

Urban mobility implications of last-mile delivery – A systematic literature review

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ABSTRACT

Urban delivery has undergone significant transformation in the past years. Analysing last-mile delivery under the umbrella of urban mobility requires considering a variety of stakeholders with different and sometimes conflicting perspectives and interests. This article analyses the effects of delivery services on urban mobility based on a systematic literature review (PRISMA) of Scopus and Web of Science databases (2010 – 2024) yielding 235 documents. The findings aim to guide future urban planning strategies that accommodate rapid change and promote liveable cities for their residents. The review assesses future last-mile delivery solutions in light of expected urban mobility scenarios, highlighting emerging market possibilities and operational approaches. The paper clarifies key themes, identifies research trends and gaps, synthesizes existing knowledge, and proposes future research directions. While existing research acknowledges the negative impact of last-mile delivery on urban mobility, it often focuses narrowly on either new technologies and operational costs or environmental issues, neglecting a holistic approach to sustainable urban mobility planning. Despite the topic's importance, this area remains under-researched, presenting significant opportunities for further academic investigation into improving urban mobility to accommodate this growing trend.

Introduction

As cities are considered the centres of a globalised society, the transport sector can be considered its foundation, facilitating the movement of people, goods, and services through efficient transport systems, infrastructure, and logistical operations. Urban logistics, a concept similar to city logistics, comprises the coordination of transportation and logistics activities in urban environments through an integrated system. It aims to support economic and social development while mitigating the challenges associated with transporting goods in urban areas (Crainic, 2008). Despite its importance, urban logistics remains a major contributor to delivery costs and road traffic, accounting for up to 53% of delivery costs, generating between 20–30% of road traffic and representing between 20–30% of vehicle-kilometres travelled (Muriel et al., 2022).

Existing literature often treats urban logistics as a standalone operational challenge, overlooking its broader implications for urban mobility systems. Despite a coordinated approach to urban mobility planning through common European planning frameworks and the application of sustainable urban mobility planning (SUMP) frameworks

even beyond Europe, city logistics, goods transport and last-mile implications receive considerably less attention than people's mobility (Munkácsy et al., 2024). This paper addresses this gap by examining last-mile delivery through the lens of urban mobility planning.

The development and constant growth of urbanisation, demographic shifts, and the expansion of e-commerce have intensified the demand for urban freight transport (Perboli and Rosano, 2019). Among these, last-mile delivery has emerged as a critical component of city logistics, impacting patterns of transport within urban environments (Visser et al., 2014; Campisi et al., 2023). Whereas last-mile delivery is crucial for the economic prosperity, environmental health, and quality of life in cities, it remains insufficiently integrated into city planning strategies, particularly in developing nations. The lack of dedicated policies and stakeholder accountability has led to inefficiencies, with last-mile emissions contributing approximately 25% of total logistics supply chain emissions, generating environmental degradation, and accounting for 28% of total transport costs (Smart Freight Centre, 2017).

Forecasts suggest that by 2030 last-mile delivery will increase by 78%, and the movement of delivery vehicles in cities would trigger a 21% increase in congestion, making a commuting trip 11 min longer in

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2030 compared with 2010 (Lozzi et al., 2022). This trend is largely due to the growth in demand and consumption of products purchased online and the rise of on-demand logistics, characterised by frequent, low-volume delivery. The last-mile phase can be characterised as the least efficient stage of the supply chain, often facing congested traffic, an increase in the number of trips with low vehicle load levels and reduced fuel efficiency, posing significant challenges to urban mobility systems that are not planned to accommodate such demand (Muriel et al., 2022; Campisi et al., 2023). Therefore, the topic deserves urgent attention from researchers, governments, and other stakeholders to ensure sustainable and feasible solutions. This study will investigate into what extent the last-mile delivery has been studied in relation to urban mobility and urban mobility plans. While technological solutions are often proposed, their effectiveness is rarely evaluated in the context of urban mobility systems. This study addresses this gap by assessing the influence of last-mile delivery on mobility planning and infrastructure readiness.

Although innovations such as drones, cargo bikes and autonomous vehicles are widely discussed and tested to address last-mile issues, only a few studies examine their integration into the urban mobility scope. Last-mile delivery not only reshape freight logistics, but also influences personal mobility, land use, and urban planning. Urban services and spaces must be designed by city planners to accommodate the ever-changing ways people move around the city (Bjorgen et al., 2021). Highlighting the challenges in last-mile is vital, as understanding the interaction between last-mile delivery and urban mobility becomes essential for developing inclusive and sustainable transport systems.

