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Review

Current and Future Trends of Information Technology and Sustainability in Logistics Outsourcing

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Abstract: Sustainability awareness across various economic sectors requires firms to use logistics outsourcing to reduce logistics-related emissions with compliant logistics service providers (LSPs). LSPs apply advanced information technologies to help achieve high efficiency, effectiveness, and sustainability goals. While logistics outsourcing has received considerable attention from researchers, limited research has identified the elements of logistics outsourcing and established research trends regarding technology and sustainability aspects of logistics outsourcing. This study aims to establish trends in technology and sustainability in logistics outsourcing and identify the important elements of logistics outsourcing. A bibliometric analysis technique using the Biblioshiny package in R. A SCOPUS search resulted in 2019 documents. Research on technology and sustainability in logistics outsourcing is growing, especially in developed countries, with little or no research from developing countries. Sustainable supply chains and third-party logistics themes dominated the past research. Current research is on reverse logistics, circular economy, and green logistics; the latter is likely to dominate the future, focusing on risk management, pollution control, and innovation through advanced technologies such as artificial intelligence, machine learning, and big data. Essential elements of logistics outsourcing are identified as maintaining a good relationship based on trust and cooperation, LSP multi-selection criteria that include sustainability and technology capabilities, proper contract management, and an appropriate in-house versus outsourcing balance for competitiveness. LSP managers are advised to develop sustainability and technology capabilities, including reverse logistics. The paper contributes to logistics management theory by identifying the elements of logistics outsourcing and presenting a bibliometric result to guide future research on sustainability and technology capabilities in logistics outsourcing.

Keywords: information technology; third-party logistics; logistics service providers; sustainability; logistics outsourcing; bibliometric analysis; future trends

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1. Introduction

The dynamic nature of customer requirements indicates that enterprises should offer more than just cheaper products to maintain or improve competitive advantages [1]. A logistics service that accompanies the products can improve customer satisfaction and customer loyalty. However, offering an effective and efficient logistics service requires firms to invest heavily in logistics assets, information technology, and operations, which divert capital invested from the core business [2]. Effective logistics service relates to punctual order deliveries, easy return service, real-time information sharing with the customer, and elaborate reverse logistics [3]. With increased environmental awareness, environmental laws that logistics services should comply with, and the high cost of IT investments required make it difficult for enterprises to arrange logistics in-house [4]. Enterprises can acquire these capabilities through logistics outsourcing to develop competitive advantages despite the difficulty of arranging effective logistics in-house. In addition, logistics outsourcing success requires that the various aspects of the relationship are diligently managed, including ensuring an objective selection of LSPs with a focus on sustainability and IT capabilities.

Logistics outsourcing is the use of LSPs by shippers to perform all or part of their logistics activities, which otherwise would have been performed in-house [5]. The adoption of logistics outsourcing has been growing over time, as illustrated by the annual "*third-party logistics study*" by Langley [6–8]. Currently, logistics outsourcing accounts for over 56 percent of total logistics expenditure and is growing [8]. Furthermore, logistics outsourcing has been increasing over the last decade due to its potential to reduce logistics costs and its ability to improve customer service levels [9]. Many enterprises find it challenging to handle logistics functions in-house; thus, they can opt to outsource to LSPs or third-party logistics providers (3PLs) to acquire specific capabilities that grant them competitive advantages [10,11]. Prior research reveals the importance of information technology (IT) capabilities in logistics and argue that shippers can acquire the capabilities through logistics outsourcing [8,12]. In addition, the emphasis on pursuing sustainability in logistics, especially as one of the reasons for engaging LSPs, has received considerable attention in prior research [13,14]. Thus, LSPs must develop elaborate IT capabilities and incorporate environmentally, socially, and economically sustainable initiatives in their operations. Despite the importance of IT and sustainability capabilities in logistics outsourcing, there is limited research to try and map out past, current, and likely future research trends that can guide practitioners and theory in the logistics management discipline. Further, the relevant elements of logistics outsourcing from a technology and sustainability perspective are not known explicitly.

Increased globalization, advancement in technology, and the significance of climate change and logistics outsourcing require researchers to predict future research directions in logistics. Logistics activities contribute significantly to greenhouse gas (GHG) emissions, mainly from transportation, packaging, and improper disposal of used products [15]. The GHG emissions impact the environment negatively regarding air pollution that is likely to cause respiratory problems [16]. However, research shows that information technology held by LSPs can help monitor and reduce emissions, mainly by providing high fuel efficiencies, reduction of power losses, optimal routing, and asset utilization [4]. Advanced information technologies will use appropriate analytics to convert data into business insights and actionable information to meet the dynamic customer requirements and help achieve sustainability goals [17,18]. Logistics activities such as procurement, material handling, production, warehousing, and transportation generate vast amounts of both structured and unstructured data that, if well utilized, will result in high logistics efficiencies and effectiveness [17].

Researchers argue that a logistics outsourcing engagement should incorporate sustainability, including reverse logistics and information technology capabilities as part of the basic offering to help develop competitive advantages for their clients and improve customer satisfaction [11,19,20]. Despite the importance of sustainability and advanced information technologies to logistics management, there is limited research that has investigated the concepts in logistics outsourcing. Prior research had examined logistics outsourcing from the perspective of selection criteria [19,21], contract structures [22], reverse logistics [20], sustainable development [23], environmental assessment [24], and risk management [25]; thus, none of the studies have examined a combination of IT and sustainability in logistics outsourcing. Therefore, this paper aims to establish the current and future trends in IT and sustainability in logistics outsourcing. The present study established research trends and provides likely future research directions on technology and sustainability in logistics outsourcing. The findings of this paper inform practitioners on the aspects of logistics outsourcing to pay attention to by answering the following questions: (1) what are the elements of logistics outsourcing, and (2) what is the research trend on information technology and sustainability in logistics outsourcing?

The rest of the paper is structured as follows. Section 2 contains a literature review on logistics outsourcing, elements of logistics outsourcing, sustainability, and technology in logistics outsourcing. Sections 3–5 present the methodology, results, discussion, and conclusion.

2. Literature Review

2.1. Logistics Outsourcing

Logistics refers to managing the flow of products and services and related information from production to consumption efficiently and effectively to meet customer requirements [11]. Logistics services are usually performed by LSPs, which are dedicated to offering services such as transportation, warehousing, order management, packaging, logistics information services, clearing, and forwarding [9]. LSPs work across a range of industries and can be classified as (1) standard service providers, which provide basic services such as transportation; (2) service developers offering additional value-added activities such as track and trace and security; (3) customer adapters, offering customized logistics services; and (4) customer developers who usually redesign customer logistics solutions to meet their efficient processes [26]. As such, logistics outsourcing allows the host enterprises to focus on core business, reduce logistics costs, improve service levels, and increase the satisfaction of their clients by using LSPs (also known as third parties) [27,28]. Logistics outsourcing can help enterprises improve their operations due to the efficiency of LSPs, thus developing the competitiveness of shippers [29]. Logistics services are resource-intensive in terms of the capital investment required for equipment, associated information technologies, and the development and management of the relevant talent, which is a burden to many enterprises whose core business is not logistics [7,8,30]. Thus, outsourcing can free some resources for investment in core business activities and consequently increase the profitability of the outsourcing enterprises [5,26]. Several logistics activities can be outsourced, including transportation, warehousing, freight clearing and forwarding, and inventory management. The likely benefits of outsourcing the aforementioned activities are improved logistics processes and reduced costs; however, the benefits can only be achieved if the LSPs are selected diligently [5,19,26,31–33]. Therefore, success depends on how well the host firm and the associated LSPs manage the various elements of logistics outsourcing. Some of the elements of logistics outsourcing include the following.

2.1.1. Relationship Management

Better relationships between LSPs and their clients will likely result in improved logistics services, logistics optimization, and value in reduced cost, high flexibility, and increased responsiveness in supply chain operations. Outsourcing firms are usually ready to develop collaborative relationships with their LSPs and competitors to reduce logistics costs and improve service quality to their customers [8]. Logistics outsourcing is a base for developing strong business relationships [26] because the LSPs help strengthen their clients' core business. To deliver the benefits of logistics outsourcing, LSPs should develop relationships based on trust and cooperation with their clients to achieve high service quality and effective returns management and reverse logistics [34]. Strong relationships are dependent on the amount, speed, and quality of information shared between the LSPs and their clients; as such, the information shared should improve planning and problem sharing to build sustainable business relationships.

2.1.2. LSP Selection Criteria

The selection of LSPs is an important step in the outsourcing process. The selection needs scrutiny to ensure that the selected LSPs' business model will support the objectives of the client organization; otherwise, there will be failure [28]. Prior research reveals that hierarchical techniques optimize the LSP selection process [19]. The criteria include LSPs' on-time performance, service delivery, good communication, financial power, value-added services, special expertise, and advanced technologies such as artificial intelligence to integrate human knowledge and big data in the selection process [19]. LSPs are also expected to offer efficient operations, real-time decision-making, and alignment with the client firm's strategic logistics business goals [21]. In addition, due to the increased importance of sustainability and technology in logistics, LSPs are expected to possess

sustainability capabilities, including reverse logistics and information technologies that offer real-time information sharing to enhance logistics efficiencies [28].

2.1.3. Contract Management

Logistics outsourcing contracts should be meaningful to both the LSPs and the host firm to meet their business objectives. There should be agreements on the type, nature, and frequency of information shared; the extent of joint planning; and how conflicts will be resolved in case they arise [26]. Shipper-LSP contract structures can be classified into the fixed price, dependent on on-time delivery rate, profit, and revenue sharing [22], whereby profit sharing and on-time delivery are considered most beneficial. It is also important that there is an alignment between the business goals of the LSPs and the shipper for win-win contract terms [8].

