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NEW CHALLENGES FOR XXI CENTURY CITIES

Global warming, ageing of population, reduction of energy consumption, immigration flows, optimization of land use, technological innovation

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Laboratory of Land Use, Mobility and Environment
DICEA - Department of Civil, Building and Environmental Engineering
University of Naples "Federico II"
Piazzale Tecchio, 80
80125 Naples

www.serena.unina.it/index.php/tema
e-mail: redazione.tema@unina.it

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Technological applications in sustainable urban logistics: a systematic review with bibliometric analysis

Suzan Oguz [a]*, Mehmet Tanyas [b]

[a] Department of Foreign Trade, Cag University
Mersin, Turkiye
e-mail: suzanoguz@cag.edu.tr
ORCID: https://orcid.org/0000-0003-4876-3173
*Corresponding author

[b] Department of International Trade and Logistics
Maltepe University, İstanbul, Turkiye
e-mail: mehmettanyas@maltepe.edu.tr
ORCID: https://orcid.org/0000-0001-8934-3787

Abstract
Today, supply chains and logistics operations in urban areas face increasing customer demands for productivity, quality, sustainability and traceability. Traditional methods cannot adequately respond to the rapidly changing challenges and requirements of this sector. Therefore, new methods have been developed to make urban logistics activities more modern, environmentally sensitive and integrated with technology. This research aims to identify sustainable urban logistics and the role of technological applications on urban logistics. In this research, which is designed as a systematic study, firstly, based on the existing literature, the basic concepts, trends, researchers and countries working in the field of sustainable urban logistics are examined by bibliometric analysis method. It is observed that the most frequently used technology applications in sustainable urban logistics are last mile delivery, vehicle routing, optimisation, electric vehicles and crowdsourcing applications. This study is expected to contribute to the development and sustainability of urban logistics.

Keywords
Supply chain; Urban logistics; Sustainability; Technology.

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1. Introduction

In recent years, as a large proportion of the world's population has been living in cities, all activities related to logistics and supply chain management in cities are of critical importance. For this reason, governments around the world are working to design sustainable and efficient ways of delivering freight in urban areas (Juan et al., 2016). Cities are the sites of significant economic activity with an ever-increasing impact on regional dynamics (Boudoin et al., 2014). In addition to urbanization and demographic growth, concerns about urban logistics activities and greenhouse gas impacts in cities have increased due to the widespread use of e-commerce, new management principles and technologies such as just-in-time delivery, especially after the pandemic (Fried et al., 2024; Patella et al., 2021). The COVID-19 pandemic has profoundly affected urban logistics processes and urban mobility strategies. There is a common consensus that logistics operations need to become more flexible, environmentally sustainable and resilient in the post-pandemic era (Ravagnan et al., 2022). On the other hand, increasing urbanization, population growth, and changes in demand patterns for products that favor just-in-time solutions, coupled with reduced stocks in stores, have intensified freight movements in cities (Melo & Baptista, 2017). Due to increased freight movements in urban areas, modern cities face problems such as traffic congestion, air pollution and noise that reduce the quality of life (Patella et al., 2021). Efficient logistics services play a crucial role in the management of supply chains, exerting a substantial influence on the reduction of transportation expenses and the enhancement of customer satisfaction. According to Leng et al. (2024), it additionally has a role in mitigating greenhouse gas emissions and associated externalities, like air pollution, noise, and traffic congestion. Due to the presence of numerous diverse economic sectors, a city is supported by numerous supply chains. Furthermore, due to the inherent diversity among cities worldwide, the implementation of urban logistics is subject to substantial variations based on local attributes (Behrends, 2016). Furthermore, the rapidity of social, cultural, and economic processes has resulted in substantial transformations in urban areas. The development of cities is influenced by various factors, such as the significance of transportation planning, the interconnection between urban and regional planning and economic planning, the utilization of information tools, the emphasis on environmental sustainability, the growing emphasis on social planning, and the evolving management techniques employed by local governments (Russi et al., 2016). Urban logistics activities are critical not only for firms and consumers, but also for the spatial organization of cities and urban planning strategies. This is because improved logistics networks help to reduce urban traffic and achieve sustainable urban development goals. Therefore, for sustainable urban logistics, it is crucial for cities to plan and manage their logistics operations in line with their urban growth strategies. Sahu et al. (2022) emphasize that the efficiency of logistics operations and planning activities is critical for urban infrastructure and traffic balance. In their study, Baker et al. (2023) emphasize that the use of digital and innovative technologies is becoming increasingly important in achieving sustainable urban logistics. These technologies play a critical role in achieving goals such as increasing energy efficiency and reducing carbon emissions. Spadaro et al. (2022) state in their study that sustainability principles have become one of the main pillars of modern urban logistics processes. They emphasized how green logistics solutions enable the development of environmentally friendly logistics operations through energy efficiency and the development of environmentally friendly mobility strategies. Urban areas worldwide are making significant endeavors to effectively handle urban logistics with the aim of enhancing their logistical efficiency and mitigating adverse environmental and socio-economic consequences (Behrends, 2016). Urban logistics encompasses the entirety of transportation and delivery activities within highly populated urban regions. Urban logistics refers to the strategic management of logistics operations in urban areas, utilizing advanced information systems to enhance efficiency (Cardenas et al., 2017; Merdesic et al., 2023), This involves considering various factors such as the traffic environment, traffic congestion, safety, and energy conservation, all within the context of a market-based economy (Perboli et al., 2018). Urban logistics can be defined as the process of transporting goods using wheeled vehicles, as well as the associated activities involved in this

