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Review

Supply chain and logistics in smart cities: A systematic literature review

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Abstract: Rapid urban expansion gives rise to smart cities which pose immense logistical and supply chain challenges. The COVID-19 pandemic transformed the holistic system identified by Zhao et al. in 2021. The system encompasses logistics and supply chain integral to the concept of smart cities, with a focus on sustainability. This transformation requires an in-depth study on challenges of a common framework of policies for smart cities in countries comprising the Organisation for Economic Cooperation and Development (OECD). The study employs an extensive literature analysis for the period 2020–2022. an approach which contextualizes the model. The model identifies the causes, impact, and spillovers of new trends in logistics and supply, including the sustainability of adopted technologies. The study includes the variables involved, and barriers to creating a shared model. The results reveal that the two elements affecting the supply chain and transport in smart cities are Industry 4.0 and 5.0 technologies supporting specific sectors. The resilience of small and medium-sized enterprises positively impacts the sustainability of large urban centres. The study presents both factors that help and hinder the adoption of environmental, social, and economic sustainability technologies.

Keywords: smart city; supply chain; logistics; systematic literature review; sustainability; smart city ecosystem; COVID-19; OECD

1. Introduction

Since 1990, research into the characteristics and configuration of cities has increased as evidenced by multidisciplinary studies more than doubling since 2009 (Bresciani et al., 2018; Ojo and Adebayo, 2017). The progressive increase in city inhabitants has prompted politicians, managers, and scholars to focus on strategies and approaches to manage rapid urbanisation and demographic changes while monitoring environmental changes, economic reform and restructuring, and digital technology disruptions (Tompson, 2017). This phenomenon gave rise to the term ‘smart city’, which includes economic growth, social development through technological innovation, and collaboration among various actors (Brescia, 2020; Sarma and Sunny, 2017). Presently, 56% of the world’s population lives in urban centres and 7 out of 10 people will live in urban centres at October 2022 (World Bank, 2022). Problems related to smart cities and urban logistics primarily influence the clusters from their inception (Winkowska et al., 2019). In the first inertial phase, congestion, traffic flow management, and autonomous vehicles define the main sub-classes related to the logistics and supply chain of smart cities.

Zhao et al. (2021) provided an integrated view of supply chain and logistics in smart cities, however, short of a comprehensive analysis the identification of related variables and characteristics were deferred to future research. An OECD analysis published in 2020 measured the progress of smart cities without considering the change caused by the effects of the global crisis. A SWOT analysis identified shortcomings from a common legislative framework, territorial division, supportive infrastructure deficits, and defective human skills perspectives (OECD, 2020). A strategic sector identified in OECD countries in 2020 related to the supply chain concerns was food, a focal theme at the time when the COVID-19 pandemic impacted normal approaches to the management and procurement of resources (Campra et al., 2020; Donthu and Gustafsson, 2020; Rahman et al., 2022). The COVID-19 pandemic affected everything associated with the supply chain, including health and safety, workforce, cash flow, consumer demand, sales, and marketing. The pandemic prompted solutions to the production difficulties during lockdown periods, understanding demand for transportation and consumer needs through demand trends and fluctuating prices. Even recommendations of practical adoption in states with integrated economies are fragmented and require full attention to supply chain and logistics implemented in smart cities and different sectors. Indeed, this theme is relevant and requires more analysis regarding future studies related to system architecture and emerging trends (Haque et al., 2022). A smart city model appeared exceptionally resilient in managing the COVID-19 pandemic (Chu et al., 2021). Traditional l models have spurred debate on the characteristics and approaches that smart city should adopt for future development (Sharifi, 2021). The Covid-19 pandemic impacted ordinary supply chain management in various sectors, changing the current model (Acar et al., 2022; Delbufalo, 2022; Dohale et al., 2021; Küffner et al., 2022; Sawyerr and Harrison, 2022; van Hoek et al., 2022). COVID-19 affected the supply chain process in small domestic companies more than in large multinational companies (Acar et al., 2022). Furthermore, during the pandemic, distribution was affected due to the wide dispersion of suppliers (Delbufalo, 2022), and a relative impact was observed in the following sectors; pharmaceuticals, food, electronics, and automotive industry, which were affected more than others by restrictions and problems related to the supply chain and transport (Campra et al., 2020; Xu et al., 2020). Furthermore, transport and logistics in smart cities, coupled with technologies, and the impact on environmental, social, and economic sustainability, point to a gap between theory and practice (Shee et al., 2021). The gap is more prominent in the policies of the OECD countries that have mapped their smart cities. In BRICS countries (Brazil, Russia, India, China, and South Africa) up to 2022, a policy was formulated for the development of technologies and approaches to mitigate supply at a regional level to improve local resilience through sustainability expressed using the Sustainable Development Goals specifically for infrastructural development (BRICS, 2020). The essential elements for modernizing infrastructure in BRICS identified strategies for comprehensive efforts to upgrade industrial, transport, and logistical systems by 2025. Key goals include promoting inter-operability for improved air, land, and sea connectivity, establishing resilient transnational transport and logistics networks, and fostering the use of advanced technologies in urban and rural areas. Emphasis is to be placed on efficient city transport systems, digitalization, and the exchange of information on transport policies. The initiative also seeks to achieve sustainable development in both urban and rural areas, encouraging the development of smart cities within the BRICS nations. Overall, these objectives aim to create a robust and interconnected infrastructure framework, fostering economic development and technological advancement (Alexandro and Basrowi, 2024; Barykin et al., 2021). While the experiments have become basic policies in the BRICS countries, the diversification and development of unitary policies that consider environmental, social, and economic development aspects are not systematized in the OECD countries.

This study is part of the debate on developing common models and policies oriented towards sustainability (Fatima and Elbanna, 2022) in smart cities adopting digital and non-digital approaches (Chivite Cebolla et al., 2021; Jabeen et al., 2023).

This study investigates the concept and approaches to supply chain and logistics in smart cities adopting in OECD countries through a systematic literature review (SLR). The literature analysis is based on an approach involving a contextualised explanation (Durach et al., 2021) by increasing and deepening the initial definition of the supply chain, logistics and smart cities. This study helps to define the model to be adopted to develop logistics and supply chains within smart cities. Zhao et al. (2021) identified a holistic smart city system by defining supply chain and logistics as one of six focal areas that should be studied and developed. In addition to the supply chain element, the Smart City as a holistic ecosystem includes several critical components that together contribute to its comprehensive and integrated approach. These elements include planning and governance, technology diffusion, strategy and implementation, evaluation and measurement, and entrepreneurship and innovation. Planning and governance in smart cities involve the application of advanced technologies to enhance urban management and planning. This facilitates smarter governance practices where data and technology-driven insights help streamline municipal operations and engage citizens actively in governance processes. Technology diffusion is central to the development of smart cities, emphasizing the integration and utilization of innovative digital solutions across various city functions. This includes deploying IoT devices, sensors, and communication networks that support connectivity and improve the efficiency of city services and infrastructure. Strategy and implementation focus on applying smart technologies to achieve sustainable urban development. This involves strategic planning and execution that not only incorporates technological innovations but also ensures they are sustainably integrated into the city’s fabric to enhance living conditions and operational efficiency. Evaluation and measurement are crucial for assessing the effectiveness of smart city initiatives. This component involves developing and implementing frameworks and indicators to measure the performance of smart technologies and strategies in improving urban environments and the quality of life for residents. Entrepreneurship and innovation drive the economic growth and social welfare aspects of smart cities. By fostering an environment that supports creative ideas and technological advancements, smart cities enhance job creation, promote social inclusion, and encourage the development of new businesses and services that contribute to overall city efficiency and resident satisfaction. Together, these elements form a cohesive framework that defines a smart city, ensuring that technological advancements are balanced with strategic planning, governance, and continuous evaluation to create a sustainable, efficient, and innovative urban ecosystem.

The theme of the supply chain and logistics associated with the technologies adopted integrates with the other pillars but also has significant implications on the ethical and, therefore, social theme (Francisco and Swanson, 2018; Manning et al., 2023; Shamout et al., 2022).

Our study integrated this initial proposed framework, identifying supporting technologies and approaches and investigating the connexion and impact of sustainability. This study identified tools, technologies, positive and negative impacts, sectors involved, and barriers to creating a shared model of logistics and supply chain to apply in smart cities in OECD countries and develop a common ecosystem. The study provides practical contributions to guide investments and the adoption of new technologies and managerial approaches in smart cities (Brescia et al., 2023; Chia et al., 2020; Singhania and Swami, 2023).