2.1.4. In-House vs. Outsourcing Mix

Developing in-house capabilities of all the logistics functions remains a daunting task for manufacturers, given the scarcity of resources as they have to focus on the core business. Infrastructural investments and talent management in warehousing, packaging, transportation, cold-chain, and technology require significant resources to develop the capabilities required to gain a competitive advantage [35]. On the other hand, outsourcing firms would like to maintain some aspects of logistics in-house to maintain some control and not lose customer contact. Balancing the in-house versus outsourcing mix requires proper systems to ensure smooth delivery of services to the customer. While some firms would outsource end-to-end logistics services, ref. [8] argued that some firms retain some cold chain activities such as packaging in-house and require LSPs to offer high precision real-time temperature monitoring and traceability capabilities. In addition, ref. [8] argued that during the COVID-19 disruption, many enterprises reduced their outsourcing activities. Although the reduction can be attributed to the uncertainty occasioned by the COVID-19, it also brings into perspective the in-house versus outsourcing mix debate—implying that during a disruption, enterprises would like to control their logistics to achieve agility [35].

2.2. Sustainability in Logistics Outsourcing

Sustainability requires that the environment be used economically to serve communities while ensuring its protection for society's benefit, implying that sustainability focuses on balancing environmental, social, and economic dimensions [17]. Logistics services such as transportation result in the emission of greenhouse gases harmful to the environment. Thus, LSPs should pursue sustainability initiatives such as using more efficient engines and recycling [36]. The current emphasis is the implementation of initiatives related to the environment, social, and governance (ESG); diversity, equity and inclusion (DEI); corporate social responsibility (CSR); and circular economy in major 3PLs players [8]. Implying that providers of logistics services should rely on innovation to create value for their customers through sustainable efficiencies and effectiveness for the benefit of society. As such, users of logistics services should be proactive in selecting LSPs by ensuring that they have the ability to or are already implementing sustainability in their business model. One of the sustainability initiatives among 3PLs is an effective reverse logistics service.

Reverse logistics helps to reduce negative environmental impacts by recovering products at the end of their life [11]. Thus, reverse logistics offers an opportunity to reprocess and recycle materials to achieve economic and environmental goals by reducing the cost of raw materials and renewing used products, respectively [37]. Hence, reverse logistics helps address the sustainability issues. From a logistics outsourcing perspective, users of logistics services would prefer to outsource their logistics services to LSPs who practice and have elaborate reverse logistics capabilities to help them achieve their sustainability goals as part of the circular economy objective [8]. Therefore, reverse logistics is being implemented currently and remains an important aspect of logistics outsourcing in the future [8,28].

The environmental dimension of sustainability aims to minimize the exploitation of natural resources and a reduction of pollution. The initiatives towards achieving the environmental dimension include promoting carbon-neutral activities and processes such as a shift of freight from road to rail and the adoption of electric trucks [36]. The LSPs are expected to use biodegradable materials, especially in packaging. LSPs should also embrace alternative fuels such as hydrogen and electric trucks in the transportation function. LSPs are expected to pursue sustainable logistics goals by implementing fuel efficiency, optimal vehicle capacity utilization, and scheduling [20]. Many governments globally are passing laws requiring enterprises to be carbon-neutral especially through recycling; thus, the firms will require their LSPs to support the circular economy agenda by providing effective and efficient sustainable logistics [8].

Enterprises implement the social dimension by tracking the impact of their activities on the communities where they operate to ensure that they address issues related to fair labour practices and human rights across the logistics network.

In addition to the three sustainability dimensions, ref. [8] argues that governance, which focuses on ensuring that the decision-makers in organisations act responsibly, should be part of sustainability. Acting responsibly requires that inter-firm relationships are improved across a supply chain by sharing relevant information, increasing visibility to eliminate human rights violations across the supply chain, and corruption in logistics, especially in cross-border transportation. To comply with supply chain governance, enterprises will select LSPs who have developed governance structures that support relationship building and promote security and visibility. Therefore, the current trend in sustainability is the addition of environmental, social, and governance (ESG) aspects, which are driven by customer preferences and climate change consciousness. Current and future challenges hindering the attainment of sustainability goals include limited finances, poor regulatory framework, lack of proper skills and technologies, and lack of supportive top leadership to implement the required governance structures that promote sustainability.

The current sustainability and logistics outsourcing trend revolves around selecting LSPs that can aid firms with compliance with environmental sustainability goals. Some firms seek LSPs with capabilities to implement closed-loop supply chains [38].

Achieving the sustainability goals requires that enterprises use advanced technologies such as machine learning to monitor and predict resource usage to enhance environmental performance effectively [39].

2.3. Technology in Logistics Outsourcing

The application of technologies such as transport management systems (TMS) in logistics brings cost savings by improving fuel efficiency, route optimization, and high service levels [40]. The next-generation mobile technology–5G is likely to promote the acquisition and analysis of big data in real-time across the supply chain including transport networks to quicken response times [17]. The 5G technology is likely to help realize the value of advanced technologies such as artificial intelligence (AI), including the internet of things (IoT) and machine learning (ML) in logistics [40,41]. Some of the benefits of adopting the advanced technologies include high operational efficiencies in transportation and warehousing and proper risk management; as such, LSPs should adopt an appropriate information technology that meets the needs of their customers [42]. LSPs are expected to invest in these logistics-based information technologies to meet their customers' requirements; thus, shippers will leverage the investment to deploy their capital resources in the core business [8]. Human-machine interaction is a significant trend being investigated in logistics as LSPs look for an optimal solution on how a balance can be achieved and how automation should be done in logistics. Large and global LSPs such as FedEx and DHL are already implementing advanced technologies and automation, and more LSPs are likely to follow suit in the future.

Prior research reveals that LSPs have either invested in IoT or are planning to invest to reap benefits such as real-time logistics network visibility, productivity monitoring,

improved asset utilization, and quick decision making [8,40]. The importance of real-time data analytics for decision-making is growing as shippers and LSPs would like to predict disruptions and do proper planning to avoid total breakdowns [8,43]. Machine learning technologies offer great potential for end-to-end supply chain automation, high precision prediction, and customization, especially in e-commerce, to improve customer satisfaction [43]. However, machine learning technologies are at an introductory stage in logistics and supply chain management. Actual benefits will be accrued in the future as LSPs adopt the technologies for their efficiencies and to benefit their clients [41].

LSPs invest in cloud-based technologies, especially in transportation and warehousing management, to achieve faster sharing of information and advanced analytics to improve service delivery [8].

LSPs are also investing in robotics, especially in warehousing, to achieve automation, reduce labour requirements, and better support cold chain operations, especially with continued growth in e-commerce.

In the future, LSPs are likely to invest more in big data analytics, drones, digital supply chain twins, electric trucks, autonomous trucks, forklifts, and smart warehouses. Enterprises search for data-driven decision-making capabilities primarily through machine learning technologies, which have accurate predictive abilities [43,44]. Ref. [26] claimed that the integration of technologies into business strategy is likely to improve business processes and customer services. Thus, enterprises can access sophisticated technologies to enhance their operations through outsourcing.

Outsourcing firms require LSPs to possess cold chain capabilities in terms of real-time temperature monitoring, product tracking and trace, and proof of compliance to set standards [8]. To achieve the cold-chain requirements, LSPs should invest in big data, IoT, and blockchain technologies [17].

The contemporary issues in logistics outsourcing and technology revolve around the supply chain as a service (SCaaS), which is made possible by adopting cloud technologies. SCaaS allows firms to fully outsource logistics activities to LSPs right from procurement to the last mile. Adoption of SCaaS requires the development of supportive business models that create alternative sources of revenue for LSPs as well as host firms. The growing adoption of cloud services allows for access to a variety of supply chain technologies that can facilitate future offerings such as logistics as a service (LaaS), inventory management as a service, reverse logistics as a service, last-mile as a service, and SCM as a service [8]. In addition to the cloud services, ref. [45] argued that crowd logistics companies could mediate the relationship between LSPs and their clients by hosting the outsourcing services through various technologies to allow sharing of information to optimize logistics operations. Thus, to meet customers' needs, LSPs are accelerating the adoption of relevant information technologies [42]. Therefore, rapid adoption of information technologies and investments in advanced technologies characterize LSPs of the 21st Century as they aim to improve service levels and logistics operational efficiencies through cost reduction.

3. Methods

The study aimed to establish the current research regarding the application of technology and implementation of sustainability initiatives in logistics outsourcing relationships. First, a scoping literature review allowed for a synthesis that mapped literature on logistics outsourcing, focusing on technology and sustainability. The scoping literature review helped identify concepts, gaps, and sources of evidence to guide practitioners and government agencies regarding the critical elements of logistics outsourcing [46]. The scoping review was guided by research questions formulated, studies were searched, relevant studies were selected, and the data obtained was analysed and reported in line with relevant prior studies [46]. A scoping review helped map the nature and characteristics of the logistics outsourcing literature to identify its dimensions and trends in technology and sustainability. The scoping review was selected because it provided adequate rigour to

answer the research question regarding the elements of logistics outsourcing, given that there is limited prior research that has examined the phenomenon.