transportation, within an urban setting (Fernandez-Barcelo & Campos-Cacheda, 2012). Urban areas serve as hubs for the production, distribution, and consumption of tangible goods. Urban logistics encompasses a comprehensive range of actions aimed at ensuring the provision of necessary materials for these activities. It encompasses all the transportation of goods that arises from the economic requirements of local businesses, such as the transportation and retrieval of all materials, components, consumables, mail, and garbage necessary for the enterprises to sustain their operations (Dablanc, 2011). The field of urban logistics has emerged as a significant element within the realm of urban planning. Efficient management of urban logistics is crucial for achieving long-term economic development. Currently, it is imperative to take into account several concerns, including traffic congestion, environmental impact, and energy conservation (Crainic et al., 2004; Taniguchi & Van Der Heijden, 2000). Enhancing comprehension of urban freight activity can facilitate planners in effectively accommodating freight vehicles by means of improved facility and infrastructure design and utilization. Additionally, it enables the exploration of the possible viability and advantages associated with different freight initiatives (Cherrett et al., 2012). Urban logistics remains an area in need of further analysis to understand the consequences of innovative developments and changing practices (Patier & Browne, 2010). Especially in recent years, the continuous increase in the population living in urban areas, pollution and safety concerns in cities, traffic and congestion problems, and new technological developments have attracted the attention of urban logistics researchers and policy makers (Lagorio et al., 2016). This study aims to examine the developments and technological applications in the field of sustainable urban logistics and to determine the importance of these developments in cities. Accordingly, the study is structured as a systematic study that aims to review the existing literature to uncover key ideas, trends and research directions in sustainable urban logistics. Firstly, a search was made in the Web of Science database using the concepts in this subject and the studies were visualized and interpreted through bibliometric analysis on the basis of type, year, author and countries. Following the literature review, information on the practices used in sustainable urban logistics activities is provided. It is expected that this study will contribute to the development and sustainability of urban logistics and guide the researchers who will work on the related subject.

2. Sustainable urban logistics

In recent years, the notions of "sustainability" and "sustainable development" have gained significant prominence in the realm of policy evaluations. According to the World Commission on Environment and Development (1987), sustainable development is commonly defined as the process of achieving development that satisfies the requirements of the current generation while safeguarding the capacity of future generations to satisfy their own needs. Currently, the impetus behind the pursuit of sustainable urban mobility arises from the imperative to establish cities that are ecologically sound, socially equitable, economically feasible, and conducive to the well-being of present and future generations (Yucesan et al., 2024). Currently, numerous cities across the globe are actively implementing sustainable transportation plans as integral components of their sustainability endeavors. According to Goldman and Gorham (2006), sustainability is intricately connected to several strategic policy objectives and exerts substantial effects on urban areas. The field of supply chains, logistics, and costs encounters progressively intricate obstacles as a result of shifts in economic frameworks, urbanization, urban planning, transportation systems, and the externalities linked to logistical operations in metropolitan regions. According to Cardenas et al. (2017), the ability to address these difficulties is heavily contingent upon the presence and advancement of transportation systems, infrastructure, efficient fleets, improved modes of transportation, and the sustainability policies implemented by enterprises. To enhance the sustainability of freight transportation, it is imperative to comprehend the characteristics of freight flows, as it is a derived demand. The driving forces influencing these flows encompass various aspects, including the geographical location of activities, transportation expenses, land prices, consumer preferences and service requirements, as well as prevailing rules governing freight transportation and land utilization. Hence, to alter

freight transportation patterns and alleviate their consequences, it is crucial to take into account these determinants of freight flows, rather than solely concentrating on the movements of freight vehicles (Anderson et al., 2005).Urban logistics has a crucial function in satisfying human requirements, but it also results in detrimental effects on the environment, economy, and society (Russo & Comi, 2020). The expansion of urban logistics services has been driven by shifts in the supply chain, including just-in-time delivery, e-commerce, and door-to-door delivery. Consequently, there has been a rise in the number of deliveries and the presence of light commercial freight vehicles in residential areas. This trend has had notable implications for urban sustainability and livability (Baur et al., 2014). Urban areas globally have implemented objectives and tactics to promote energy sustainability and decrease greenhouse gas emissions. Logistics operations are crucial in attaining these objectives and strategies. The successful shift towards a more energy-efficient urban transport sector necessitates a comprehensive examination of many facets of transportation, encompassing both human transportation and urban logistics (Rosales & Haarstad, 2023).

2.1 Bibliometric analysis application

Bibliometric analysis is an analytical method often used in systematic literature reviews and involves the quantitative analysis of scientific studies (Lim et al., 2024). Bibliometric analysis is used to examine and evaluate large amounts of scientific data. While this method helps to understand the development of a particular subject, it also presents new trends in that field (Donthu, 2021). In this study, it is aimed to examine the studies on technology-based applications in sustainable urban logistics in 2010-2023 in the Web of Science (WoS) database within the scope of bibliometric analysis and to create visual maps. In this context, on March 10, 2024, Web of Science was searched through the categories and criteria specified in Tab.1 Vosviewer package program was used for the visual maps created within the scope of the study.