This paper contributes to the interdisciplinary discourse by conducting a comprehensive systematic literature review that synthesises existing research on last-mile delivery within the context of urban mobility. It identifies key thematic areas and emerging trends, highlights critical research gaps – especially in planning and policy integration – and proposes a future research agenda to guide sustainable urban freight and city logistics strategies.

By combining logistics, planning, and sustainability perspectives, this paper aims to inform both academic researchers and practical solutions. Therefore, it seeks to clarify the main thematic trends in last-mile delivery research, identify the gaps that limit its integration into urban mobility planning, and outline promising directions for future research. The structure is as follows: Section 2 defines last-mile delivery and its typologies; Sections 3 and 4 detail the methodology and present the results of the systematic literature review; Section 5 discusses the findings in relation to urban mobility planning; and Section 6 concludes with implications for future research and policy development.

Last-mile delivery definition and types of delivery

The term “last-mile delivery” is nowadays regularly used but with a few competitive definitions. According to Boysen et al. (2021, p. 4.) a common understanding is that “last-mile delivery starts once a shipment has reached a starting point in an urban area, e.g., a central depot after long-haul transportation, and ends once the shipment has successfully reached the final customer’s preferred destination point”. In a broader sense, last-mile delivery is the last stage of the supply chain before the recipient receives their product/parcel, where the driver delivers the product/parcel to the customer’s location. This location can be their residence, a business premise, or a public location such as a locker. From the supply chain perspective, it can account for 53% of shipping costs (Freightwaves, 2022), which goes against the main goal of profitability from retailers, aiming for cost-saving measures.

In a broader sense, from an urban mobility perspective, last-mile delivery includes the final leg, i.e., how the product/parcel is moved to its destination not only by a courier but also by the customer, for example from a collection point or parcel locker to their home or another location. Table 1 below presents some of the main last-mile

Table 1
Main types of last-mile delivery.

Type of last-mile delivery	Definition	Main characteristics from urban mobility perspective
Home delivery	The delivery made directly to the final recipient, on their home address or another address (e.g. family member, the office).	It will likely cause supplementary traffic congestions and environmental problems in urban areas (Park and Regan, 2004), aggravated by the fact that large goods with large frames causes 12% chance of failure of delivery (Visser et al., 2014) resulting in extra trips.
Collection points	Available via staff or self-service kiosks in locker boxes (Rai et al., 2020). Goods are delivered to the collection point and informed to the customer, who can then pick up the item.	It can offer a more efficient and flexible alternative to home delivery, quoted as a more sustainable method. It is necessary to consider not only the journey of the courier to the collection point, but also the journey of the customer to pick it up, and whether green modes are used to do so.
Parcel Lockers	Is a collection point usually 24/7 where customers can have complete autonomy while picking up their parcel. It can be used as a delivery address, alternative delivery location, and/or as a service by logistics operators in a customer return strategy (Lagorio and Pinto, 2020).	An intelligent solution located in strategic and easily accessible places to avoid/decrease customers route deviation. It requires the consumer to make the final leg of the journey. The absence of specific regulations restricting the creation of parcel locker networks; and the risk of parcel lockers poor design can be challenging (Lozzi et al., 2022).
Click and collect	Popular among retailers, where products are picked up by customers at the e-retailer’s physical store or at a pre-defined central collection point, reducing the price of the product, the transportation cost for the company and possible missed deliveries (Milioti et al., 2020).	It can be less polluting than delivery directly to the final consumer, depending on how they transit in the city to pick up the order at the collection point (whether by car, public transport or active mode). The association of delivery at collection points with the incentive to use public and/or active transport can become a sustainable action.
Crowd-shipping	An app-based method used to deliver packages to customers, by connecting an individual that is willing to ship a packet with someone keen to carry it in the first or last-mile of urban areas (Le and Ukkusuri, 2019), leveraging non-professional and local couriers’ services.	This type of delivery can represent a passenger-freight transport integration, but it is difficult to manage the platform and the role of regulations (Lozzi et al., 2022). It doesn’t represent necessarily an additional trip for the courier, as they can take advantage of typical travel patterns, choosing the closest to the delivery route and offering a cheaper delivery fee (Le and Ukkusuri, 2019).
Off-hour delivery	It is the distribution of packages off-peak hours, to distribute the traffic more evenly during the day, achieve decongestion and more efficient operations (Gatta et al., 2019).	It can combine parcel lockers, electric vehicles and urban consolidation centres, for example, promoting internal and external cost-reduction. Whilst it lowers the risks for pedestrians, is more efficient in loading and unloading activities (Lozzi et al., 2022).

delivery methods.