Second, a bibliometric analysis was adopted to establish research trends on sustainability and technology in logistics outsourcing. Bibliometric analysis is a science mapping technique that uses statistics and visualization techniques to present bibliographic data [47] related to researchers, affiliations, journals, countries, collaboration networks, keywords, and thematic evolutions. Similar studies that have applied a similar methodology include sustainable logistics [48]. Bibliometric analysis can be presented as (1) performance analysis, which is descriptive, and (2) science mapping, which visualizes various relationships [49]. The database selected for this bibliometric search is SCOPUS. SCOPUS is a large curated academic database with a global collection [50]. SCOPUS has also been recognized as sufficient for bibliometric research [50]. A bibliometric search was conducted in SCOPUS using the keywords "logistics outsourcing *" OR "third-party logistics*" AND "technology" AND "sustainability". The search focused on journal articles, conference papers, review papers, and book chapters published in business and economics subject areas. Only papers written in the English language were considered. The search yielded 2019 articles from 280 sources. All the papers were selected and exported as a BibTeX file. The R language was selected to conduct the bibliometric analysis because it provides an open-source environment (making it readily available). The Bibliometrix package in R was used to analyze the obtained documents using the code "bibliometrix::biblioshiny()" for bibliometric analysis. The Bibliometrix package provided a range of capabilities adapted for bibliometric analysis and the possibility to export to other packages such as Excel for further analysis. The analysis helped to calculate and visualize statistics of the various bibliometric measures, including authorship, performance and influence analysis, main information, publishers, institutions, and keywords, among others. The main information about the collection is presented in Table 1.

Table 1. Main information of the data.

Description	Results
Main information about data	
Timespan	2001:2022
Sources (Journals, Books, etc)	280
Documents	2019
Average years from publication	3.6
Average citations per documents	22.11
Average citations per year per doc	3.96
References	91,330
Document types	
article	1702
book chapter	79
conference paper	101
review	137
Document contents	
Keywords Plus (ID)	2231
Author's Keywords (DE)	3125
Authors	
Authors	2750
Author Appearances	6487
Authors of single-authored documents	81
Authors of multi-authored documents	2669
Authors collaboration	
Single-authored documents	153
Documents per Author	0.734
Authors per Document	1.36
Co-Authors per Documents	3.21
Collaboration Index	1.43

The research documents extracted through the bibliometric analysis were related to logistics outsourcing, technology, and sustainability as per the search criteria, revealing documents for the last 21 years. As per Table 1, the average citation per article per year is 3.96, with 91,330 references. The documents contained 75.67% of articles, with the majority being co-authored. A total of 2750 authors have contributed to technology and sustainability in logistics outsourcing.

4. Results

4.1. Performance Analysis

Performance analysis helped to study the contributions of authors, affiliations, journals, and countries. The bibliometric technique is used to study the development of research in a specific area over time [51]. The published research on technology and sustainability in logistics outsourcing started in 2001 with a single article, 21 articles in 2011, and increased gradually to 531 articles per year in 2021, as illustrated in Figure 1, revealing that 2012–2021 was a decade when the research output increased the most. By the time this search was conducted in 2022, 132 articles had been published, revealing continued interest in technology and sustainability in logistics outsourcing as a research area. The growth in research in this area can be attributed to the increased importance of logistics, especially to manufacturers, in terms of reducing cost and improving customer service and customer satisfaction [5]. The growth in documents per year can also be attributed to the growth in scientific research. The growth in advanced technologies has also made it easier to collect and analyze data quickly and share information in almost real-time for decision making [52], thus making it possible to develop competitive advantages through efficient and effective logistics.

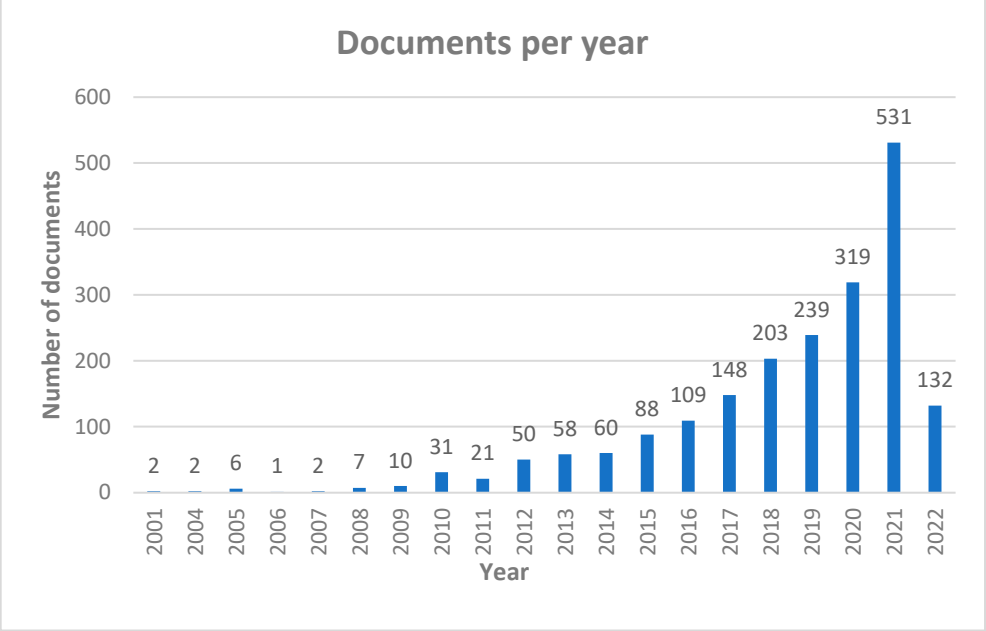

Figure 1. Documents per year on between 2001–2022. Source: Own study based on SCOPUS.

4.1.1. Publications Per Journal

The most influential journals on technology and sustainability in logistics outsourcing were identified and ranked (as illustrated in Table 2). In the top 20 ranks, the Journal of Cleaner Production published the largest number of articles at 194 between 2001 and 2022. Many of the articles in this might be related to sustainability initiatives in logistics. The second most relevant was the International Journal of Logistics Management, with 114 published articles, whereby many of the journals are related to the management discipline.

Table 2. Total publications per journal.

Sources	Articles
Journal of Cleaner Production	194
International Journal of Logistics Management	114
International Journal of Production Economics	82
International Journal of Production Research	76
International Journal of Logistics Systems and Management	72
International Journal of Logistics Research and Applications	64
Benchmarking	55
International Journal of Physical Distribution and Logistics Management	50
International Journal of Supply Chain Management	46
Production Planning and Control	46
Transportation Research Part E: Logistics and Transportation Review	44
Industrial Management and Data Systems	36
Supply Chain Management	36
International Journal of Operations and Production Management	34
Journal Of Enterprise Information Management	34
Business Strategy and The Environment	32
Proceedings Of The International Conference On Industrial Engineering And Operations Management	24
International Journal of Services and Operations Management	22
International Journal of Productivity and Performance Management	20
Journal Of Modelling in Management	20

4.1.2. Total Citations and Impact Per Journal

The productivity and influence of the published research on technology and sustainability in logistics outsourcing were examined using the *h*-index [53]. The *h*-index combines citations and publications to measure each research constituent [49]. Research on technology and sustainability in logistics outsourcing attracted more scholars in the last five years than in previous years. The top 20 publications by total citations were ranked, all published after 2011, as illustrated in Table 3. The most influential source was the Benchmarking journal, with an *h*-index of 17 and an impact factor of 29 (*g*-index) when calculated since 2011, followed by the British Food Journal with an *h*-index of 6 over the same period. The *h*-index represents the number of papers with citations equal to or greater than *h* [51]. The Asia Pacific Journal of Marketing and Logistics journal was ranked third with an *h*-index of 4 in productivity and influence.

Table 3. Citations and publications per journal.

Element	*h*_Index	*g*_Index	*m*_Index	TC	NP	PY_Start
Benchmarking	17	29	1.42	906	49	2011
British Food Journal	6	6	0.50	336	6	2011
Asia Pacific Journal of Marketing and Logistics	4	5	0.50	64	5	2015
Bar–Brazilian Administration Review	2	2	0.18	15	2	2012
Baltic Journal of Management	2	2	0.29	11	2	2016

Table 3. *Cont.*

Element	*h*_Index	*g*_Index	*m*_Index	TC	NP	PY_Start
Asia-Pacific Journal of Business Administration	2	2	0.67	8	2	2020
Asian Business and Management	2	2	0.50	8	2	2019
Advances In Production Engineering and Management	2	2	0.50	38	2	2019
Advances In Business Marketing and Purchasing	2	2	0.25	16	2	2015
Academy Of Entrepreneurship Journal	2	2	0.40	46	2	2018
2nd International Symposium On Technology Management and Emerging Technologies, Istmet 2015–Proceeding	2	2	0.25	4	2	2015
2018 5th International Conference on Industrial Engineering and Applications, Iciea 2018	2	2	0.40	4	2	2018
Best Practices in Manufacturing Processes: Experiences From Latin America	1	1	0.20	2	2	2018
Benchmarking: An International Journal	1	1	0.09	4	1	2012
Analyzing The Impacts of Industry 4.0 In Modern Business Environments	1	1	0.20	2	2	2018
Agri-Food Supply Chain Management: Breakthroughs in Research and Practice	1	1	0.14	2	2	2016
Administrative Sciences	1	1	0.33	2	1	2020
Academy Of Strategic Management Journal	1	1	0.50	2	2	2021
2020 International Conference on Computer Science, Engineering and Applications, Iccsea 2020	1	1	0.33	2	2	2020
2019 16th International Conference on Service Systems and Service Management, Icsssm 2019	1	1	0.25	2	2	2019

4.1.3. Source Growth

The top five journals have been examined since 2001. The Journal of Cleaner Production (JCP) provided the earliest publication in the research area (as illustrated in Figure 2); this supports a study [48] on sustainable logistics using a bibliometric analysis technique. Real growth is manifested after 2008 with the International Journal of Production Economics leading the field; however, after 2015, more articles were published annually in the JCP, making it a top journal in the research area. Many of the articles published in the JCP are related to green transportation, logistics, and supply chains, thus emphasizing the need to engage LSPs that are environmentally conscious. The reasons for the growth of research on sustainability can be associated with the awareness of climate change and the need to reduce emissions in logistics functions such as transportation and production activities and the use of biodegradable materials in packaging [54]. The International Journal of Logistics Management (IJLM) picked pace after 2013 and maintained a steady growth yearly thereafter. The IJLM published research related to both technology and sustainability in logistics outsourcing. The identified top five publications' trends reveal that they all have a high impact factor (for example, the JCP, impact factor 9.297) and a wide readership (especially in China, the US, and Great Britain), thus signaling the importance of technology and sustainability in logistics outsourcing practice.