Category	**Search Criteria**
Keywords	Urban logistics, city logistics, sustainability, technology
Search string	Topic (containing keywords)
Types of documents	Article, Proceeding Paper, Book and book chapter, Editorial Material
Time range	2010-2023
Language	English

Tab.1 Search criteria in Web of Science database

As a result of the search using the categories and search criteria shown in Tab.1, 843 studies were found. The distribution of the studies by years is as shown in Fig.1. When Fig.1 is examined, it is seen that the related studies have generally tended to increase over the years, but the highest number of publications was made in 2022 with 149 publications.

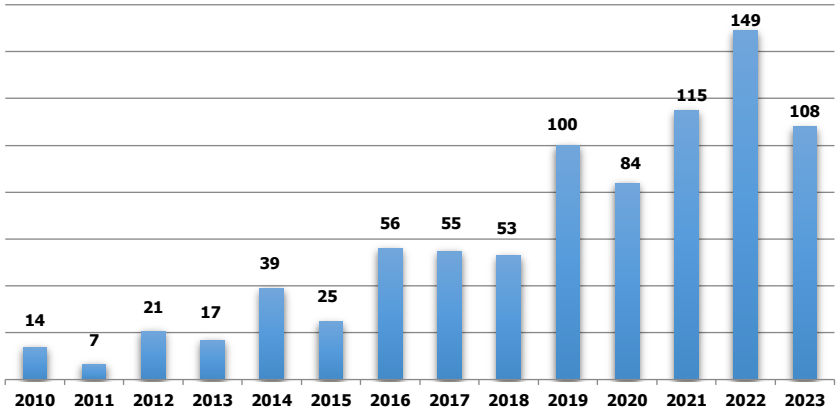

Fig.1 Number of publications by year

The 2020s have been a period of accelerating digitalization and technology-based applications. In particular, the COVID-19 pandemic has caused major disruptions in global logistics and supply chains, increasing the need for more sustainable, flexible and technology-based solutions. Moreover, the European Union's Green Deal strategies have exerted significant pressure on countries to adopt sustainable urban logistics and regulations with the objective of reducing carbon emissions. These policy orientations have accelerated the search for sustainable solutions in the logistics sector during the 2020s, leading to an increased focus on this area in scientific studies. The distribution of studies on technology-based applications in sustainable urban logistics according to publication types and web of science indexes is shown in Tab.2.

Type	**Numbers of publications**
Article	544
Proceeding Paper	265
Book and Book Chapter	22
Other	12
Web of Science Indexes	
Science Citation Index Expanded (SCI-E)	352
Social Sciences Citation Index (SSCI)	313
Conference Proceedings Citation Index - Science (CPCI -S)	223
Emerging Sources Citation Index (ESCI)	106
Book Citation Index	32

Tab.2 Distribution of publications according to types and indexes

When Tab.2 is examined, it is seen that the highest number of publications related to the subject in terms of publication type is article with 544 publications. In terms of index, it is seen that the related publications are mostly published in SCI-E indexed journals with 352 publications. The most commonly used keywords in studies on technology-based applications in sustainable urban logistics are shown in Fig.2.

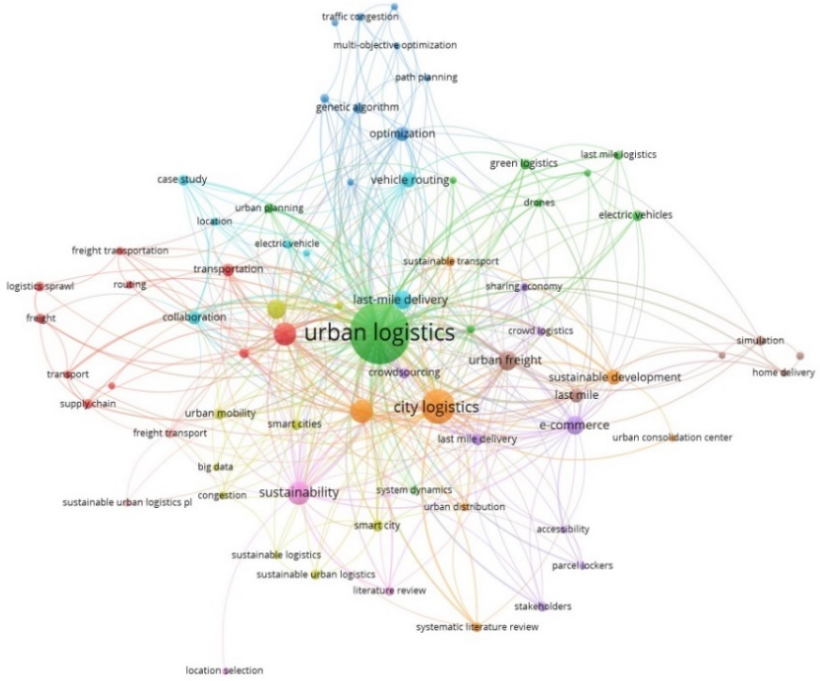

Fig.2 Most used keywords (elaboration from VosViewer)

When the distribution of keywords in the studies included in the scope of the analysis in Fig.2 is examined, it is observed that there are 72 keywords used at least five times. The most frequently used keywords were

"urban logistics" and "city logistics", which were used 322 and 103 times, respectively. The concept of "sustainability" used 47 times, ranks third in terms of frequency of use. The keywords used for technological applications in urban logistics and the number of times they are used are shown in Tab.3.