Understanding the prevalent last-mile delivery methods is crucial for assessing their environmental and urban mobility impacts across different urban locations. Analysing the various options allows for a comprehensive understanding of each method’s implications, facilitating the integration of relevant research into urban planning.

Systematic literature review

A systematic literature review targets to select and analyse existing knowledge in the field, from which research priorities can be identified, such as research gaps and problem identification (Page et al., 2021). For this aim, this paper conducts the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to guarantee scientific rigour and a transparent search process. It focuses on a clearly defined topic derived from the research questions and applies pre-determined criteria for document search and selection, evaluating and synthesising the evidence in research (Page et al., 2020).

Research questions

As mentioned in the introduction, despite the growing interest in last-mile delivery in urban contexts, its integration into mobility planning remains underexplored. To address this gap, to synthesise existing knowledge on last-mile delivery and its implications for urban mobility, identify research gaps, and propose directions for future inquiry, this review is guided by the following research questions:

RQ1: What are the key research interests for last-mile delivery within the context of urban mobility, how can these areas be categorised, and what emerging trends can be observed?

RQ2: What are the main research gaps that require attention?

RQ3: What are the promising avenues for future research on last-mile delivery within urban mobility, considering both the opportunities and challenges involved?

These questions aim to bridge the gap between logistics-focused studies and urban mobility planning, as highlighted by Bjørgen et al. (2021) and Lozzi et al. (2022).

Methodology

This review maps last-mile delivery using journal articles and grey literature. The literature search includes academic research articles, conference papers, and case study reports published between 2010 and 2024 in English. Studies prior to 2010 were not included to examine up-to-date studies only, as several methods for last-mile delivery have been recently developed and implemented. The search strategy (Table 2) used the databases from Scopus and Web of Science up to 06 September 2025 and was based on five strings separated by proper Boolean operators as follows: Urban AND Mobility AND last AND mile AND delivery. The search was refined by title, abstract and keywords, resulting in 118 documents from the SCOPUS database, and 117 documents from the Web of Science database, summing up a total of 235 documents combined with grey literature. After removing 57 duplicates, 178 unique records remained. Finally, to construct this systematic methodology a snowball approach was also applied adding 4 more documents to the analysis, resulting in 182 records for title/abstract screening.

The following step involved ranking the relevant papers using the SCImago database. The analysis of the abstracts, as well as the accessibility of the articles, marks an eligibility criterion focusing on the connection between last-mile delivery and urban mobility, including integration and impact. The screening resulted in the exclusion of 83 papers that did not meet the inclusion criteria, leaving 99 for a full-text assessment based on their relevance to the main research purposes of this study. Of these, 75 papers were excluded with reason (e.g. limited

Table 2
Paper selection criteria.

Items	Description
Database	Scopus, Web of Science, and SCImago
Language	English
Time interval	2010—2024
Inclusion criteria	Urban AND Mobility AND last AND mile AND delivery

connection to planning, urban infrastructure, and policy; insufficient focus on last-mile delivery within urban mobility; inaccessibility of full text for analysis). A total of 24 studies were included in the qualitative synthesis.

Thematic categorisation

In the second phase, we analysed the content of the remaining papers by categorising them according to their primary subject matter. This descriptive categorisation aimed to assess how extensively they addressed the impact of last-mile delivery on urban mobility, and to clearly identify key elements central to urban mobility. To analyse the literature, papers were categorised into eleven thematic areas:

- New technologies and solutions (e.g., drones, cargo bikes, autonomous vehicles, and light-duty vehicles);
- Sustainability
- Urban plan
- Urban mobility plan and Mobility plan
- City/urban logistics
- Shared mobility/economy
- Crowdsourcing
- Parking
- Regulations and policies
- Pollution (air, noise)
- Operational cost and profitability

These categories were selected for their relevance and frequent citation within the literature. The classification of each study relevant to this paper can be found in Appendix 1. Papers marked with a “✓” substantially address the category, either as a primary focus or through a dedicated significant section. Papers without a “✓” lack meaningful engagement with the category.

Following this initial analysis the next section presents the results of the systematic review and highlights under-represented themes such as planning, policy, and infrastructure, offering a foundation for interdisciplinary research that connects logistics, urban planning, and sustainability.

Results

This section presents a structured synthesis of the reviewed literature, categorised by thematic focus and analysed for trends, gaps, and future research directions.