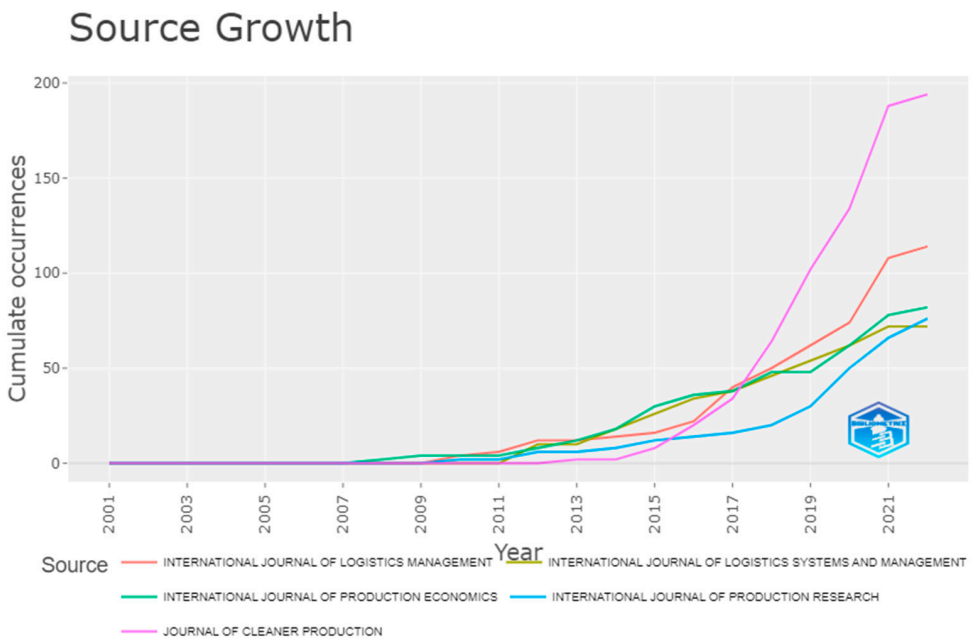

Figure 2. Source growth between 2001–2022. Source: Own study based on SCOPUS.

4.1.4. Influential Authors

About 2750 authors contributed to the 2019 documents in the corpus, in which only 81 (2.95%) were single authors, revealing that most of the research is through collaborations. The top 50 authors were ranked by productivity and influence to describe the research dynamics in technology and sustainability in logistics outsourcing. The ranking was based on the *h*-index as well as the total citations, as illustrated in Table 4. Gunasekaran A emerged as a pioneer researcher in this area with 1950 citations, $h = 15$, and an impact of 18 (*g*-index) since the year 2005; he is the only researcher who has published consistently in the research area for about two decades. The top five *h*-indices were 18, 17, 17, 15, 15 by Govindan, Mangla, Kumar A, Gunasekaran A and Luthra S, showing the researchers with the highest impact as well as publications. Except for Gunasekaran, many of these top researchers started publishing in this area in 2016, a fact implying that research on technology and sustainability in logistics outsourcing is on an upward trend.

Table 4. Author impact and total citations.

Element	*h*_Index	*g*_Index	*m*_Index	TC	NP	PY_Start
Gunasekaran A	15	18	0.833	1950	18	2005
Seuring S	10	14	0.769	1602	14	2010
Searcy C	4	4	0.364	1506	4	2012
Surti C	2	2	0.182	1372	2	2012
Hassini E	2	2	0.182	1372	2	2012
Govindan K	18	18	2.571	1352	18	2016
Luthra S	15	25	2.143	1349	25	2016
Mangla Sk	17	23	2.429	1329	23	2016
Perotti S	11	16	0.917	1093	16	2011
Gold S	3	4	0.231	1084	4	2010
Beske P	2	2	0.154	1078	2	2010
Ngai Ewt	2	2	0.111	780	2	2005
Kumar A	17	25	2.429	690	31	2016
Timor M	2	2	0.154	686	2	2010
Sipahi S	2	2	0.154	686	2	2010
Marchet G	6	6	0.6	622	6	2013
Marasco A	2	2	0.133	600	2	2008

Table 4. *Cont.*

Element	*h*_Index	*g*_Index	*m*_Index	TC	NP	PY_Start
Raut Rd	13	22	2.167	567	22	2017
Liao H	8	13	2	557	13	2019
Gardas Bb	14	16	2.333	555	16	2017
Papadopoulos T	5	5	0.714	552	5	2016
Wang Y	6	6	0.75	536	6	2015
Schultmann F	4	4	0.571	534	4	2016
Fröhling M	4	4	0.571	534	4	2016
Mishra N	6	6	1.2	514	6	2018
Melacini M	5	5	0.417	511	5	2011
Dubey R	5	6	0.714	510	6	2016
Knemeyer Am	3	3	0.3	495	3	2013
Durach Cf	4	4	0.667	492	4	2017
Huang Gq	6	6	0.75	488	6	2015
Winter M	2	2	0.2	486	2	2013
Wieland A	2	2	0.333	470	2	2017
Singh A	6	8	1.2	470	8	2018
Kembro J	2	2	0.333	470	2	2017
Moktadir Ma	9	9	1.8	466	9	2018
Hartmann E	8	10	0.8	460	10	2013
Shankar R	12	20	1.091	459	20	2012
Colicchia C	4	8	0.333	457	8	2011
Subramanian N	5	5	0.625	448	5	2015
Zimmer K	2	2	0.286	422	2	2016
Pishvaee Ms	4	4	0.571	418	4	2016
Büyüközkan G	3	3	0.231	408	3	2010
Dora M	6	7	1.2	401	7	2018
Rich N	2	2	0.25	394	2	2015
Piercy N	2	2	0.25	394	2	2015
Micheli Gjl	4	4	0.364	390	4	2012
Cagno E	4	4	0.364	390	4	2012
Xu K	2	2	0.286	386	2	2016
Hitt Ma	2	2	0.286	386	2	2016
Diabat A	4	4	0.571	386	4	2016

4.1.5. Author Affiliations

The affiliations indicate the institutions where the authors are working as well as the countries. It also helps to show the various collaborations among the authors. Over 1400 author affiliations were represented in the publications on the research area. Six Indian institutions were among the top 20 in terms of contributions, indicating that most research on technology and sustainability in logistics outsourcing is being conducted in India as per Table 5. The National Institute of Industrial Engineering from India was host to the authors who contributed close to 70 publications. Cumulatively, Indian institutions in the top 20 contributed over 7% of the total documents. There were also significant contributions from institutions in Malaysia, Sweden, and Australia.

4.1.6. Contribution by Country

Figure 3 illustrates that most of the research on sustainability and technology in logistics outsourcing is conducted in Asia, Australia, Europe, North America, and some parts of the South American continent. Only a few parts of Africa contributed to the research, as per Figure 3, with contributions from South Africa and North Africa. China is known to lead in research, especially artificial intelligence [51]; thus, China's significant contribution to the research on technology and sustainability in logistics outsourcing was expected. China is also the second most cited country after India, as illustrated in Table 6. With regard to the emerging economies (Brazil, Russia, India and China), Russia is not well represented. The reason might be that they do not publish in SCOPUS indexed sources or

that they do not publish in English, and as such, their works might be available in Russian journals, which might not be available in the SCOPUS database.

Table 5. Publications per institution.

Affiliations	Country	Articles
National Institute Of Industrial Engineering (Nitie)	India	70
Politecnico Di Milano	Italy	30
Universiti Sains Malaysia	Malaysia	30
Indian Institute of Technology Delhi	India	27
The Hong Kong Polytechnic University	Hong Kong	27
University of Southern Denmark	Denmark	26
Montpellier Business School	France	25
Indian Institute of Technology	India	24
Delhi Technological University	India	23
Cranfield University	England	22
Linköping University	Sweden	22
Chalmers University of Technology	Sweden	19
Indian Institute of Management	India	19
Rmit University	Australia	19
Universiti Teknologi Mara	Malaysia	19
University of Sharjah	UAE	19
Chongqing University	China	18
Griffith University	Australia	18
Management Development Institute	India	18
Universiti Teknologi Malaysia	Malaysia	18

Table 6. Most cited countries.

Country	Total Citations	Average Article Citations
India	4812	16.148
China	4686	20.374
United kingdom	4583	35.254
Usa	3996	41.625
Germany	3524	44.608
Italy	2873	36.367
Australia	1803	27.738
Canada	1712	122.286
Turkey	1705	34.1
Denmark	1528	61.12
Hong kong	1418	56.72
Sweden	1357	28.271
Iran	560	22.4
Singapore	530	26.5
Malaysia	527	9.411
Finland	476	14
Brazil	447	10.643
France	384	13.241
Portugal	270	30
Spain	261	16.312

The most influential countries in technology and sustainability in logistics outsourcing research were ranked with the total citations criterion. India emerged as the most cited country with 4812 citations, effectively influencing research on logistics outsourcing across the globe. It was closely followed by China, UK, USA, and Germany in that order in the top five. There was no African country in the top 20 influential countries; however, countries classified as emerging economies or BRICS were well represented by India, China, and Brazil. The ranking of countries helped identify where the most impactful research

is conducted to guide future research; it is evident that authors in developed countries conducted most research in logistics outsourcing. Developed countries endeavor to reduce their logistics costs and improve customer service [26].