Keywords	Number of uses
Last mile delivery	30
Vehicle routing	33
Optimization	17
Electric vehicles	13
Crowdsourcing	12

Tab.3 Keywords used for technological applications in urban logistics

When Tab.3 is examined, it is seen that the keywords last mile delivery, vehicle routing, optimization, electric vehicles and crowdsourcing are prominent in studies on sustainable urban logistics. These key concepts play a strategic role in reducing the environmental impact of logistics operations, lowering carbon emissions, improving delivery times and optimizing energy consumption. On the other hand, it reveals how technological innovations in the logistics sector contribute to the achievement of sustainability goals of cities and provides an important guide in shaping future logistics processes. Information on these concepts and their use in sustainable urban logistics is provided in the following paragraph. The countries with the highest number of publications on the subject are shown in Fig.3.

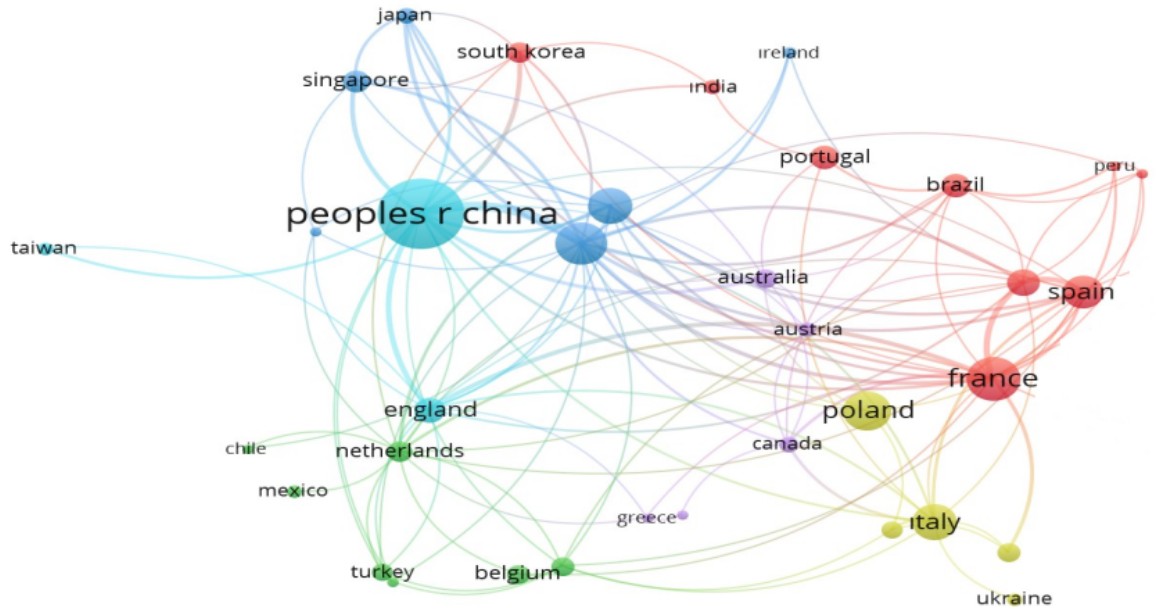

Fig.3 Countries with the most publications (elabotation from VosViewer)

Fig.3 shows the countries with the highest number of publications on technology-based applications in sustainable urban logistics. A total of 38 countries were included in the publications analyzed within the scope of the analysis, with the condition of at least five publications. Among these countries, it is seen that China (227 publications) has the highest number of publications using the related concepts. China is followed by France (87 publications), USA (80 publications), Poland (70 publications) and Germany (59 publications). The fact that China has the highest number of publications using related concepts can be attributed to China's rapidly growing logistics sector and its large investment in technology-driven solutions in this field. China has become an important hub of global supply chains and is pioneering technological innovations to improve the efficiency of logistics processes and minimize environmental impacts.