Publication trends

The great majority (76%) of the publications were published between 2020 and 2024, highlighting the growing significance of last-mile delivery as a crucial element reshaping urban mobility (Fig. 1). The high note was reached in 2021, with over one-fourth of the publications. This trend, fuelled by critical delivery challenges experienced during the COVID-19 pandemic, reflects the growing urgency to address urban freight challenges considering e-commerce expansion and sustainability goals (Lozzi et al., 2022, Campisi et al., 2022).

The distribution of the studies is quite diverse across journals and other publication types, with no dominant journal or clear trend. In total, there were 53 different journals, conferences, and grey documents. The journals with the greatest selection for publications under this topic can be seen in Fig. 2.

Thematic distribution

Of the 99 reviewed documents, 87 focuses on technologies and solutions as the main approach of the paper (Fig. 3). These papers suggest that such innovations will significantly mitigate, or even resolve, urban

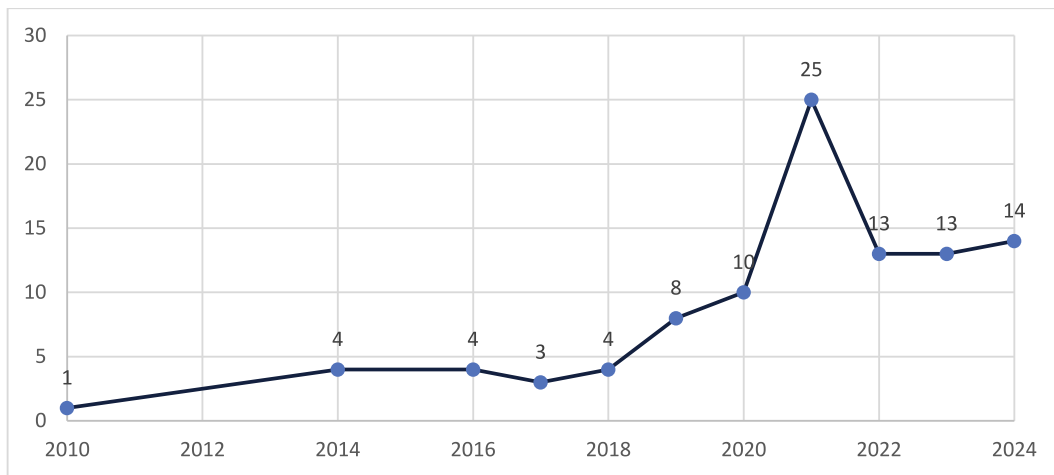


Fig. 1. Number of papers per year of publication.

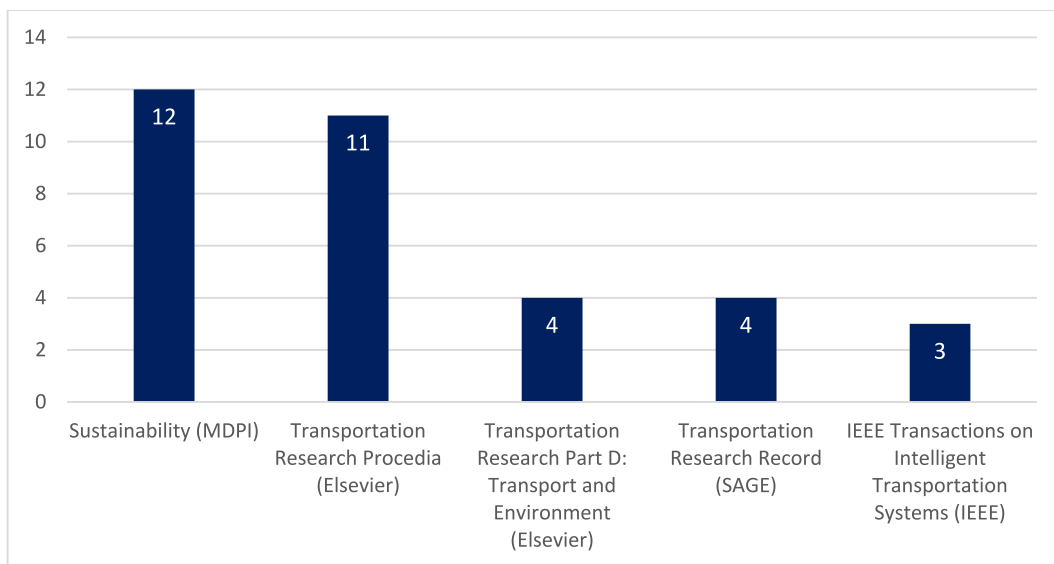


Fig. 2. Distribution of publications per journal.

mobility challenges, leading to reduced traffic congestion, enhanced city logistics, lower operational costs, faster delivery times, increased sustainability, and reduced pollution.