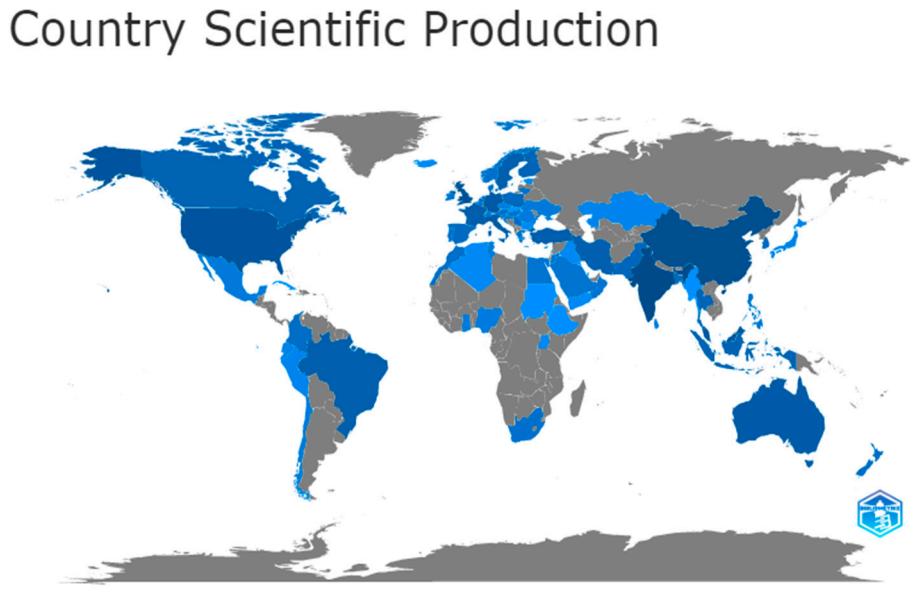

Figure 3. Contributions per country. Source: Own study based on SCOPUS.

4.2. Science Mapping

Science mapping helps to investigate relationships between various researchers, institutions and countries in a specific area of research [49]. Science mapping can be established by examining co-citation, citation, thematic clusters, co-word, and co-authorship analysis. Collaborations between countries on technology and sustainability in logistics outsourcing research reveal that African countries produced less research and were rarely involved in research collaborations than the rest of the world. Only South Africa can be observed to have established meaningful collaborations with countries in Europe and Asia (as illustrated in Figure 4). There are strong collaborations between the USA, India, Europe, and Australia. There is also significant research from South American countries, especially Brazil, with collaborators in Europe.

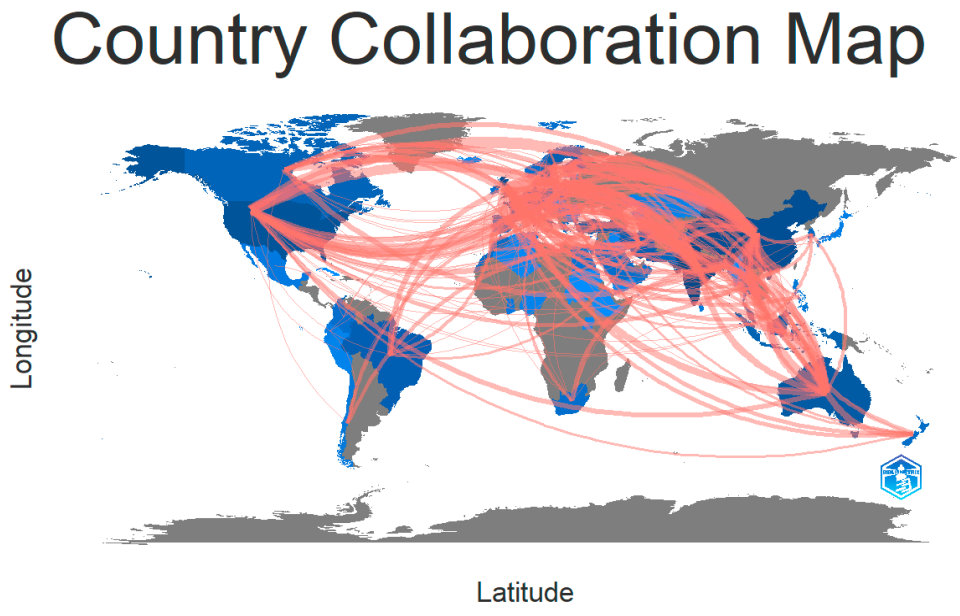

Figure 4. Country collaborations. Source: Own study based on SCOPUS.

4.2.1. Co-Citations

Co-citation analysis helps identify various intellectual structures and underlying themes in a research area. It highlights the most cited articles, thus revealing " . . . seminal publications and knowledge foundations" [49] (pg. 288). Three clusters are identified from the extracted documents (as illustrated in Figure 5). One of the clusters is led by Fornel (1981), showing that many of the researchers in logistics outsourcing have followed the statistical techniques, especially structural equation modeling. This is a research methodology cluster. The second cluster led by Seuring 2008, Zhu 2004, and Carter 2008 reveal the seminal works related to sustainability in logistics outsourcing and supply chain management. The third cluster is related to the foundational research in logistics outsourcing led by Lieb KJ and Wolf C 2010. The fourth cluster is related to technology as a way of integrating green logistics initiatives in organizational processes; the cluster is led by Govindan K 2015. Therefore, a co-citation analysis presents the past works leaving out the current or emerging studies in the research area.

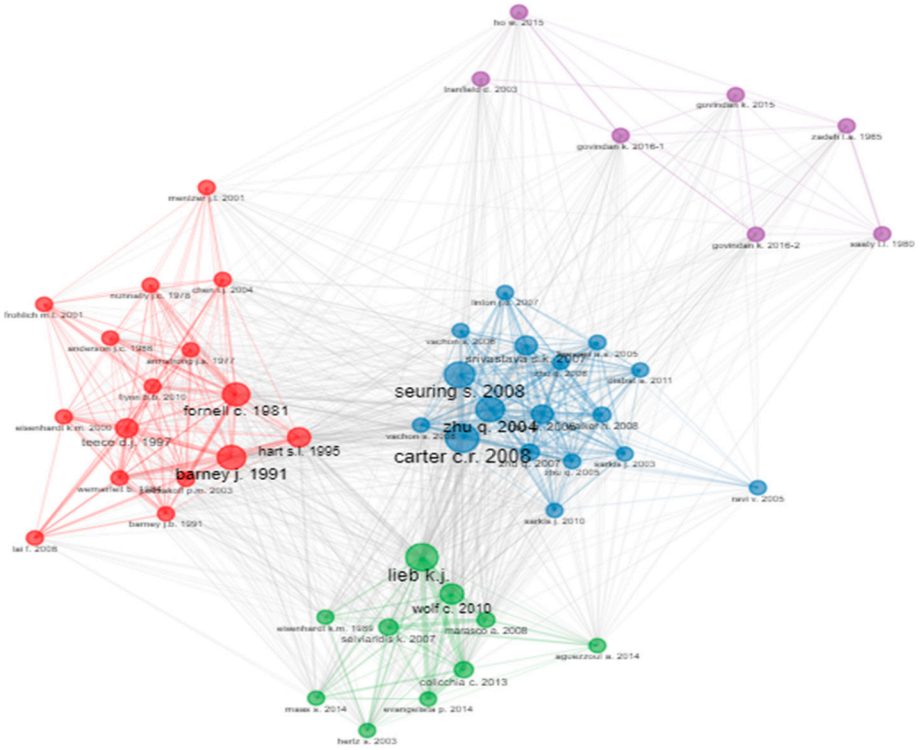

Figure 5. Co-citation analysis. Source: Own study based on SCOPUS.

4.2.2. Co-Word Analysis

Co-word analysis is a science mapping technique that uses the actual words in a published document to identify current themes and predict future research directions [49]. Words used in the key words, abstracts, titles and full texts of the published articles on technology and sustainability in logistics outsourcing were examined. Co-word analysis helps to identify the emerging themes that can predict the likely future research directions in the study area [49]. There are about 2233 words/set of words identified, whereby the highest frequent phrase is sustainable development, which is under the theme of sustainability. Similar words include environmental management, reverse logistics, green supply chain management, and environmental performance. The word frequency illustrates that the concept of sustainability has been addressed by research currently and into the future, given the importance of climate change awareness especially through the United Nations Sustainable Development Goals number 11 and 12, which allude to sustainability. Table 7 presents the top 100 most frequent words or sets of words extracted from the documents. Based on the word frequency, the concept of technology in logistics outsourcing

appears sparingly, implying that research in the area is emerging or in the initial stages. The critical technologies identified include decision support systems, electronic commerce, artificial intelligence, industry 4.0, technology adoption, and big data. The word frequency illustrated the methodology used in terms of research design and data analysis. The research designs include surveys and literature reviews, and the analysis techniques include hierarchical systems, structural equation modeling, factor analysis, integer programming, and dematel.

Table 7. Most frequent words.