1.1. Definition of the supply chain and logistics in smart cities

Zhao et al. (2021) defined the state of smart cities and their holistic characteristics; the ecosystem generated includes planning and governance, technology diffusion, strategy implementation, evaluation and measurement, entrepreneurship and innovation, supply chain and logistics. The supply chain and logistics aspects are the characteristic elements of the analysis. The literature analysis based on 2* ABS-2018 journal ranking list identified ten articles that characterised the smart city supply chain and logistics concept. These common themes which relate to smart cities, big data, and the supply network, could increase their effectiveness (Öberg and Graham, 2016), or potential for open data systems that address the difficulties of public and private mobility while supporting supply chain (Garau et al., 2016). However, the positive aspects associated with the use of technologies in smart cities are also aspects of the supply chain that increase its complexity, costs, and vulnerability to the market (Martinez and Viegas, 2017). Complexity is generated by particular attention to emerging ethical, cultural, political, financial, and economic factors (Solano et al., 2017).

Sustainability may be an opportunity, but the relationship and balance between smart cities and supply chains should be comprehensively measured in terms of entrepreneurship. The difficulty sharing information between policymakers and businesses regarding intellectual property is obvious (Peris-Ortiz et al., 2017). The study emphasized that all smart cities should have an efficient and reliable transport system (Yan et al., 2020). The smart city ecosystem identified innovative distribution approaches, such as aerial vehicles (UAVs) for supply chain thereby reducing traffic congestion to increase efficiency. The logistics system in smart cities depends on data collection, analysis, and functional systematic approaches (Ruhlandt et al., 2020), which are supported by the use of big data for the supply chain (Rathore et al., 2016). However, scholars have highlighted the need to develop an integrated and shared framework with practitioners in smart cities (Öberg and Graham, 2016) to effectively identify the shift from a management perspective to a technology-based decision-making approach (Qi and Shen, 2019). The latter is particularly relevant and has been confirmed in the recent literature (Secinaro et al., 2022).

Logistics and the supply chain in smart cities is a particularly relevant topic, necessitating a structured analysis of the literature requires definition and resolution of the conflicting elements in the holistic vision of smart cities. Furthermore, Zhao et al.'s (2021) analysis is partial, given the challenges and the need for new approaches driven by the COVID-19 pandemic. The effect of the pandemic included the destruction of models and approaches of the supply chain, thereby impacting the delivery and collection system of food, medicine, consumption preferences, delivery times, and disposal of food waste aimed at reducing infections (Veselovská, 2020). While initially destructive, in the long term, the COVID-19 pandemic resulted in an improvement of models and approaches similar to the supply chain system managed by the local government and companies after the Fukushima Daiichi nuclear power plant disaster (Vardon et al., 2019; Veselovská, 2020). The COVID-19 pandemic led to a social and technological transformation that shaped supply chain models, although the level of sustainability needs to be clarified (Sarkis, 2020). The analysis of the supply chain in smart cities is part of studies that define the vision of smart city 2.0, that is, studies oriented towards the diffusion of technologies and the economic and corporate aspects associated with smart city projects (Trencher, 2019). **Table 1** summarizes the main variables on the smart city supply chain and logistics.

Table 1. Main studies on Smart city supply chain and logistics.

Main elements	Source
Big data and supply network	(Öberg and Graham, 2016)
Open data system	(Garau et al., 2016)
complexity, costs, and vulnerability at the market	(Martinez and Viegas, 2017)
the new ethics, cultural, political, financial, and economic approaches	(Escamilla Solano et al., 2017)
Difficulties to share intellectual property between policymakers and businesses	(Peris-Ortiz et al., 2017)
Efficient and reliable transport system.	(Yan et al., 2020)
Innovative distribution and use of aerial vehicles (UAVs)	(Mohamed et al., 2020)
The logistics system is based on data collection, analysis and functional systematic approaches	(Ruhlandt et al., 2020)
Positive effect of big data	(Rathore et al., 2016)
No operational management, more decision-making approach technology-based	(Qi and Shen, 2019)

1.2. Logistics and sustainability in smart cities

Smart cities are identified as complex organisms capable of supporting sustainability, economic growth, and social and environmental issues (Law and Lynch, 2019). Supply chains and transport affect smart cities and are the theoretical and practical pillars influencing infrastructure, energy, health, and education (Lee et al., 2014). Shee et al. (2021) identified the specific technologies associated with sustainability that affect the three dimensions of sustainability. Economic sustainability (production, entrepreneurship, and labour market), environmental sustainability (mobility and natural resources), and social sustainability (social and plurality, participation and creativity, and quality of life). Kirch et al. (2017), Jabeur et al. (2017), Taboada and Shee (2020), and Uckelmann (2008) identified the main technologies with an impact on sustainability. Barcodes, RFID, wireless sensors, and retina scanners support the accurate identification of all elements in the supply chain process. The global positioning system (GPS) guarantees the localization of services, which uses a satellite navigator and tracks the localization of objects and people in real time. IoT sensors (cooling unit, missing parts, vehicle brake) monitor the general conditions of vehicles and the status of products. The 4G and 5G networks guarantee connectivity, which supports IoT and allows the connection and collection of data through the cloud. GPS provides visibility and traceability of vehicles and goods. The IoT wireless sensors allow the impact on the environment (e.g., temperature and pollution) to be measured granularly; the same technologies associated with automation are used to make some functions autonomous. Therefore, IoT and sensors also increase transport safety (especially environmental toxicity for loads) and reliability. Enterprise resource planning (ERP) and management systems are integrated with the warehouse management system (WMS) to analyse and support the business.

2. Materials and methods

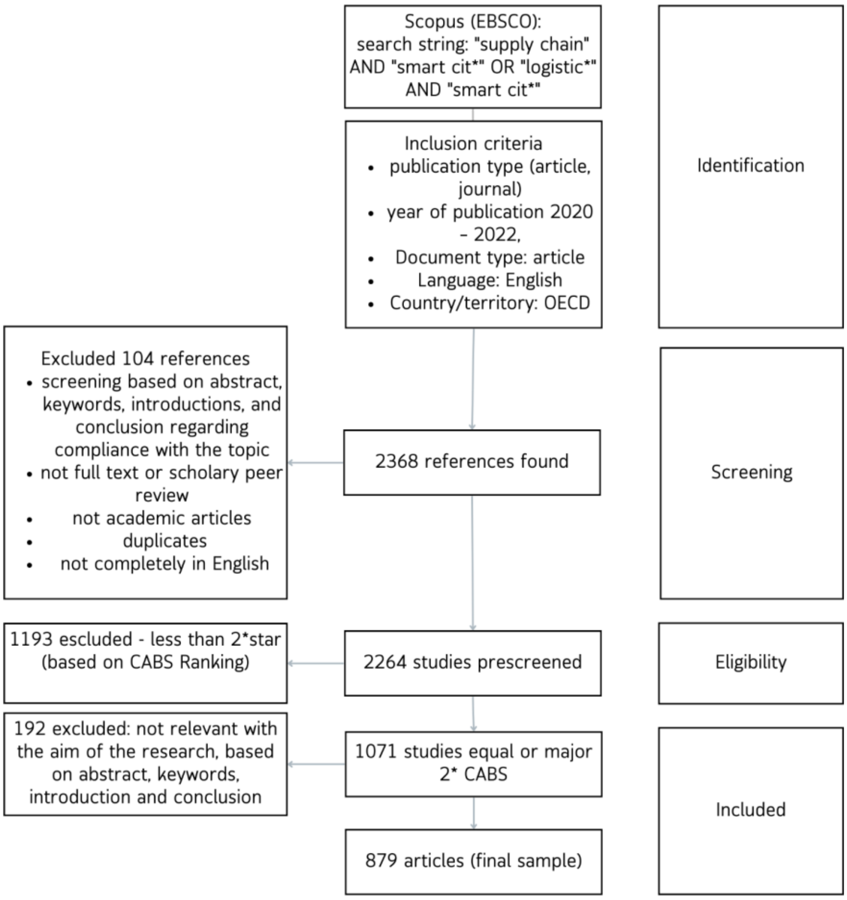

Figure 1. Search strategy.

The study adopts an SLR, a contextual explanation (Durach et al., 2021), to identify, summarise, criticise, understand, and integrate conceptualisations and new constructs on logistics and supply chain in smart cities (Battisti et al., 2021; Durach et al., 2017, 2021; Wong et al., 2015). SLR provides a rigorous approach that can be replicated to help identify missing and current information and integrate them (Tachizawa and Wong, 2014; Vrontis et al., 2021; Vrontis and Christofi, 2021). In particular, the SLR method has been used to investigate the concept of supply chain and logistics within smart cities, starting from the holistic definition of the ecosystem offered by Zhao et al. (2021). This study focuses on OECD countries where the analysis revealed insufficient knowledge. Therefore, a conceptualisation in developed countries with shared democratic values, and market economy is required (OCSE, 2022; OECD, 2020).

