- What is the relationship between organizational maturity and the implementation of LSPs 4.0?
- What are the barriers to deploying LSPs 4.0 in small- and medium-sized enterprises?
- How can operational excellence be achieved through LSPs 4.0?
- What is the relationship between performance requirements and value delivery to customers?

- What is the role of lean logistics in a LSPs 4.0 context?

This study sought to create a consistent conceptual model, whereby logistics professionals may direct strategies and decision making, act in a proactive and more autonomous manner within the supply chain of the future, and remain essential and strategic players for organizations and shippers.

Future research might consider conducting a survey with LSPs to empirically validate the model. This should include case studies and should form part of the future agenda derived from this study.

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