S/No	Words	Occurrences	S/No	Words	Occurrences	S/No	Words	Occurrences
1	sustainable development	241	35	efficiency	26	68	industry	17
2	supply chains	227	36	hierarchical systems	26	69	analytical hierarchy process	16
3	supply chain management	187	37	india	26	70	carbon dioxide	16
4	decision making	145	38	information management	26	71	critical success factor	16
5	outsourcing	96	39	structural equation modeling	26	72	emerging economies	16
6	logistics	90	40	closed-loop supply chain	24	73	emission control	16
7	competition	70	41	innovation	24	74	environmental protection	16
8	environmental management	66	42	risk management	24	75	green supply chain management	16
9	manufacture	64	43	third party logistics providers	24	76	greenhouse gases	16
10	design/methodology/ approach	62	44	china	23	77	least squares approximations	16
11	sustainable supply chains	60	45	environmental performance	22	78	operational performance	16
12	literature reviews	53	46	pollution control	22	79	performance	16
13	costs	48	47	carbon	20	80	technology adoption	16
14	environmental impact	44	48	circular economy	20	81	game theory	15
15	freight transportation	44	49	competitive advantage	20	82	human resource management	15
16	reverse logistics	44	50	decision support systems	20	83	automotive industry	14
17	sensitivity analysis	44	51	environmental regulations	20	84	big data	14
18	sales	43	52	food supply	20	85	cleaner production	14
19	surveys	42	53	logistics services	20	86	climate change	14
20	commerce	41	54	optimization	20	87	cost benefit analysis	14
21	economic and social effects	40	55	planning	20	88	cost effectiveness	14
22	economics	40	56	ships	20	89	decision making trial and evaluation laboratories	14
23	developing countries	34	57	electronic commerce	19	90	factor analysis	14

Table 7. *Cont.*

S/No	Words	Occurrences	S/No	Words	Occurrences	S/No	Words	Occurrences
24	risk assessment	32	58	analytic hierarchy process	18	91	green manufacturing	14
25	systematic literature review	32	59	artificial intelligence	18	92	green supply chain	14
26	third party logistics	32	60	benchmarking	18	93	industrial economics	14
27	environmental sustainability	30	61	carbon footprint	18	94	industrial engineering	14
28	logistics service provider	30	62	freight transport	18	95	managerial implications	14
29	knowledge management	29	63	industry 4 0	18	96	manufacturing industries	14
30	industrial research	28	64	integration	18	97	multi-criteria decision making	14
31	integer programming	28	65	profitability	18	98	partial least square (pls)	14
32	managers	28	66	supply-chain integration	18	99	recycling	14
33	sustainability	28	67	third party logistics (3pl)	18	100	triple bottom line	14
34	dematel	26						

Word frequency analysis helps to visualize word growth over time. Word growth analysis represents the themes and leading concepts within the research area. The top 10 most frequent words were examined over time to establish their growth, as presented in Figure 6. The general trend observed reveals that many of the words or sets of words emerged in 2009 after the reign of "sustainable development" since 2001. After 2013 there was an exponential growth of the words (that is, "sustainable development," "supply chains," and "supply chain management") in terms of frequency. This is in line with the growth in published research in the field. Moderate growth can be witnessed in "decision making," "logistics," and "outsourcing." The words "competition," manufacture," and "environmental management" manifest the least growth, implying that the low research associated with logistics outsourcing focuses on competition. Research related to "decision making" in logistics outsourcing is current and growing; the research may be associated with technologies or decision-making IT capabilities required by LSPs to help make informed logistics related decisions.

4.2.3. Co-Occurrence Network

The co-occurrence network is visualized in Figure 7 The network shows the cluster/themes that co-occur and the link between the themes and the coverage or topics within a cluster [49]. Four clusters are identified based on the colour codes. The largest cluster is identified as sustainable development and covers sub-themes, including supply chain management and decision making. Some of the sub-themes in this cluster have few co-occurrences indicating that they might be emerging and be of great interest in the future. The likely emerging themes in this cluster include sustainability, sustainable supply chains, risk management, pollution control, circular economy, and knowledge management. A cluster carrying the theme of outsourcing is identified; the theme can be linked to logistics, which includes freight transportation. The outsourcing theme is explained by sub-themes, including efficiency, logistics service providers, and reverse logistics. As such, the sub-theme of reverse logistics, which is related to the closed-loop supply chain, is attracting research currently and more likely in the future. The likely perspective is how LSPs can arrange reverse logistics efficiently in a logistics outsourcing relationship. The third cluster is labeled manufacture, with a focus on environmental management; however, this theme is domi-

nated by contextual and methodological topics, but it remains important given that many of the LSPs are usually engaged by manufacturing or production firms. The fourth theme is related to competition, implying the objective of shippers to engage LSPs with relevant technology capabilities and sustainability records to acquire competitive advantages.

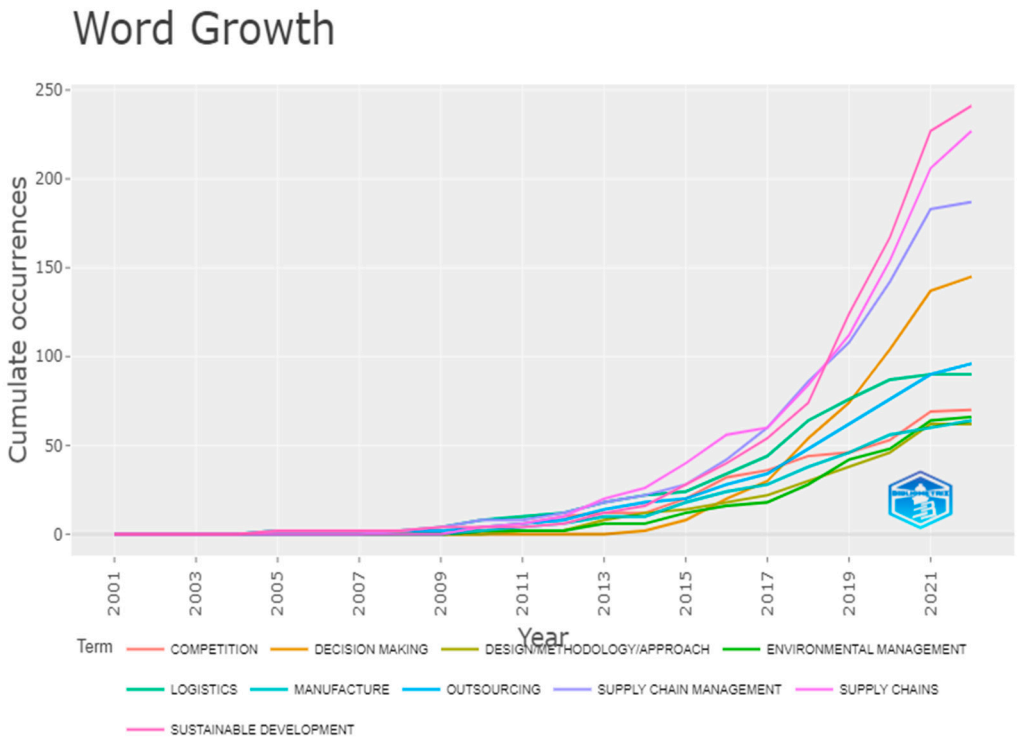

Figure 6. Word growth over time. Source: Own study based on SCOPUS.

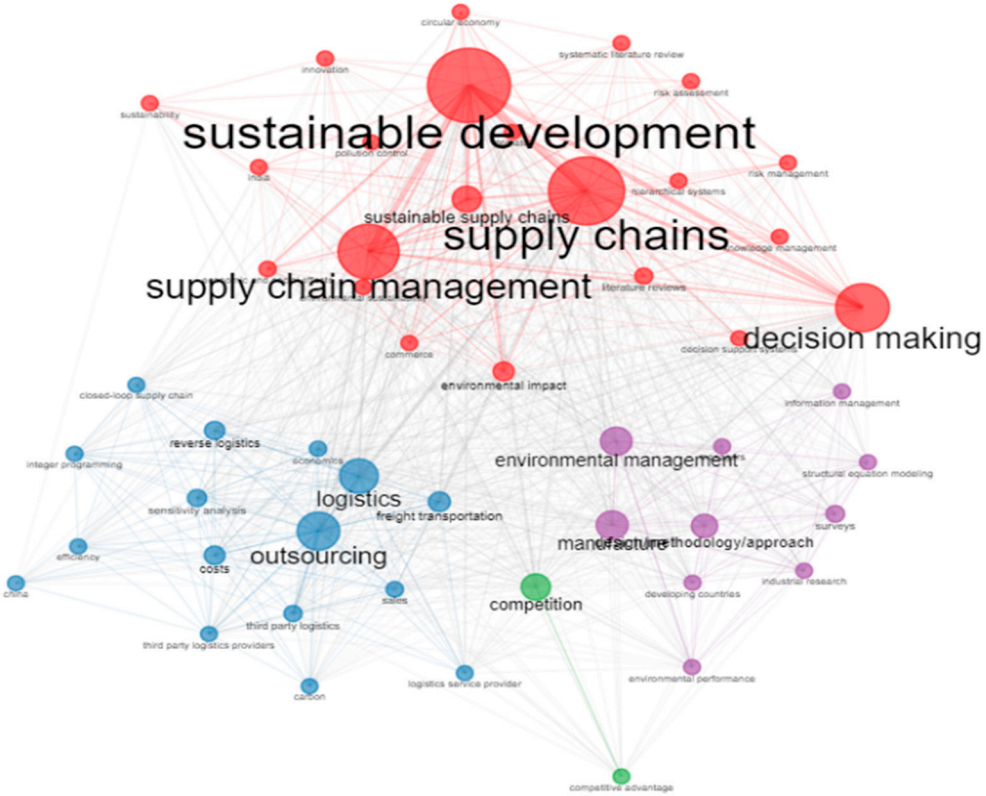

Figure 7. Keyword co-occurrence network. Source: Own study based on SCOPUS.