This study deepens the existing holistic system by investigating causal mechanisms based on theoretical aspects while integrating Zhao et al.'s model (2022). The assumptions are based on contextualizing the sectors, tools and adoption methods based on casual mechanisms (Miller and Tsang, 2011).

As suggested by Denyer (2009) and Legorio et al. (2016) and adopted by He (2020), the analysis is divided into five steps (Denyer and Tranfield, 2009; He, 2020; Lagorio et al., 2016) (see **Figure 1**).

Step 1. Research question and delineation of scope: Proper development of an SRL begins with the definition of the research question (Nguyen et al., 2018). Based on the literature review, the authors propose the following:

What characteristics and impacts on sustainability have transport and the supply chain suffered following the COVID-19 pandemic in smart cities?

This question includes approaches and changes while considering the impact of the pandemic on previous models, technologies adopted, and sectors examined.

Step 2. Keywords and sample selection: Keywords are selected in accordance with Step 1, and in line with Zhao et al.'s (2021) conceptualisation. The keywords and Boolean operators respond to the following formula: ("supply chain" AND "smart city*" OR "logistic*" AND "smart city*"). The Scopus database is used as the source of the articles because of its compatibility with Business Source Complete (EBSCO). Scopus collects the same articles as EBSCO. We consider only academic journals and articles in English. The research was limited to studies from the beginning of the COVID-19 pandemic in 2020, to when the conceptualisation of smart cities was first made public. Only sources from OECD countries were selected. Keyword combinations identified 2368 possibilities for relevant articles related to supply chain and logistics in smart cities. The total, excluding duplicates and all non-OECD sources, was 2359. To ensure the quality of the sample and its selection, only high-quality peer-reviewed articles are selected, using the Chartered Association of Business School (ABS) journal ranking as a benchmark for journal quality (the same approach used by Zhao et al. (2020)). The Association of Business Schools (ABS) classifies leading journals into seven recognized social, economic, and statistical areas with policy implications and management analysis of technologies. The analysis based on this classification is homogeneous and accommodates as Zhao et al. (2020) approach and defines a significant sample. Selecting items rated 2* ABS or higher denotes acceptable standard magazines (AJC, 2021). ABS journals included in the Chartered Association of Business Schools (ABS) journal ranking are of the highest calibre and publish only original, high-quality research; the higher the number of stars, the better the originality and quality (Bhukya et al., 2022). Previous studies have shown that journals from 2* ABS provide consistent information for building consistent literature analyses (Dal Mas et al., 2019; Goodell et al., 2023). Articles from journals with a score of two or more stars out of four on the ABS-2021 journal ranking list were initially selected, resulting in 1071 selections.

Steps 3 and 4. Reading titles and abstracts: We read the abstract, keywords, introductions, and conclusion to determine whether to include or exclude the sources identified on the basis of the research objectives. When the contents were unclear from the abstract, the entire article was read. In total, 192 articles were excluded, after which the remaining 879 were analysed. The large number of sources justifies a quantitative bibliometric approach to support the analysis as it allows researchers to focus on the topic (Centobelli et al., 2020; Secinaro et al., 2022).

Step 5. Bibliometrics analysis and research framework: The analytical approach supports the main topic and elements and defines the related literature through analytical keys, consistent with He (2020). The researcher used the R package bibliometric developed by Aria and Cucurullo (2017) to execute a descriptive bibliometric analysis, constructing a matrix that encompasses all pertinent documents. In addition, we used Biblioshiny for creating a map and SLR, following the approach of Secinaro et al. (2022) and Nicolò et al. (2023). The process of coding the articles assigned through Biblioshiny on the basis of the thematic map and the dendrogram. Coding activity was recorded in an Excel file to facilitate subsequent analysis. The two authors conducted a final check to reach consensus on the subcategories assigned to the articles, and thus eliminating the need for formal reliability checking, as in Manes-Rossi et al. (2020).

3. Results and analysis

3.1. Descriptive analysis

Table 2. Twenty major journals included in the studies by weight (%).

Sources	No. Of Articles	Weight (%)
Technological Forecasting and Social Change	56	6.4
Journal of Cleaner Production	49	5.6
Journal of Business Research	23	2.6
Computers and Industrial Engineering	19	2.2
International Journal of Information Management	19	2.2
Cities	13	1.5
Production Planning and Control	12	1.4
Government Information Quarterly	11	1.3
Industrial Marketing Management	11	1.3
International Journal of Production Research	11	1.3
International Journal of Production Economics	10	1.1
Transportation Research Part E: Logistics and Transportation Review	10	1.1
Business Strategy and The Environment	9	1.0
Journal of Enterprise Information Management	8	0.9
Business Process Management Journal	7	0.8
European Journal of operational Research	6	0.7
Information Processing and Management	6	0.7
Systems Research and Behavioral Science	6	0.7
Information and Management	5	0.6
Journal of Management in Engineering	5	0.6

The analysis of the selected articles identified research patterns, characteristics, and central elements of the supply chain and logistics in OECD countries attributable to the COVID-19 pandemic.

The content and scope of supply chain and logistics in smart cities is multidisciplinary. The main publications are oriented not only to strictly legal aspects of logistics and production (International Journal of Production Research, Transportation Research Part E: Logistics, and Transportation Review) but also to journals dealing with the adoption of technologies, sustainability, management, decision-making, and marketing (Technological Forecasting and Social Change, Journal of Cleaner Production, Journal of Business Research, Production Planning and Control, and Government Information Quarterly), as shown in **Table 2**. **Figure 2** shows the dynamic trend of the top ten publications, highlighting the increased attention to the supply chain and smart cities from 2020 to 2022.

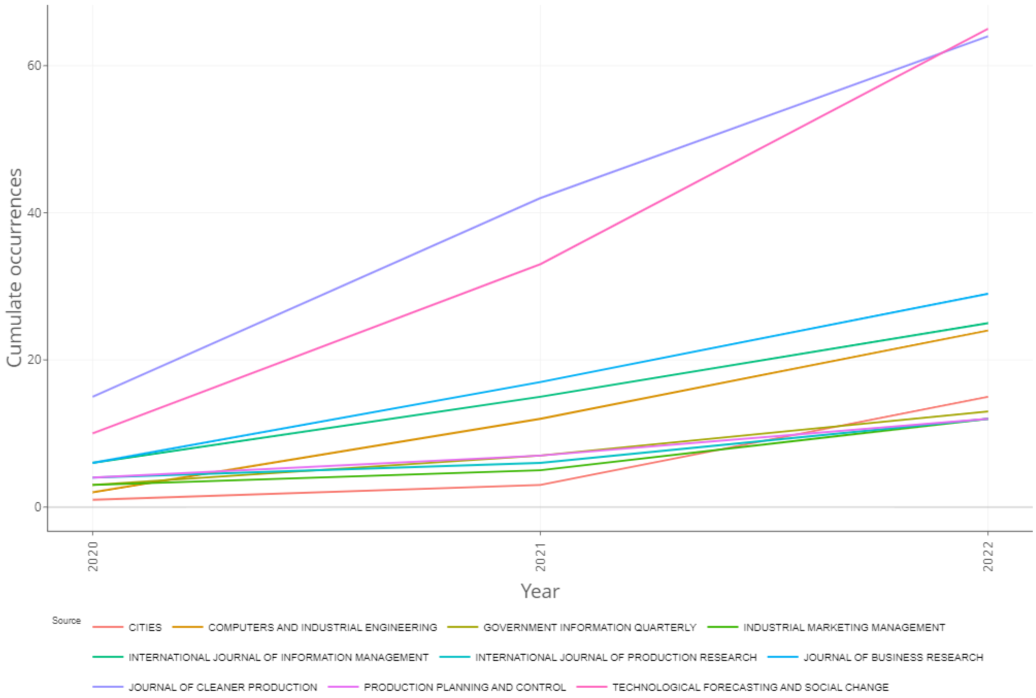

Figure 2. Source Dynamics of first 10 journals extracted from Biblioshiny.

The growth in the number of publications was 37.44% on average every year. All but 57 articles, hade at least four authors per article on average. (**Table 3**). The relationship among the identified countries confirms strong international collaboration among the authors.

The closest international collaborations were between the USA and China, France and Australia, Australia and China, China and Canada, France and China, Japan and China, France and Italy, China and the United Kingdom, India and the United Kingdom, Italy and the UK, USA and the UK, and India and the USA (**Figure 3**). The countries that have cooperated the most are also those most affected by the COVID-19 pandemic during the acute phase of its spread (Dawood et al., 2020). The boundary of the topic of supply chain and logistics in smart cities expanded to countries not belonging to the OECD; the major publications (compared to the authors who contributed to each paper) are concentrated in the UK (12%), China (11%), USA (11%), Italy (8%), India (6%), Australia (6%), France (4%), and Canada (3%).