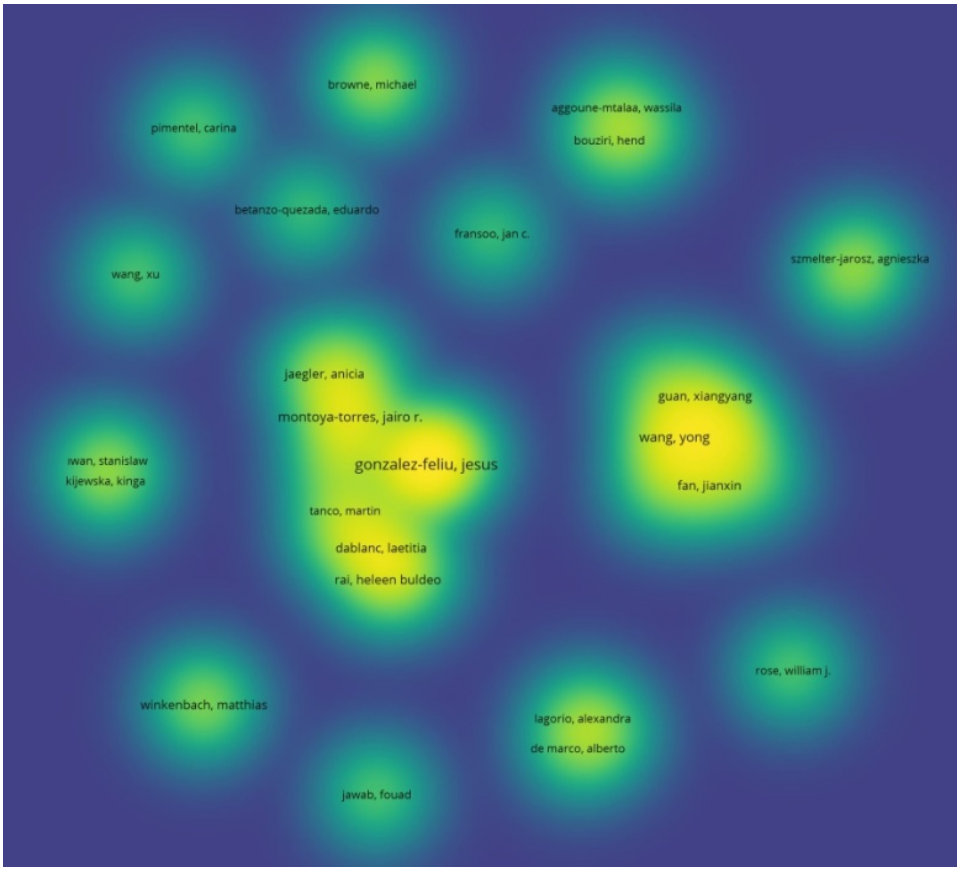

Fig.4 Researchers with the most publications and co-authorship (elaboration from VosViewer)

Fig.4 illustrates the distribution of publications and co-authorships among scholars who have made significant contributions to the field of technology-based applications in sustainable urban logistics. This figure shows the frequency with which the authors work together and the intensity of their collaborations. In the context of the analysis, it was observed that a total of 37 researchers had a minimum of five publications. The color of the field containing the names of the researchers varies based on the number of co-authorships, as depicted in Fig.4. Names with a vibrant blue hue are indicative of a limited quantity of co-authorships. Authors exhibiting a prevailing yellow hue tend to have a higher frequency of co-authorships. Jesus Gonzalez Feliu has the greatest number of co-authorships in this topic, with a total of 24 publications. According to the rankings, Yong Wang holds the second position with 14 publications, while Jairo R. Montoya-Torres ranks third with 13 publications. The researchers with the highest number of citations are presented in Tab.4.

Author Name	**Number of citation**
Jesus Gonzalez Feliu	302
Winkenbatc Matthias	277
Laetitia Dablanc	264
Alexandra Lagorio	226
Roberto Pinto	225
Jairo R. Montoya-Torres	210
Yong Wang	206
William J. Rose	193
Andrés Muñoz-Villamizar	184
Haizhong Wang	175

Tab.4 Most cited researchers

When Tab.4 is examined, it is seen that Jesus Gonzalez Feliu (302 citations) is the most cited author in the studies on the research topic. Winkenbatc Matthias (277 citations) ranks second and Laetitia Dablanc (264 citations) ranks third. The number of citations received by the countries where publications on the subject are made is shown in Fig.5.

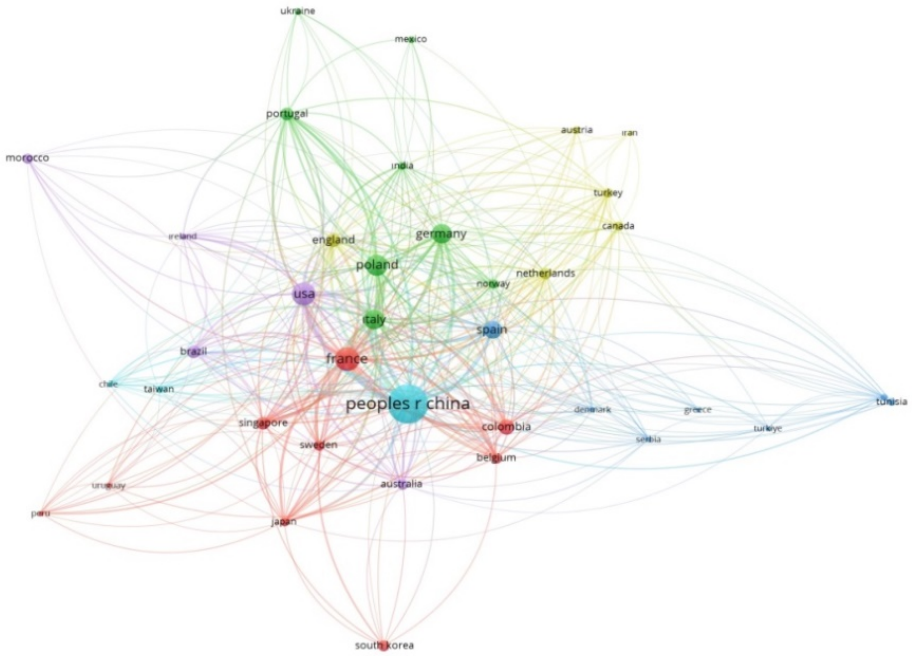

Fig.5 Most cited countries

Fig.5 shows the 39 countries with at least five publications and citations among the most cited countries. In this context, the most cited country is China (2,036 citations - 227 publications). China is followed by the USA (1,584 citations - 80 publications), France (1,410 citations - 87 publications), Italy (1,333 citations - 58 publications) and the UK (983 citations - 30 publications). There are also clusters and connections between countries.