4.3. Emerging Themes and Trends

In a bibliometric analysis, the evolution of themes in a research field can be quantified and visualized using the statistics of keywords [55], also known as co-word analysis. Co-word analysis starts with identifying keywords or a set of keywords related to themes within the research area [55,56]. Each set of words can then be analysed based on their centrality and density. Centrality signifies the strength of the linkage between sets of words; stronger links mean that the theme is important to the research community [51]. High centrality implies that the theme is strategic to the research field and discipline. Density refers to the internal linkage of keywords and sets of words, thus highlighting the developmental nature of the themes within the research area [56]. Building on the foregoing discussion, the themes can be presented on a four-quadrant two-dimensional diagram with density and centrality on the vertical and horizontal axes, respectively (see Figure 8), to measure the degree of centrality and density [56]. The themes classified under quadrant 1 are principal motor themes that are highly developed and central. Quadrant 2 themes are basic and transversal; though central, they are less developed than those in quadrant 1. Quadrant 3 themes are developed but have low centrality. Quadrant 4 themes have low centrality and are undeveloped. They can be considered distant from the field of study, emerging, or declining themes.

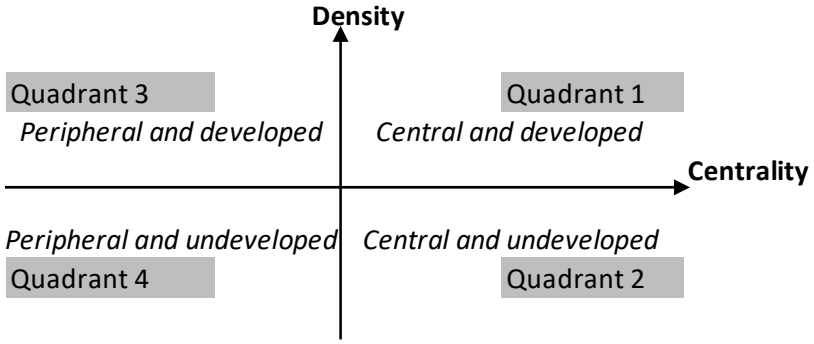

Figure 8. Strategic diagram showing degree of centrality and density of a theme (adapted from Ref. [56]).

4.3.1. Environmental Sustainability

Themes on technology and sustainability in logistics outsourcing were analysed between 2001 and 2022. The thematic map in Figure 9 shows the classification of main themes, with the labels being the most frequent words in that cluster and the size of the circle signifying the frequency [51]. Sustainability is identified as a motor theme with competition, environmental management, and manufacturing as the labels. Environmental management is one of the dimensions of sustainability [57]. The finding might imply that research on sustainability, especially from a manufacturing perspective, has matured. As such, environmental sustainability offers opportunities for developing competitiveness, especially in the manufacturing industry and more specifically through greening the supply chains as well as selecting LSPs that are environmentally conscious [58,59]. The theme of environmental sustainability, especially in logistics outsourcing, is developing with the emergence of alternative fuels in transportation, electric trucks, and advanced technologies that can improve efficiencies for competitiveness, as illustrated in the niche theme quadrant. There is sufficient evidence in prior literature [58,60,61] that the implementation of environmental sustainability initiatives, such as green packaging, high fuel efficiency engines, green energy, ISO 4001 certifications, GHG emission reduction targets, and internal environmental management system [36,62] in the logistics, can yield competitive advantages [63]. Environmental sustainability goals are now among the performance measures for top management and are part of corporate strategy [62]. Large customers of logistics firms have put pressure on them to adopt environmental sustainability initiatives to reduce costs and fit into their value chain. This implies that enterprises are already using

environmental sustainability as a selection criterion for LSPs. This is likely to carry more weight in the future as sustainability shifts from individual firms to supply chains [64].

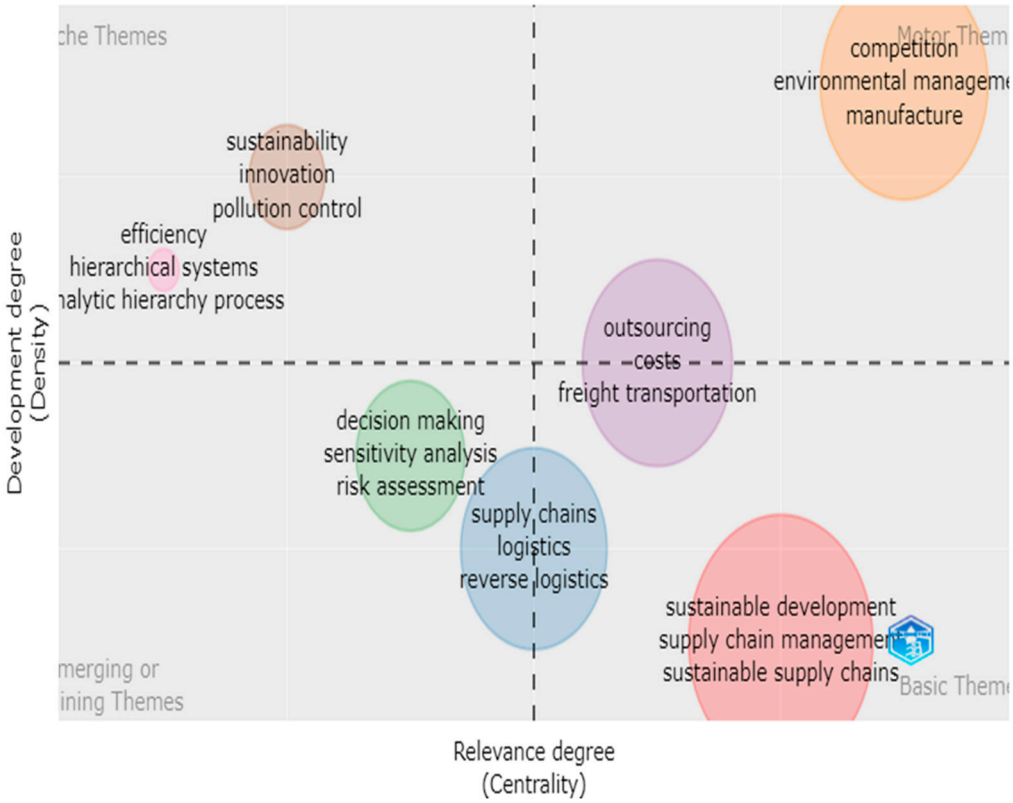

Figure 9. Thematic map of research on sustainability and technology in logistics outsourcing. Source: Own study based on SCOPUS.

4.3.2. Cost Reduction

The theme of cost reduction cuts across the basic and motor themes with high relevance and medium development as per the thematic mapping. The theme is labeled as outsourcing, costs, and freight transportation. The cost reduction theme is indeed under development, highly studied in third-party relationships, and identified as one of the reasons for logistics outsourcing [65]. The transportation of freight is one of the most outsourced logistics activities and one that offers the greatest potential for cost reduction when the operations are managed diligently [8]. To reduce logistics costs, enterprises make use of advanced technologies for route optimization, improved asset utilization, increased fuel efficiency, and real-time freight monitoring and information for timely decision-making. Therefore, logistics outsourcing offers an opportunity for enterprises to reduce their logistics costs by leveraging the expertise of LSPs, especially those with relevant advanced technologies. The cost reduction theme is current in the logistics industry and will continue to be discussed in the future due to its impact on the bottom line [8]. The cost reduction theme fits well within the larger theme of sustainability under the economic dimension, which advances the concept of improved profitability through the adoption of sustainability initiatives [66]. Therefore, logistics practitioners are guided to acquire logistics capabilities through logistics outsourcing to improve their profitability; however, LSPs should be selected based on the ability to develop efficient logistics operations.

4.3.3. Sustainable Supply Chains

The "sustainable supply chain" theme is classified as secondary, undeveloped, but very relevant in the study area. In this cluster, sustainable development refers to environmental management, including returns management and reverse logistics [23]. Thus, firms are required to develop elaborate reverse logistics capabilities to meet various government

policies and environmental laws. Compliance, especially with environmental policies, requires advanced technologies and methodologies, which some firms, even the large ones, cannot cope with given the rapid changes in logistics technologies in the era of industry 4.0 as well as dynamic government policies. As such, firms opt to outsource their logistics functions to LSPs to maintain and increase their competitiveness and be compliant [4]. In the context of sustainable development, LSPs are expected to design a green logistics network across the whole supply chain, which would lead to sustainable supply chain management.

Based on the sustainable supply chain theme, LSPs should focus on social and environmental aspects as they are pursuing the economic goals of profitability, especially in improving resource utilization and efficiencies. LSPs are expected to comply with regulatory measures related to sustainability to meet the selection criteria of shippers [24]. This theme is also related to life cycle analysis (LCA), which requires shippers to do an internal as well as external assessment of their activities and determine which functions can be performed in-house and which ones to be outsourced to LSPs in the context of sustainability. With the right help from LSPs, shippers can achieve sustainability objectives faster than developing the capabilities in-house [24]. Thus, ref. [4] calls for elaborate multiple selection criteria that assess the individual LSP and its entire logistics network to ensure the attainment of sustainable supply chain goals of shippers [67].