Table 3. characteristics of the sample.

Description	Results
Main Information About Data	
Timespan	2020–2022
Sources (Journals)	462
Documents	879
Annual Growth Rate %	37.44
Authors	
Authors	3001
Authors of single-authored docs	57
Authors Collaboration	
Single-authored docs	57
Co-Authors per Doc	3.95
International co-authorships %	56.88

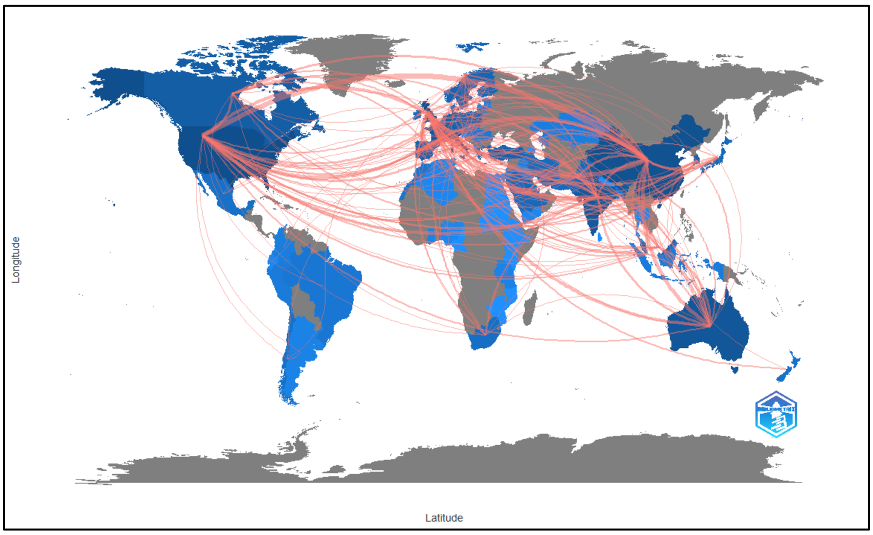

Figure 3. Collaboration world map.

The selected journals were 73% journals with 2* ABS, 25% with 3* ABS, and only 2% with 4* ABS (**Figure 4**). The prevalence of the type of journals classified with 4 ABS highlights the technical topics of logistics, manufacturing production, and statistical analysis associated with decision-making capacity with the recall of emerging technologies. However, there were no significant differences between 3* and 2* ABS with an interdisciplinary impact on multiple areas and disciplines covered by the analysis.

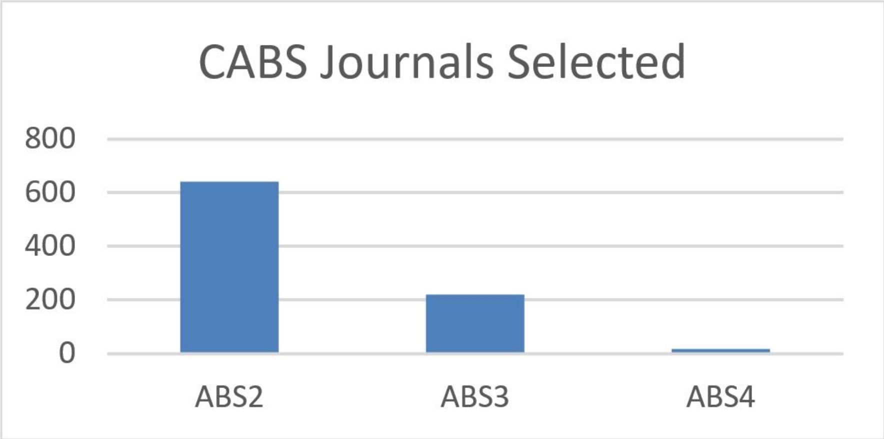

Figure 4. Sample of articles based on ABS-2021 journal ranking list.

The prevalence of literature analyses (58%) and partial theoretical frameworks (14%) of the supply chain, logistics, and smart cities concept, with a few empirical (15%) and applied methods and modelling (13%) studies were noted, as shown in **Figure 5**.

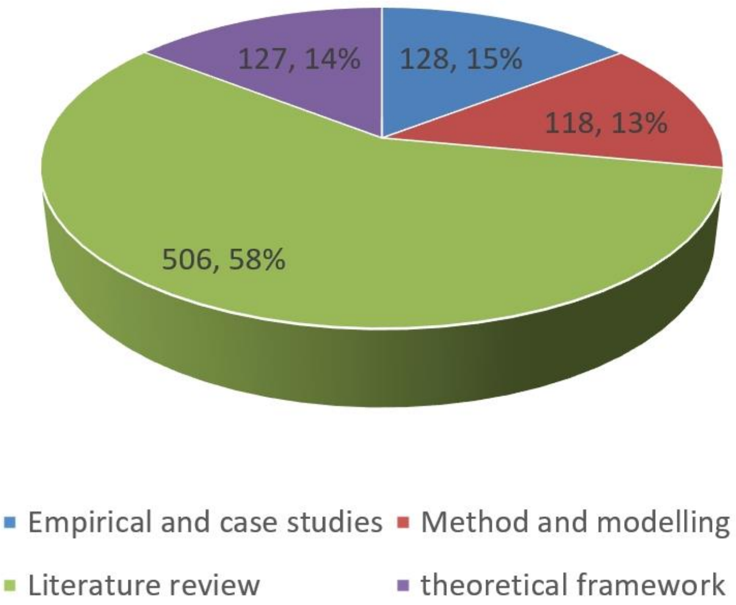

Figure 5. Distribution of methodologies approach.

3.2. Results and concepts

This section discusses the results of the multidimensional scaling analysis. The analysis, following Xie et al. (2020) and Biancone et al. (2022), is an exploratory method for condensing multidimensional space search variables into a two-dimensional space for placement, analysis, and classification while maintaining the original link between objects (Biancone et al., 2022; Xie et al., 2020). Keywords are plotted in the graph as a cluster plot, based on similarity. Each keyword placement indicates the similarity of the keywords. The centrality and vitality of a keyword status increase with proximity to the cluster's centre (Mori et al., 2016). Consequently, the authors identified four clusters (**Figure 6**). Clusters were constructed with the R-bibliometrix conceptual structure function to perform multiple correspondence analysis (MCA) to draw a conceptual structure of the field and K-means clustering to identify clusters of documents that express common concepts based on 50 terms (Aria & Cuccurullo; 2017). The four groups highlight the central themes of supply chain and logistics development in smart cities. The first group refers to technologies that support the evaluation of performance, choices, and processes; the second group is oriented towards new sales approaches and customer relations; the third refers to sustainability and is associated with the effects of the COVID-19 pandemic on all sectors, including the healthcare system; and the last refers to human capital and technology-driven management and managerial change.