Journal Name	Number of Publications
Sustaniability	71
Transportation Research Part E: Logistics and Transportation	20
Research in Transportation Business & Management	16
Transportation Research Part A: Policy and Practice	14
Journal of Transport Geography	14
Energies	13
Computers & Industrial Engineering	12
Applied Sciences	12
Transport Policy	11
Sustainable Cities and Society	10

Tab.5 Most published journals

Tab.5 shows the 10 journals with the highest number of publications. Sustainability journal was the most published journal with 71 publications (1,093 citations). In second place is Transportation Research Part E: Logistics and Transportation with 20 publications (495 citations). Research in Transportation Business & Management ranks third with 16 publications (213 citations). Sustainability journal stands out as the journal

with the highest number of publications in the related field. As its name suggests, the journal focuses on sustainability in logistics processes by publishing in a multidisciplinary field such as not only urban logistics but also sustainable development, environmental management and technology-based solutions.

2.2 Technological applications in sustainable urban logistics

The presence of commercial and industrial transport in urban areas significantly affects the quality of life in cities, primarily owing to external issues such as pollution and congestion (Abouelrous et al., 2023). The European Commission has implemented a range of measures and strategies aimed at mitigating the adverse effects of urban logistics on both congestion and the natural environment. One illustrative instance involves the growing adoption of cargo bicycles in urban logistics, which can be attributed to their enhanced energy efficiency, decreased emissions, and diminished traffic disruption (Melo & Baptista, 2017). The field of urban logistics has received significant attention in recent years. However, it is important to note that this area of study is continuously developing due to shifts in individuals' behaviors, including the rise of e-commerce and increased awareness of environmental concerns. Additionally, advancements in technology have facilitated the emergence of novel delivery methods, such as electric vehicles with enhanced autonomy, unmanned aerial vehicles (drones), and non-motorized or driverless vehicles. Nevertheless, despite its significance and increasing attention, the existing body of research pertaining to urban logistics is fragmented, impeding a comprehensive comprehension of the subject matter and posing challenges in identifying areas that require attention (Lagorio et al., 2016). This section explains the technology-based concepts used in sustainable urban logistics studies, which are shown in Tab.3. Today, technological innovations play an important role in making urban logistics processes more sustainable and efficient. In particular, digital platforms, data-based decision support systems and automation solutions enable more efficient use of resources and optimization of logistics operations (Marzani & Tondelli, 2024). Urban development is linked to social, economic and technological developments. New technologies create impactful changes in urban and regional systems. The city adapts to new opportunities related to ICT, energy and mobility (Russo et al., 2016). The importance of urban logistics is increasing as a result of increasing urban population density and the spread of e-commerce. Enhancing urban logistics efficiency and mitigating environmental effect necessitate the use of several solutions such as last-mile delivery, electric vehicles, vehicle routing, optimization, and crowdsourcing. When employed with caution, these solutions have the potential to mitigate urban traffic congestion, enhance air quality, and yield cost savings in logistics-related expenses. These strategies exemplify state-of-the-art logistics techniques that are bolstered by advancements in technology and infrastructure.

Last Mile Delivery

The final stage of delivery, known as last-mile delivery, is widely acknowledged as a costly phase in the supply chain, accounting for a substantial proportion of the total cost, which can range from 13% to 75%. Wei et al. (2024) state that this stage includes all the essential activities in the delivery process, from the last transit point to the final drop-off destination in the delivery chain. The current literature on last-mile delivery primarily examines the efficient use of resources, operational procedures, energy usage, distance coverage, and time management (Cardenas et al., 2017; Gevaers et al., 2011; Giuffrida et al., 2022; Golinska & Hajdul, 2012; Halldórsson & Wehner, 2020; Park et al., 2016; Ranieri et al., 2018; Staricco & Brovarone, 2016; Wiese et al., 2012). The concept of last-mile delivery pertains to the deliberate and systematic organization and implementation of delivery services, typically involving the conveyance of merchandise from specified locations, such as warehouses, to prearranged destinations as specified by customers. The term "last mile" denotes the moment when a courier package departs from the transportation system, namely the ultimate phase in the delivery procedure (Wei et al., 2024). The concluding phase of business-to-consumer parcel delivery involves the transportation of packages to consumers' residences, cluster/collection sites, or

warehouses, until the recipient either retrieves the parcel or redirects it to an alternative address. The emergence of retail and e-commerce trends has resulted in a heightened need for urban freight and last-mile delivery. The issue at hand is of significant importance to urban planners, parcel carriers, and people alike, as they endeavor to address the challenges posed by the escalating volume of freight within urban environments (Lyons & McDonald, 2023). Sustainable urban logistics encompasses last-mile delivery solutions that focus on efficiently managing transportation to the final recipient, with the aim of reducing environmental harm and generating social advantages.

In order to decrease external expenses and enhance customer service, logistics organizations must explore autonomous delivery alternatives (Engesser, 2023). Autonomous vehicles are one of the most prominent examples of technological innovation in urban logistics processes. These vehicles increase the efficiency of logistics operations while also ensuring environmental sustainability. Studies on the integration of autonomous vehicles into urban delivery processes reveal the positive effects of this technology on logistics operations (Belkouri et al., 2022). E-commerce companies are making efforts to provide increasingly prompt and efficient delivery services to their clients in order to boost their sales and market dominance. In this context, the organization endeavors to prioritize business efficiency through the adoption of strategies that facilitate the establishment of streamlined supply chains, resulting in cost reduction and enhanced delivery speed and efficiency. Hence, there is a need for activities that are both time- and cost-effective, while also being ecologically friendly, in order to effectively utilize resources (Prajapati et al., 2023). Especially in densely populated areas, accurately identifying delivery points contributes to reducing urban congestion and helping urban logistics operations achieve environmental sustainability goals. Currently, there is a growing trend in late mile delivery solutions that promotes the use of electric cars and the implementation of smart route planning techniques. These initiatives aim to identify the most efficient delivery routes, ultimately contributing to the reduction of carbon emissions.