4.3.4. Information Technology and Innovation

The theme of technology and innovation was identified as developed but with low relevance within the research area, thus a niche theme (Figure 9). While the technology may be classified as peripheral or niche within the research area, ref. [8] argued that the enterprises in the contemporary logistics outsourcing market require LSPs who have some level of information technology capabilities. As such, LSPs are accelerating the adoption and development of advanced information technology capabilities for efficiency and competitiveness. The application of legacy hierarchical analytical systems in sustainability and logistics outsourcing research [32,33,68,69] for cost reduction and customer service improvement in logistics has received considerable attention from researchers. However, the current trend in terms of innovation requires the same techniques to be used to select LSPs with sustainability and information technology capabilities to achieve the expected efficiencies. More research is required to identify innovative technologies that can be applied to reduce pollution, especially from transportation vehicles, and develop the required efficiencies while still operating with sustainability goals [66]. The application of hierarchical analytical techniques may signal the likely application of big data analytics to provide sustainable solutions within logistics outsourcing engagements [8].

4.3.5. Risk Management

The theme of risk management was also identified as emerging or declining. Risk management refers to the ability to quantify any peril within the business and take cover through risk transfer or prepare adequately to reduce its effects. Risks occur due to the uncertainty in the business environment in terms of supply, demand, price, and cost [70]. Outsourcing enterprises generally transfer the risks associated with the management of logistics activities to LSPs due to their expertise in managing logistics activities. However, logistics outsourcing or the use of LSPs also creates another risk [71]. As such, outsourcing firms use elaborate criteria to select the right LSPs who have the capabilities to minimise disruptions in their logistics network [25]. Risk management is an emerging theme in logistics outsourcing and is likely to develop further with the increased use of LSPs. Timely decision-making between LSPs and shippers can be achieved only when there is a strong relationship built on trust and cooperation as well as the use of relevant technologies to share information. The timely sharing of information is likely to reduce the risk of disruptions as well as relationship risk within the logistics outsourcing contract. The use of advanced technologies will also improve the quality of decision-making through sensitivity

analysis, which would lead to better risk management. Logistics practitioners are likely to select LSPs who have risk management capabilities as well as technologies to sense, detect, and respond to likely disruptions.

4.3.6. Reverse Logistics

The theme of reverse logistics is in between quadrants 4 and 2. Based on the research area, the theme is under transition to quadrant 2 given its relevance to sustainability. Research on reverse logistics is currently evolving due to the environmental consciousness and the potential benefits of sustainability in the contemporary business environment [37]. Firms are under pressure to develop an elaborate reverse logistics system that can support the efficient flow of goods from consumption to origin for repair, reuse, recycling, and proper disposal activities [23,37]. Many enterprises find it challenging to develop a functional reverse logistics system due to the huge capital, technology and expertise required. Thus, they outsource reverse logistics to LSPs, which have developed the capabilities over time and can generate enough volume to minimise cost [23]. The reverse logistics theme is currently on issues related to adoption and outsourcing to manage product returns as well as to achieve sustainable development goals [37]. The drivers of reverse logistics over time include economic, regulatory requirements, environmental protection, competitiveness, and proper management of returns to retain value [20,37]. Reverse logistics is more complex compared to forward logistics in terms of planning, transportation, order fulfillment, packaging, and cost management [20]. Nevertheless, it plays a key role in completing the product life cycle by reducing waste. Reverse logistics implementation results in environmental protection by selecting biodegradable packaging materials, enabling reuse, recycling, and remanufacture [20]. Future research in logistics outsourcing is likely to focus on reverse logistics, given its central role in promoting sustainability across supply chains.

5. Discussion and Conclusions

The objectives of this paper were to identify the elements of logistics outsourcing from the literature and to establish the trends in sustainability and technology in logistics outsourcing research. It is observed that research on logistics outsourcing has received attention in literature over the years and is growing, given the number of past and recent publications. The interest in logistics outsourcing research indicates how important the sector is to shippers, especially from a sustainability perspective and as a way of organizing the movement of goods in an efficient manner across supply chains, as also claimed by [72]. However, limited studies have tried to identify the common elements of logistics outsourcing from a technology and sustainability perspective. In this paper, the main elements of logistics outsourcing engagements are identified as (1) relationship management, which is based on trust, cooperation, and information sharing [9]; and (2) LSP selection criteria, which ensure that the most efficient service provider is selected from a shipper's perspective. Prior researchers have advocated for an electronic multi-criteria selection process. Prior research shows that shippers outsource logistics services to LSPs with relevant IT capabilities to allow for the integration of processes [73]. In addition, [3] claimed that LSPs are pursuing sustainability goals. Based on the published research, the likely future trend is that shippers might be forced to consider LSPs with both a sustainability record and expertise in applying advanced technologies. (3) Reverse logistics capabilities regarding returns management, repair, reuse, recycling, and proper disposal are important aspects when selecting LSPs to handle logistics functions. This is because firms can have efficient and effective forward logistics but struggle with reverse logistics; as such, LSPs with reverse logistics capability are desirable among shippers, as also claimed by [42]. (4) Contract management is an important aspect of logistics outsourcing. LSPs and shippers should have common goals and aim for 'win-win' contractual agreements. There should be a clear conflict resolution mechanism and service level agreements that protect common interests. In the future, there is a likelihood of using automated smart contracts to improve contract management; this is because some shippers might have multiple LSPs in each of the lo-

gistics activities, as argued [73], making contract management a daunting task. As such, contract management is a critical aspect of logistics outsourcing. (5) The in-house versus outsourcing mix is a critical issue in logistics outsourcing. Shippers should ensure that they outsource to the extent that they benefit from outsourcing without losing touch with their customers. As such, ref. [23] argued that to achieve sustainability goals and benefit from the IT capabilities of LSPs, shippers should embrace the outsourcing of logistics functions. The most gains can come from outsourcing transportation and transportation planning, warehousing, order fulfillment, IT, and clearing and forwarding. The logistics outsourcing trend is likely to persist into the future due to environmental compliance legislation and the difficulty in developing logistics competencies to maintain competitiveness. While the identified five elements might not be an exhaustive list of the logistics outsourcing elements, it offers a guide to logistics practitioners to ensure that the elements are taken into consideration to ensure the most benefit to the shipper and reduce the likely pitfall of logistics outsourcing. The identification of these elements also ignites a debate on the importance of sustainability and technology-related capabilities in logistics outsourcing.

The second objective of this study was to establish the trend of logistics outsourcing research from a sustainability and technology lens. The co-citation analysis helped to map the past research in logistics outsourcing based on the search criteria described earlier. Prior research focused on three main areas that are sustainable supply chain management led by [58], logistics outsourcing [30], green supply chain management, and reverse logistics [74,75], and foundational knowledge theories, especially the resource-based theory and quantitative research methods that have dominated logistics outsourcing research. It is notable that studies where technology and sustainability are investigated as important aspects of logistics outsourcing are limited.

Sustainability in logistics and supply chain management research picked pace at the beginning of the 21st Century, with sustainable development as the main theme. In 2009, it picked up more pace, and it has grown exponentially up to the present moment due to the increased awareness of climate change and the potential benefits of reducing GHG emissions in the transportation of goods. However, the research focused more on the sustainability of supply chains and not logistics outsourcing. Some of the focus areas were environmental management and certifications such as the ISO 14001, developing frameworks for sustainable supply chains, and integrating sustainability in organizational goals [58,66]. In the recent past, the research focus has been shifting towards integrating sustainability with firm-specific processes; thus, the focus areas are recycling, remanufacture, closed-loop supply chain, reverse logistics, carbo neutral initiatives, circular economy, innovation, pollution control, efficiency, environmental laws, and application of advanced technologies to minimize emissions to the environment [76,77]. With increased environmental awareness, compliance legislation and the adoption of logistics outsourcing, the shift is now towards contracting LSPs that have a sustainability capability across the entire supply chain. Therefore, future research in this area is likely to focus on LSPs' implementation of environmental, social, and governance (ESG) aspects within their networks. Research on the application of advanced technologies such as machine learning to improve environmental performance is likely to be the future research direction.

Past research on technology in logistics outsourcing has not received much attention as expected. Notable research focused on decision support systems, especially in sustainable development. However, the increased advancements in information technologies and their central role in improving processes within the logistics sector are likely to encourage researchers to focus on this theme. Current research focuses on technologies such as transport management systems for cost savings, route optimization, and increased asset utilization. Other technologies examined in the literature include visibility technologies such as track and trace, enterprise systems, inventory management systems, as well as warehouse management systems. Future trends are likely to include real-time big data analytics for quick decision-making use of cloud computing services such as supply chain as a service and logistics as a service for real-time information sharing. IoT and machine

learning to improve planning and predictions are likely to be implemented within logistics in the future.

Managerial Implications

Practitioners are informed that there should be a proper contract management process in a logistics outsourcing engagement to ensure a 'win-win'; LSP selection criteria should be enriched with reverse logistics, sustainability, and technology capabilities. Practitioners are advised that shippers should endeavour to develop a strong relationship with their LSPs based on trust and cooperation to benefit fully from logistics outsourcing. It is also important that logistics outsourcing be balanced so that shippers do not lose control of the quality of service offered to their customers. Ensuring technology, reverse logistics, and sustainability capabilities in logistics outsourcing will likely promote efficiency, effectiveness, circular economy goals, and compliance with environmental laws by LSPs and shippers.

The research was limited to a bibliometric analysis and review of documents obtained from the SCOPUS database, focusing on technology and sustainability in logistics outsourcing. An empirical study can be conducted to model and predict future trends in technology and sustainability in logistics outsourcing. The themes identified include environmental sustainability, cost reduction, sustainable supply chains, information technology and innovation, risk management, and reverse logistics. These themes are likely to lead future research on technology and sustainability in logistics outsourcing, and it may add value to investigating their importance to shippers and LSPs empirically.

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