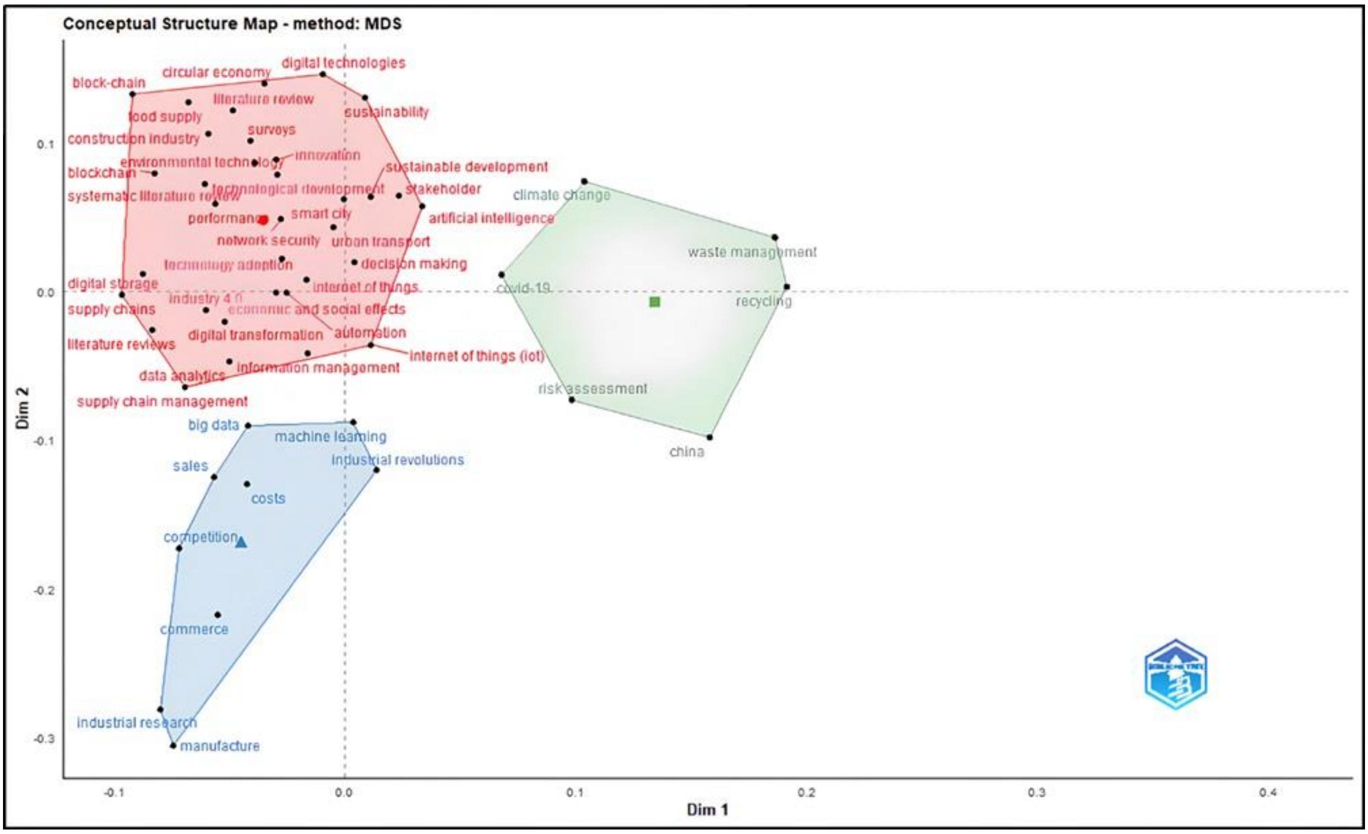

Figure 6. Conceptual structure MAP.

The topic dendrogram identifies the main clusters and the relationship among the issues addressed in the literature (**Figure 7**). **Table 4** highlights the significant elements and reference sectors, and it highlights the main articles identified in each cluster where there are also references relating to the sector of adoption of each technology or approach.

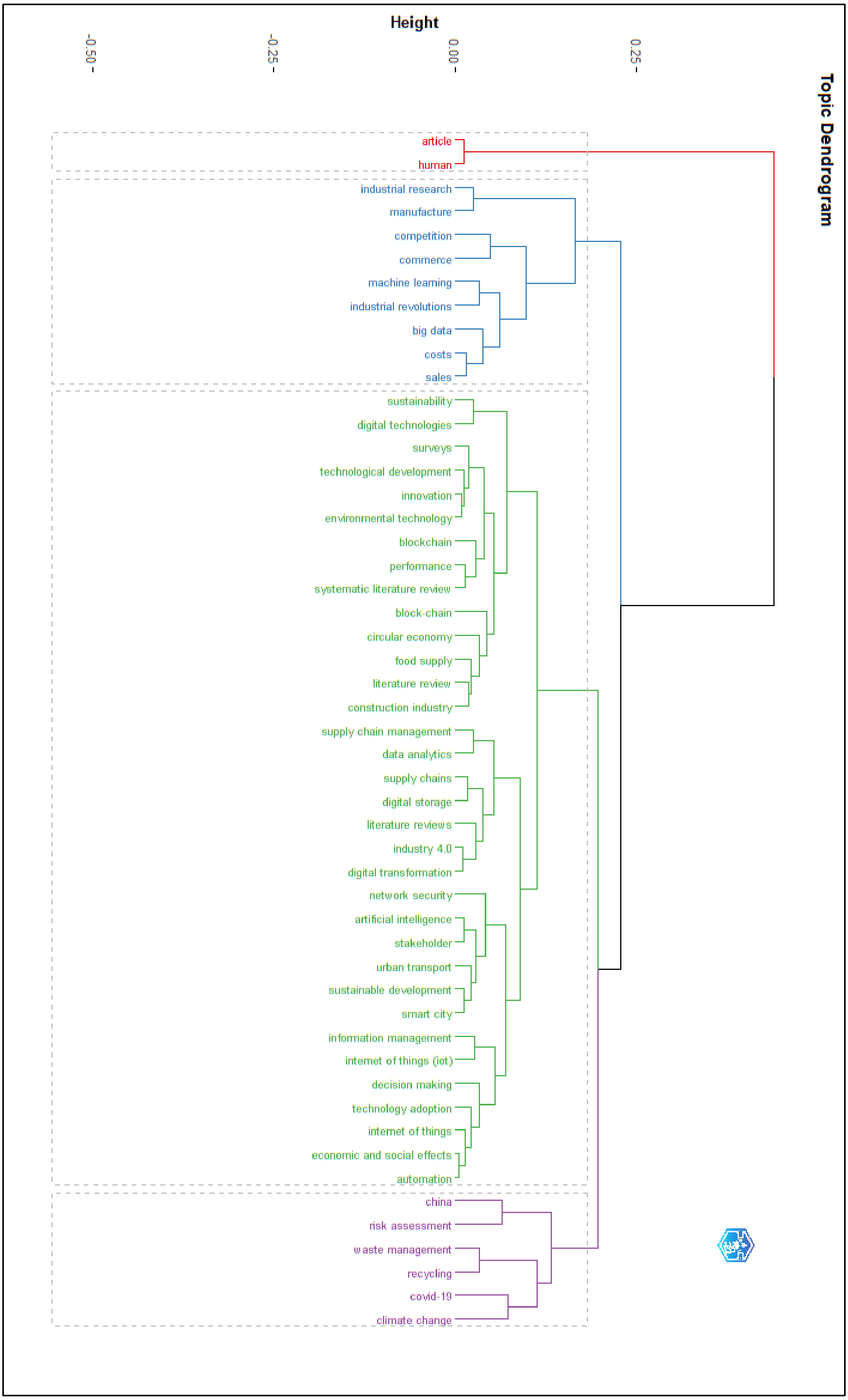

Figure 7. Topic dendrogram.

Table 4. Smart city supply chain and logistics.

Main elements	Sector	Source
Self-driving ships and network between ports	Supply chain all sectors Smart cities	(Makkonen et al., 2022)
Use of cooperatives and automated vehicles1 (CAV) to reduce CO_2 emission	Vehicle Manufacturers	(Pribyl et al., 2020)
Autonomous vehicles and IT to define the new system	City context	(Alvarez León and Aoyama, 2022)
Fleet of autonomous vehicles for delivery using Intelligent Transportation Systems (ITS) and predictive algorithms	Delivery urban area	(Richter et al., 2020)
Autonomous electric vehicle as alternatives of track and machine learning	Delivery urban and extra urban area	(Monios and Bergqvist, 2020; Qi et al., 2022)
Autonomous vehicle and machine learning to predict and study scenarios	Urban supply chain	(Bongiovanni et al., 2022)
Use of drones to overcome traffic problem and deliver orders	Supply chain smart cities, Food delivery	(Hwang et al., 2021)
Policy of recycling battery and supply of battery to reduce cost	Commercial activity of supply chain	(Raeesi and Zografos, 2022; Zhu et al., 2020)
Big data to support flexibility and speed of logistic activity	Supply chain and logistic sector	(Dessai and Javidroozi, 2021; Yu et al., 2021)
IOT support the increase of GDP and change in distribution	Smart system and private firms	(Islam et al., 2020)
Blockchain and exchange of information between public organizations and private on the supply chain	Public-private	(Chang et al., 2020)
Digital storage to support blockchain of supply chain process or integrate other technologies of industry 4.0	Food industry Industry 4.0 (multisector)	(Kittipanya-ngam and Tan, 2020; Massaro et al., 2020)
BIM and GIS applied in Digital of Construction supply chain and procurement	Built environmental and construction sector	(Yevu et al., 2021)
Internet of things, 5G and robotics	All sector	(Dolgui and Ivanov, 2022)
Autonomous vehicle and use of data collection for decision making	Urban supply chain	(He et al., 2022)
IIOT to increase satisfaction, profit and reduce time of delivery	Manufacturing production	(Vadlamudi, 2021)
Big data using blockchain of clients support production and supply chain process and service, products, and services	Supply chain Food sector	(Kayikci et al., 2022)
Big data support performance	Supply chain and logistic sector of SME	(Chatterjee et al., 2022)
Buying and selling processes through Bitcoin and digital currency	Supply chain in Smart Cities (public and private sector)	(Frizzo-Barker et al., 2020)
Digital market and predictive supply chain system and B2B activities	Private sector	(Akter et al., 2020; Behera et al., 2022)
Blockchain and smart contract	Manufacturer supply-chain	(Manimuthu et al., 2022)
Customer satisfaction through IA and blockchain	Food sector	(Dora et al., 2022)
Internet of things and supply chain, predictive	All sectors	(Passlick et al., 2021)
Internet of things, alternatives and increase of efficiency	Manufactory industry and healthcare industry	(Dantu et al., 2021)
Blockchain as interoperability between system of e-procurements	Smart cities	(Nodehi et al., 2022)
Blockchain as integration in the relationship between buyer and supplier	Private industry	(Benzidia et al., 2021)

Table 4. (*Continued*).