Vehicle Routing

The optimization problem of vehicle routing involves the determination of optimal service sequences and routes from a warehouse to consumers that are geographically separated. This problem takes into consideration operational restrictions (Merdesic et al., 2023). Efficient management of transportation and distribution operations in the logistics business relies heavily on vehicle routing.

The field of urban logistics involves the effective administration and synchronization of transportation and delivery activities within highly populated metropolitan regions. This involves considering multiple elements, including population density, fluctuations in traffic patterns, customer preferences, and adherence to environmental rules (Merdesic et al., 2023). Manufacturing organizations strategically optimize the routing of their logistics network to minimize logistical expenses and maximize profits in a fiercely competitive market. Hence, the incorporation of efficient logistics management within the supply chain and the prompt addressing of consumers' demands are seen as supplementary avenues for generating profits (Lo & Chuang, 2023). When there is a strong demand and the package sizes are tiny, it is more cost-effective to use smaller delivery vehicles like cargo bikes and walkers. These vehicles are more ecologically friendly compared to larger delivery trucks (Bayliss et al., 2023). Hence, the implementation of a proficient vehicle routing strategy has the potential to enhance a company's profitability through the mitigation of transportation expenses. The selection of shorter routes has the potential to decrease fuel consumption and enhance operational efficiency through the reduction of empty turns. Efficient routes additionally contribute to environmental sustainability through the mitigation of carbon emissions and alleviation of traffic congestion.

Optimization

Traditional supply chain models primarily prioritize operational efficiency through the reduction of overall cost, lead time, defective products, unused capacity, and processing time. However, contemporary supply chain

models have expanded their scope to encompass environmental and social objectives alongside economic performance. The significance of this matter is heightened when taking into account the various phases of the supply chain, namely procurement, production, storage, distribution, and transportation. Additionally, it is crucial to consider the different types of supply chains, such as forward, reverse, and closed loop, as well as the different levels of decision making, namely strategic, tactical, and operational. Furthermore, the supply chain environment, characterized by certainty or uncertainty, also plays a noteworthy role in this context (Jayarathna et al., 2021). The prevalence of logistics optimization has experienced a substantial surge in recent decades. Organizations are required to make critical decisions while evaluating and modifying their logistics strategies, hence enhancing the efficiency of associated operational processes. The progress in computational capabilities, modeling tools, and organizations' commitment to dedicating time to modeling research has facilitated the rapid resolution of previously inefficient models (Bartolacci, 2012).

The transportation and logistics of goods are closely linked to climate change, particularly in relation to global warming caused by a range of pollutant sources. Hence, it is imperative to enact efficacious measures and regulations aimed at mitigating the escalating environmental harm caused by the rising emissions of vehicle pollution. Additionally, it is crucial to foster the establishment of sustainable and low-carbon regional transportation and logistics systems (Zhang et al., 2018). Currently, it is imperative for logistics enterprises to develop strategies that include the environmental consequences when formulating the most viable and economically efficient route plan for a certain delivery or service requirement.

Electric vehicles

Over 50% of the global population resides in urban regions, resulting in significant obstacles for urban transportation. These challenges include traffic congestion, the prevalence of private transportation, air pollution, noise pollution, and reliance on energy (Duarte et al., 2016). Prevalent instances of these effects include the influence on traffic congestion created by commercial vehicles, the decrease in road capacity resulting from frequent stops for loading or unloading activities, and the subsequent increase in energy consumption and emissions. Electric cars utilize an electric motor as their power source, as opposed to a traditional internal combustion engine, and are comparatively smaller in size when compared to regular commercial vehicles. Electric vehicles are more convenient for parking compared to vans or trucks powered by internal combustion engines in logistical operations. Additionally, they are widely acknowledged by the public as being safer and more ecologically beneficial (Melo et al., 2014). Electric vehicles are widely recognized as a significant technological advancement that has the potential to enhance the resilience and sustainability of supply chains through the mitigation of greenhouse gas emissions and air pollution (Khan et al., 2023).

The use of electric vehicles plays a critical role in reducing carbon emissions as well as improving energy efficiency in cities. They not only reduce energy consumption in logistics processes, but also affect the spatial and temporal management of cities. Accordingly, urban planners are taking steps to reduce traffic congestion and air pollution by making strategic decisions such as the location of charging stations and the integration of electric vehicles into traffic (Martinelli, 2024). Therefore, regarding urban logistics, electric vehicles are increasingly being regarded as a more ecologically sustainable option. The use of electric vehicles within urban settings is progressively gaining significance in relation to both economic and environmental sustainability, owing to their lower carbon emissions compared to conventional fossil fuel-powered automobiles.

Crowdsourcing

Crowdsourcing is a strategic approach employed by enterprises or institutions to mobilize individuals using digital platforms, such as websites or applications, with the aim of accomplishing a certain objective. The emergence of this strategy can be attributed to the rapid expansion of internet users, the widespread presence of collaborative networked networks, and heightened consumer consciousness. The creation of the sharing economy has been facilitated by various causes, leading to the development of new business modes (Bin et

al., 2020). Currently, crowd logistics pertains to the practice of corporations or retailers delegating the distribution of products to public entities that possess flexible schedules, ample time, and transportation capabilities, utilizing the internet as a medium. Mass logistics offers the benefit of enhancing distribution efficiency and minimizing mobility when compared to conventional logistics methods (Renard et al., 2014). According to Samad et al. (2023), crowd logistics refers to a conceptual framework in which logistical activities are chosen from a group of individuals who are either private or public travelers. These logistics operations are then facilitated through an online platform, with the aim of providing advantages to the relevant stakeholders. The organization and execution of urban logistics have undergone substantial transformations due to the ongoing growth of the sharing economy and advancements in information and communication technologies. The concept of mass logistics has recently gained prominence as a novel approach to organizing logistics operations, particularly in the context of urban logistics. As mass logistics becomes increasingly crucial in addressing the final stage of delivery in numerous locations, the ongoing participation of mass workers has emerged as a significant factor impacting the expansion of the mass logistics platform (Huang et al., 2020). Hence, crowdsourcing in the context of urban logistics is widely acknowledged as an effective approach. This phenomenon enhances the economic growth of the local community, expedites the process of delivery, and contributes to the expansion of logistical networks.

3. Conclusion

The efficient transportation of material flows from the producer to the end user is one of the main objectives of logistics today. Current scientific approaches focus on finding solutions to different problems at various logistics system stages. However, the efficiency of the functioning of logistics systems differs from issues related to improving overall productivity, including the end-user. Social, economic and technological progress are all related to urban development. Transitions in economic structures, urbanization, urban planning and transportation systems, as well as externalities related to logistics activities in urban areas, make supply chains and logistics issues more complex than ever. The development and advancement of transportation networks, infrastructure and logistics operations in the context of environmental sustainability is critical to tackling these issues.Urban logistics is a critical component for the development of cities in terms of both economic and environmental sustainability. With the growth of cities, effective management of logistics operations requires efficient use of urban infrastructure and reduced environmental impacts. Effective management of urban logistics improves the quality of life in cities by enhancing environmental sustainability and is a driving force in increasing competitiveness by helping businesses reduce costs. Urban and regional systems are actively changing and evolving through new technologies. Cities are adapting to new opportunities in the areas of energy, mobility, information and communication technologies. Especially in recent years, urban logistics has become increasingly important due to the growth of e-commerce and the increase in urban population density. Implementation of various strategies such as crowdsourcing, electric vehicles, vehicle routing, optimization and last stage delivery are crucial for increasing urban logistics efficiency and reducing environmental impacts. When implemented correctly, these strategies can reduce traffic in cities, improve air quality and save logistics-related costs. The findings of the study are broadly in line with the main trends towards sustainable urban logistics processes in the existing literature (Duarte et al., 2016; Cardenas et al., 2017; Bin et al., 2020; Ravagnan et al., 2022; Gargiulo & Sgambati, 2022; Rosales & Haarstad, 2023; Baker et al., 2023; Marzani & Tondelli, 2024). In particular, the integration of autonomous and electric vehicles into logistics processes offers significant opportunities to both increase operational efficiency and reduce carbon emissions. Duarte et al. (2016) stated that the use of electric vehicles in the logistics sector has a significant potential to reduce environmental impacts, and these findings are supported in this study. Bin et al. (2020) emphasize that the integration of crowd logistics and other technological innovations plays a key role in ensuring sustainability in

logistics operations. Belkouri et al. (2024) emphasized that the integration of autonomous and electric vehicles into urban logistics processes is critical for increasing energy efficiency and reducing carbon emissions.
Another striking element in the bibliometric analysis is the diversity of keywords used in studies from different countries. While studies in China focus more on concepts such as 'electric vehicles' and 'optimization', research in Europe focuses on topics such as 'last-mile delivery' and 'crowdsourcing'. These differences suggest that each country is turning to different technologies according to its own sustainability strategies. Therefore, this study aims to reveal how sustainable urban logistics is addressed in different disciplines and countries.
An important gap in terms of contributing to the literature and guiding researchers in the field is the limited number of comprehensive studies on sustainable urban logistics and technology-based applications used in this field in international and national studies. Based on the results of such a bibliometric analysis, researchers working in the field of sustainable urban logistics can have a deeper understanding of the relevant literature. It is recommended that future studies should consider different databases instead of focusing only on specific indices and evaluate the studies in these databases in the analysis. In addition, the use of visualization tools such as VOSviewer will enable comprehensive analyses in other databases such as SCOPUS, EBSCO Host, etc. without being limited to Web of Science. Again, in future research, it will be possible to analyze the data obtained by using tools such as Citespace and R Studio, which are different visual mapping programs, more comprehensively and to make comparisons on a more solid basis. Using these methods, research on sustainable urban logistics can contribute more to the literature and help improve knowledge in this field.

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Author's profile

Suzan Oguz

She is an Assistant Professor at the Foreign Trade Department of Cag University in Mersin, Turkiye. She received her doctorate degree from the Department of International Trade and Logistics at Akdeniz University in Antalya, Turkiye. Her research interests are international trade, logistics and supply chain management.

Mehmet Tanyas

He is a Professor Doctor at the Department of International Trade and Logistics at Maltepe University in İstanbul, Turkiye. He is also the head of the International Trade and Logistics Department at the university. His research interests are logistics and supply chain management.