Main elements	Sector	Source
Blockchain as a ledge system for accounting sharing and systematization of the materials supply chain	Private-public service	(Secinaro et al., 2021)
Autonomous maritime transport and use of blockchain to guarantee security	Supply chain all sectors	(Tijan et al., 2021)
Semi-autonomous drivers and use of Digital Twin (DT) to support human driver	Not defined	(Nayernia et al., 2021)
Big data map human activity increases integrated policy	Smart city and logic integrated sector – system	(Miah et al., 2022)
Blockchain to support traceability, trust and accountability	Food sector	(Kayikci et al., 2022)
Sustainability and reduce food waste	Food supply chain	(Hellemans et al., 2022)
Sustainability and correct use of resources and reduction of environment impact	Supply chain processes in all sectors	(Nižetić et al., 2020; Parmentola et al., 2022)
Sustainability and circular economy (principles adoption, cleaner production, total quality environmental management, zero-waste performance and green differentiation advantage)	Food sector, textile, demolition materials and all sectors	(Afum et al., 2022; Christensen, 2021; Luthra et al., 2022; Parmentola et al., 2022)
Sustainability and recycling	E-waste and electric battery	(Alblooshi et al., 2022)

3.2.1. Technologies that support the evaluation of performance, choices, and processes

The first cluster represents the relationships among human factors, namely, work organisation, skills and attitude, and the other clusters. The COVID-19 pandemic significantly pushed the digitisation of human labour associated with supply chain and logistics processes in smart cities. Digitalisation is pivotal for defining the future in human resources management, where the related elements mostly involve the balance between the approach to digital work and private life, the democratisation of approaches to digital work, rewards for both employees and the entrepreneur and rules and guidelines for safeguarding workers' well-being against excessive digitisation (Bamel et al., 2022). Digital transformation has led to the concepts of post-human or post-anthropocentrism in which machines and ecosystems rather than individuals define involvement in processes that assess general human well-being (Bedford et al., 2022; Susen, 2022; Wang et al., 2021).

The first cluster relationship defines the balance of new technologies in global commercialisation and distribution; human capital tends to direct procurement and distribution based on the size of cities and the most industrialised centres, while technologies normalise choices by directing information and logistics based on the capacity of the distribution service, triggering a change process called the new economy (Wang et al., 2022).

3.2.2. New sales approaches and customer relations

The second relationship between clusters highlights how the industrial revolution and the concept of Industry 4.0 have significantly impacted human factors and activities, enabling greater efficiency of Logistics 4.0 processes—with the introduction of automation and new technologies (Krstić et al., 2022). Moreover, this cluster highlights the adoption of all technologies that can be used to improve supply chain and logistic services in smart cities.

3.2.3. Sustainability and effects of COVID-19

The last relationship entails the impact of the COVID-19 pandemic on workers' health and the management of medical and non-medical waste. The COVID-19 pandemic led to the prioritisation of securing personnel involved with the collection of solid waste through procedures and new protocols to prevent not only the current pandemic but also future spreads (Sharma et al., 2020). At the same time, the COVID-19 pandemic drew attention to the management of medical waste, with particular concentration in China, where the reorganisation of the transfer stations for medical waste from hospitals to a disposal plant reduced pollution and human infections and increased the return on investment linked to the service (Liu et al., 2020). This cluster is associated with the digitisation of waste collection services, the difficulty and challenge of adopting a circular economy approach linked to food shortage resulting from the COVID-19 pandemic and the promotion of sustainability evidenced by a positive impact on the population (Alblooshi et al., 2022; Bellezoni et al., 2022).

3.2.4. Characteristics of supply chain and logistics in OECD countries

More detailed cluster analysis provides essential information about the characteristics required for supply chain and logistics in smart cities in OECD countries. First, the adoption of technologies in manufacturing is one of the primary themes in the relationship between the consumer and the production cycle. Consumer needs greatly affect production and delivery processes. This approach involves new AI technologies capable of collecting information using clustering and transmitting it via blockchain-based subsystems to ensure data security, integrity, transparency, and traceability (Dora et al., 2022). The supply chain is also conditioned by modes of transportation and sectors, including vehicle manufacturers. In particular, the adoption of cooperatives and automated vehicles (CAV) capable of defining greater efficiency between infrastructures and the local network could reduce CO_2 production by 19%–20%, an element that has effects beyond domestic traffic (Pribyl et al., 2020). The development of autonomous vehicles (AVs) and the ability to understand the needs of the system, even though information technology shows that these are not isolated studies but consolidated approaches introduced in smart cities (Alvarez León and Aoyama, 2022).

The fleet of AVs for delivery in urban centres is supported by intelligent transportation systems (ITS), which define routing and scheduling by reducing and avoiding traffic through an integrated network with vehicles and the use of algorithms (Campisi et al., 2022; Richter et al., 2020). The use of electric vehicles (EVs) has been adopted not only as an alternative to tracks within the city but also as a means of transporting goods over long distances (Monios and Bergqvist, 2020; Qi et al., 2022). The pandemic rapidly prompted the use of these alternatives for supply chain management, as well as the introduction of machine learning in addition to AVs to support testing travel times and possible scenarios (Bongiovanni et al., 2022). Digital Twin (DT) systems are tools that support human-assisted autonomous driving, allowing for greater sensitivity to possible scenarios (Nayernia et al., 2021). Moreover, the use of AVs allows the collection of data for operations management and research by providing essential elements to support data-driven decision-making (He et al., 2022). However, the use of autonomous maritime transport poses a security-related problem, which can be solved through the use of blockchain (Tijan et al., 2021). Policies associated with commercial EV batteries and recycling and repurchase services are critical in deciding whether to use EVs and AVs for complete adoption in smart cities supply chain and logistics processes (Raeesi and Zografos, 2022; Zhu et al., 2020). The use of self-driving vehicles and the adoption of blockchain and IoT innovate not only the supply chain processes on land but also those of maritime transport and the widespread network between ports (Makkonen et al., 2022); sea transport is also integrated by aerial drones for the transportation of goods with similar technologies (Hwang et al., 2021).

The use of e-commerce has increased the pressure on the market in terms of costs and on-time supply of goods. Therefore, an Internet of Things (IoT) system has been developed for manufacturing production to increase user satisfaction and profit and reduce delivery time (Vadlamudi, 2021). The first cluster also includes the use of big data to map human activities conducted on social media as well as the definition of integrated policies (Miah et al., 2022). The adoption of big data supports the quality of the information used and increases the flexibility and speed of logistics processes (Dessai and Javidroozi, 2021; Yu et al., 2021). Furthermore, consumer big data using blockchain can be used to enhance production and supply chain processes, products, and services (Kayikci et al., 2022). Big data supports the supply chain transformation process by fostering an understanding of performance as a balance between the costs incurred and sales achieved by the small and medium-sized enterprises (SME) (Chatterjee et al., 2022).

The third and fourth clusters are related; the third mainly lists the technologies adopted, while the fourth refers to considering sustainability in smart cities, which impacts specific logistics and supply chain processes, given the impact of the COVID-19 pandemic.

The technologies adopted in smart cities to manage supply chain and logistics include digitising services and payments backchain digital storage systems, IoT, Industry 4.0 and automation. In digitisation processes, the literature highlights the possibility of mapping the supply chain phases using new backchain tools, such as smart contracts and Bitcoin and other digital currencies, especially in the procurement and distribution phases (Frizzo-Barker et al., 2020). The digitisation of markets has increased the possibility of studying consumer interests on various online channels and supporting production and delivery systems by anticipating demand (Akter et al., 2020) and supporting B2B activities.

Investments in IoT have revolutionised commercial and social solutions, boosting GDP (Islam et al., 2020). Digitised processes greatly promote sustainability through the adoption of blockchain, as inter-operability between public and private systems in the e-procurement process, traceability in the food industry, and exchange of information between public and private organisations within the supply chain to create transparency accounting in the construction industry and public private relations (Benzidia et al., 2021; Chang et al., 2020; Islam et al., 2021; Kayikci et al., 2022; Manimuthu et al., 2022; Nodehi et al., 2022; Secinaro et al., 2021). Furthermore, the blockchain positively integrates with relational capital based on the interaction between the buyer and supplier (Benzidia et al., 2021).

Digital storage is closely related to the accessibility of the information provided by the blockchain, as in the case of food or as an integration with other technologies that comprise the digital transformation of Industry 4.0 and the change of supply chain models encouraged by the limitations caused by the COVID-19 pandemic (Kittipanya-ngam and Tan, 2020; Massaro et al., 2020).

IoT is often associated with other Industry 4.0 technologies (Chae and Olson, 2022). It provides predictive tools and possible alternatives for improving the supply chain's efficiency by generating a connexion between devices and technologies and re-organising and delivering processes through robotics supported by 5G (Dantu et al., 2021; Dolgui and Ivanov, 2022; Passlick et al., 2021). Several innovative technologies associated with Industry 4.0 support the built environment, including building information modelling (BIM) and geographic information systems (GIS). These technologies are incorporated in the digitalisation of the construction supply chain and procurement (Yevu et al., 2021).

The last cluster presents the consequences of sustainability policies associated with smart cities and technologies. Sustainability mainly concerns the effective management of resources, including in the food, construction, and textile sectors in the supply chain process (Christensen, 2021), as well as decreasing the consumption of raw materials, fuel, and energy, which can be enhanced by technology to counter harmful effects, such as CO_2 emissions (Nižetić et al., 2020; Parmentola et al., 2022). However, when sustainability in the supply chain and logistics is analysed, another key issue relating to the circular economy is identified, namely smart cities inclusion policies and sustainability, which influence the processes of transformation, procurement and production. In developed economies, purchasing technology is accelerated by such policies and sustainability. In these contexts, the disposal phase of recycling e-waste and the electric batteries of self-driving vehicles has been highlighted (Zhu et al., 2020).

4. Discussion

Analysis of the supply chain and logistics in the context of smart cities is an emerging and relevant theme for OECD countries; the COVID-19 pandemic forced a redefinition of models and the adoption of new technologies for the sustainability of urban centres. The analysis, based on an SLR and bibliometric methods, highlighted the high level of collaboration among countries and the need to define an efficient framework for integrating the supply chain and logistics model defined by Zhao et al. (2020) to develop a holistic ecosystem of smart cities. In addition, the authors critically investigated the effects of the COVID-19 pandemic as evidenced in the literature. Although the analysis focused on OECD countries, efforts to avert a pandemic crisis prompted wider collaboration among scholars and nations in exploiting various beneficial practises and models. The analysis integrated the Smart Cities report by the OECD (2020) based on the pillars defined by Zhao et al. (2021) and explained new constructs and propositions in the supply chain and logistics contexts that support smart cities ecosystems. The current integration of the initial model identified technologies as the cornerstone of change and confirmed the previous trends observed, as summarized in **Figure 8**. The initial model envisaged the use of big data, improvement of the transport system, data collection and systematic approaches, and the use of aerial vehicles. Meanwhile, the present theoretical and practical model is more significant and integrated (Escamilla Solano et al., 2017; Garau et al., 2016; Martinez and Viegas, 2017; Mohamed et al., 2020; Öberg and Graham, 2016; Peris-Ortiz et al., 2017; Qi and Shen, 2019; Ruhlandt et al., 2020; Rathore et al., 2016; Yan et al., 2020; Zhao et al., 2021). Shee et al. (2021) identified specific technologies recalled in the analysis conducted (Barcodes, RFID, Wireless sensor and retina scanner, GPS, IoT sensor, 4G and 5G Network, ERP system) which confirm the impact on social sustainability and environmental and economic aspects. The analysis integrates and increases the number of technologies introduced by the supply chain, generating positive and negative impacts on the new framework (machine learning, Artificial Intelligence, Blockchain and data, Intelligent transportation system, Digital Twin, BIM, GIS).

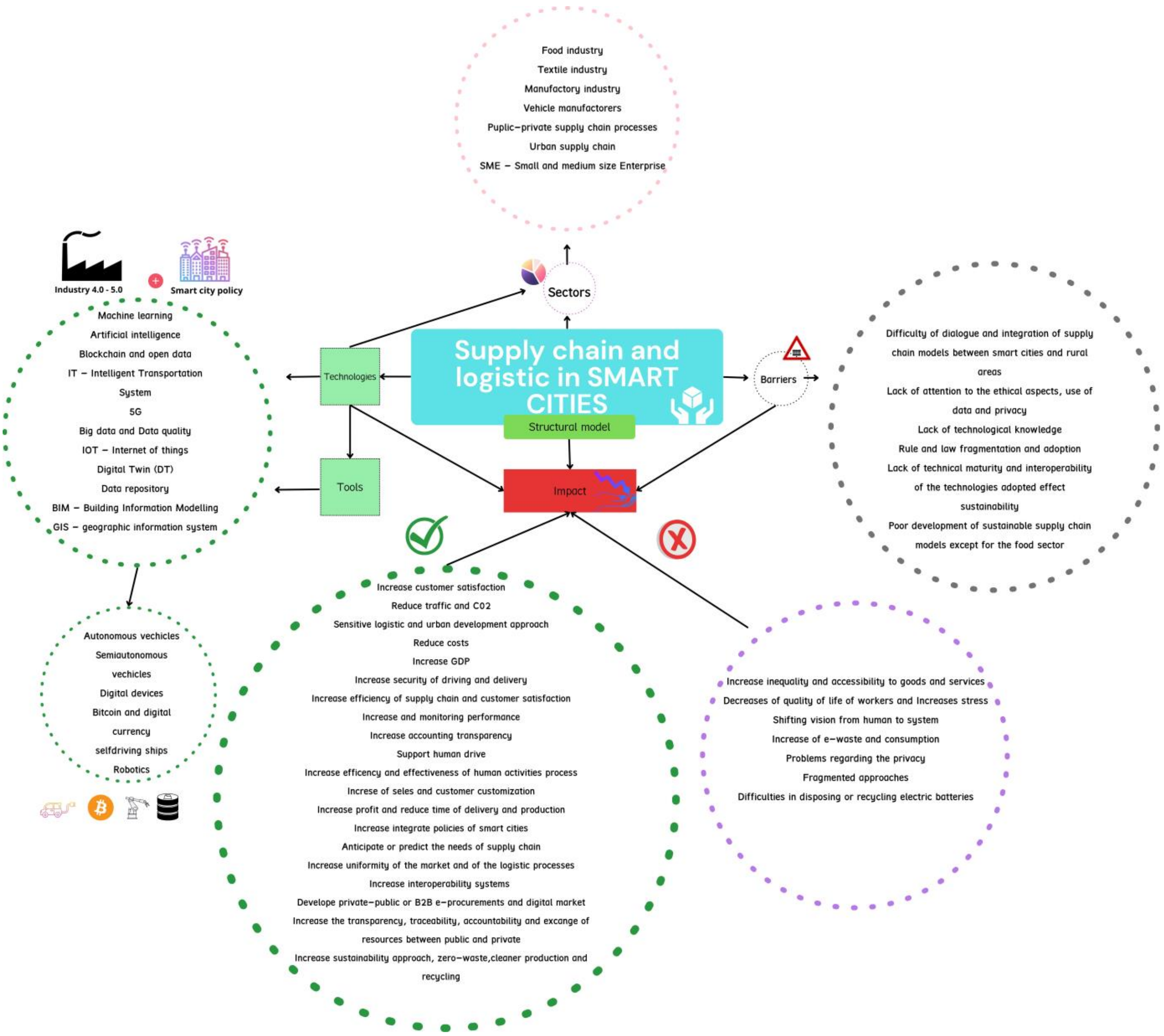

Figure 8. Represents the current model of supply chain and logistics in Smart Cities.

The SLR did not identify individual technologies, but automation and development based on Industry 4.0 and 5.0, including the use of big data and other disruptive technologies such as machine learning, blockchain, IoT, data quality, ITS, BIM, and GIS. Furthermore, the use of drones or aerial vehicles in supply chain processes is no longer a priority but a form of sustainable transportation. However, AVs or self-driving ships have been added to previous experimental adoptions, gaining a central role in practical applications and future research. Big data not only supports the last mile delivery of products and market study phases but also direct production, performance, and personalised assistance to the customer in advance. The open data system is supported by blockchain, which integrates the previous model and guarantees transparency of the supply chain phases, not only in the food sector but also in accounting and materials management in both the construction and private sector. Blockchain and ledges support the development of a new market based on bitcoin and other digital currencies and the adoption of smart contracts. The study underlines that the technologies adopted for the supply chain and logistics in smart cities have been applied in specific sectors and lead to impacts at the time of adoption. Studies by Shee et al. (2021) have highlighted the possible impact of technologies in the supply chain and transport on economic, social, and environmental aspects; the analysis highlights important evidence in all three areas. The use of technologies also has ethical implications that impact the assessments carried out (Francisco and Swanson, 2018; Manning et al., 2023; Shamout et al., 2022). The use of technology has brought positive and negative effects on social aspects such as people's well-being and on human condition; it allows mapping of human operations, making them more efficient and functional, and supports activities such as guidance and logistics efficiency. This shift towards a smart system has two contrasting visions that should be addressed and associated with ethical aspects to achieve the effective goals defined by cities. Alongside the role of technologies, environmental impact, which fosters sustainability (reduce CO_2) and circular economy approaches, influences the supply chain processes and makes logistics and accessibility equal in all cities of similar size, also leads to an increase in potentially toxic waste (e-waste) and greater consumption of limited resources. Finally, technologies also impact the economic aspect, increasing GDP, reducing costs associated with the value chain in the procurement process and the final product, and improving the efficiency and effectiveness of human processes. However, the adoption of new technologies in supply chain management and logistics has to consider ethical dimensions of using autonomous technologies (Francisco and Swanson, 2018; Manning et al., 2023; Shamout et al., 2022). The sharing of data and the application of artificial intelligence (AI), machine learning, IOT and blockchain highlighting the complexity of ethical considerations in operational and decision-making contexts considering the use of data collected (Bag et al., 2023). The ethical outcomes and the processes of technology adoption, ensuring that governance structures in smart cities can adapt to evolving ethical challenges (Shamout et al., 2022). Traditional ethical approaches, which often address discrete elements in isolation, are insufficient for handling the interlinked and interdependent ethical outcomes in modern process. Instead, a more holistic approach, as provided by reflexive governance, is necessary to effectively manage the ethical impacts at all stages of technology and product lifecycle—from conceptualization through design to realization and adoption (Manning et al., 2023). Ethical considerations on the use of technologies do not stop only at the collection and use of data but also at the conservation and responsibility of companies in their use (Macnish and Van der Ham, 2020). Various ethical considerations related to data security and the protection of sensitive information within supply chain and logistics systems effect the social sustainable aspect. Key issues include the potential threats posed by cyberattacks, which can lead to significant data breaches. These breaches not only compromise personal and corporate data but also expose companies to legal and reputational damage. The responsibility to protect this data falls on companies who must implement robust cybersecurity measures. Data handling and security protocols keep pace with technological advancements and can defend against sophisticated cyber threats. Companies must also be transparent about their data use and protection strategies to build trust with stakeholders and comply with increasingly stringent regulations on data privacy and protection.

In summary, the ethical management of data security in supply chains involves a comprehensive approach that includes risk assessment, proactive cybersecurity practices, ethical guidelines for technology use, and compliance with legal standards (Miller, 2024).

Unfortunately, digitisation still experiences numerous limits and barriers; for instance, rural areas face the difficulty of using and relating to digital systems in highly developed smart cities, particularly in e-commerce and e-governments, creating a dichotomy and separation between smart cities and surrounding areas (Sharma et al., 2021). Another limitation of the digitisation of services and processes in B2B relationships is the limited awareness of the ethics of the relationship, which is a requirement for an efficient system (Behera et al., 2022). Skills are needed to accompany the digitisation process which are sometimes absent in both the private and public sectors (Giacosa et al., 2022). The observations on the possible applications of the supply chain indicate a series of solutions that can be adopted to improve the supply chain and logistics systems, but a shared and applied holistic system that integrates the different applications, and the various sectors is necessary (Hajek et al., 2022). Sustainability also collides with a lack of technical maturity and inter-operability of the technologies adopted, which fragments approaches and impacts (Erol et al., 2022). COVID-19 has pushed the development and immediate adoption of various technologies in the food sector (Dos-Santos et al., 2021), while the technologies identified for the textile, manufacturing, and urban services sectors are still in the adoption and diffusion phase. Nonetheless, the push is leading to the creation of a development system involving small national entrepreneurs who suffered a greater negative impact during the pandemic (Acar et al., 2022). Although the adoption of technologies has increased in the pandemic period, generating an impact on current models, it is also true that this change has yet to have the time and the way to consider the effect and inequity generated by the massive use of technologies (Nugent and Suhail, 2021). The technologies detected in the analysis while aimed at enhancing supply chain management and efficiency, often lead to increased social and economic divisions. The implementation of sophisticated technological solutions tends to benefit those who are already technologically adept or those who have the economic means to access these new systems, thus widening the gap between the affluent and the less privileged (Caragliu and Del Bo, 2023). Moreover, the push towards smart cities can marginalize those who are less tech-savvy, effectively excluding a significant portion of the population from fully participating in the benefits that these technologies are supposed to bring. This technological divide can lead to a form of exclusion where the less privileged are denied certain services and opportunities simply because they cannot access or afford the necessary technology (Nguyen and Boundy, 2017). Overall, while the integration of advanced technologies in urban settings promises improved efficiency and connectivity, it also poses serious ethical questions regarding equity and access, suggesting that without careful consideration and inclusive planning, the move towards smart cities may exacerbate existing inequalities rather than alleviating them (Nugent and Suhail, 2021).

5. Conclusion

5.1. Scope for future research

Future analyses could focus on the effective impact of policies on adopting technologies to support the development of smart cities and ecosystems considering national investments (Adesiyan and Raffington, 2024; Brescia et al., 2023; Blanco-Alcántara et al., 2024; Simonsen et al., 2024; Transchel et al., 2024). The analysis also highlights barriers and negative impacts to which future analyses and investigations should provide answers and greater insights. Furthermore, more practical analyses associated with all production sectors are required to highlight the implications and better impacts provided by the model and the adoption of approaches and technologies. Furthermore, future investigations can be adopted in non-OECD countries to determine policies, technologies, and sustainability implications of the supply chain and transportation field, identifying any differences with those defined in OECD countries. The analyses will have to overcome the numerous ethical problems linked to the use of new technologies by investigating how smart city policies can address this barrier, which can currently generate risks and inequity with a significant impact on the social sphere (Ahmad et al., 2022).

5.2. Contributions and implications

The analysis demonstrated how the diffusion of supply chain and logistics models applied in smart cities of OECD countries has not yet led to a uniformity of rules, technologies, and simultaneous adoptions. Moreover, if the use of technologies positively conditions the market both in terms of the fairness of the offer and the economic impact generated, digital markets involving cities as well as B2B are not yet widespread. The experimentation has advanced more than two years ago. Nonetheless, the study contributes significantly to the determination of an initial framework on which smart cities in OECD countries can support the development of the supply chain with particular attention to the social, environmental, and economic impacts. The study contributes significantly to the evidence of the pillar linked to logistics and supply chain, considering the impact of sustainability, and identifying emerging and evolving technologies as a significant adoptable element expressed through different tools in the city context. The study also contributes to the ongoing debate with a vision of adopting this framework's potential positive and critical negative impacts. The study is also part of a trend highlighting the organizational, social, and economic changes caused by COVID-19 in the medium term. The strategy of the BRICS countries for 2025 currently determines the relationship between technologies and sustainability in infrastructure development policies. However, studies that systematize these aspects analyzed by Alexandro and Basrowi (2024) and Barykin et al. (2021) need to delve into the effects of the supply chain and transport on environmental, social, and economic impacts. Therefore, this study supports the systematization and analysis process and can be adopted as a guide to defining the factors adopted and applied according to the academic literature.

In terms of managerial implications, the SLR study results will support governments in defining supply chain and logistics policy implementation and technical experts and managers in understanding which technologies can affect and support the system. This study provides the basis for OECD countries to adopt common logic and strategic investments to support smart city ecosystems. The evidence demonstrates the potential impact on both the private and public sectors with shared objectives. Management should introduce relevant technologies to support processes to improve personnel management, managerial control, financial management, and governance with impact on the market. Technologies improve human capacities by increasing the efficiency of workers and decreasing human error. Management control benefits the traceability of materials and the reduction of environmental risk, guarantee of product quality and reduction of warranty costs, reduction of CO_2, energy efficiency, reuse of materials with cost reduction production, performance analysis through big data, and artificial intelligence. Financial management benefits from the increased efficiency and effectiveness of enterprises impacting local GDP. It supports small- and medium-sized national companies with greater productivity within a common market supported by automation and new payment types and systems, negotiation, and customer relationships. Governance in light of data and processes has greater decision-making capacity. It can introduce elements associated with the new corporate social responsibility criteria related to the European taxonomy legislation (Stefanescu, 2021) and the Global Reporting Initiatives (Adams et al., 2021).

5.3. Limitations of the study

The method adopted does not consider non-ABS ranking journals, which could offer different perspectives and research orientations. Future research may provide different results on disciplinary areas other than those considered by the Chartered Association of Business Schools.

Data availability: The data is public and extractable following the indications of the method.

Conflict of interest: The authors declare no conflict of interest.

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