Eighty-seven studies emphasised environmental concerns and carbon reduction strategies, highlighting sustainability as a key factor when connecting urban mobility with last-mile delivery. Seventy-six studies addressed air and noise pollution linked to delivery operations. Shared mobility and crowdsourcing were underlined in 28 and 14 of the documents, respectively.

City logistics and operational cost were frequently on the spotlight, usually as a justification for the implementation of a new solution, and to attract stakeholder attention, since budget and time are important KPIs. City logistics appeared in 72 papers, exploring logistics frameworks and urban freight models, while 70 papers depict the operation cost to implement the suggested change on the document. A much smaller number of papers focused on urban planning (20), urban mobility (30), parking spaces (23) and policies (43). This reflects that the research field remains limited in exploring last-mile delivery’s impact on urban environments and requiring sustainable mobility plans that address infrastructure and regulatory improvements for this emerging trend.

Of the 99 documents reviewed, only 24 clearly addressed thematical elements central to this study. Although 30 papers mentioned or

discussed urban mobility, whether emphasising its significance or examining related areas of study, not all were pertinent to this specific research focus. Fig. 4 represents the entire systematic literature review process and illustrates how the final 24 papers were selected.

The selected papers were analysed, summarized, and their key findings highlighted. Table 3 provides a complete list of these papers.

Key findings

Most research focuses on technology-based solutions, frequently neglecting the importance of planning and policy. While sustainability is a common theme, few studies offer comprehensive solutions that merge logistics with urban mobility strategies. Despite being crucial for efficient deliveries, infrastructure problems such as parking, cycling infrastructure, and road access receive insufficient attention (Muriel et al., 2022; Orhan et al., 2024; Gruber et al., 2024).

Strategic urban and mobility planning must incorporate last-mile delivery to prevent future mobility challenges by acting strategically and in an orientated manner, as advocated by numerous researchers (Bjørngen et al., 2021; Lozzi et al., 2022; Muriel et al., 2022; Serrano-Hernandez et al., 2021; Raia et al., 2020; Pettersson et al., 2018; Bjørngen and Ryghaug, 2022; Navarro et al., 2021; Bucchiarone et al.,

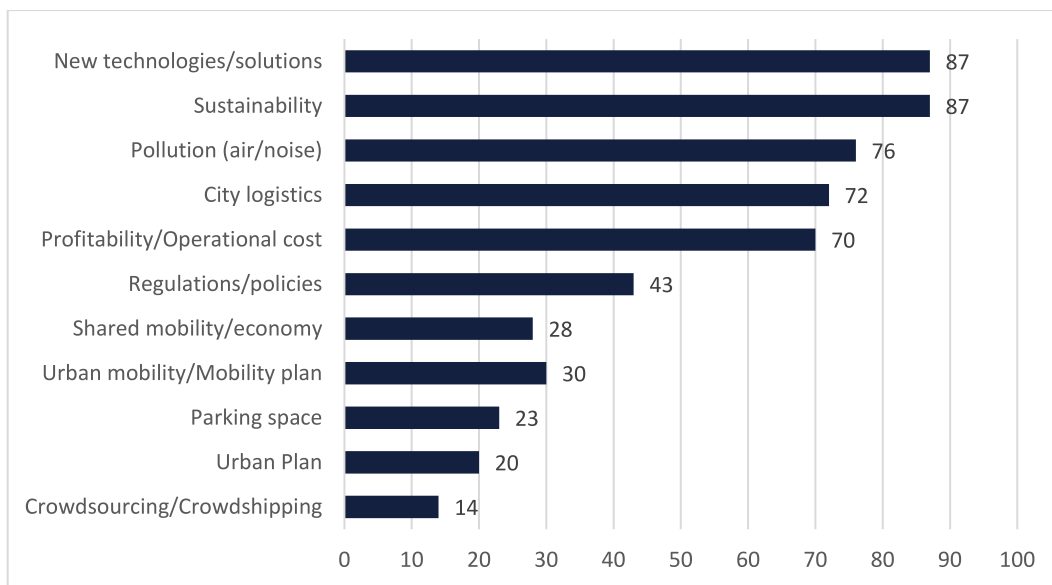


Fig. 3. Main topics covered by papers.

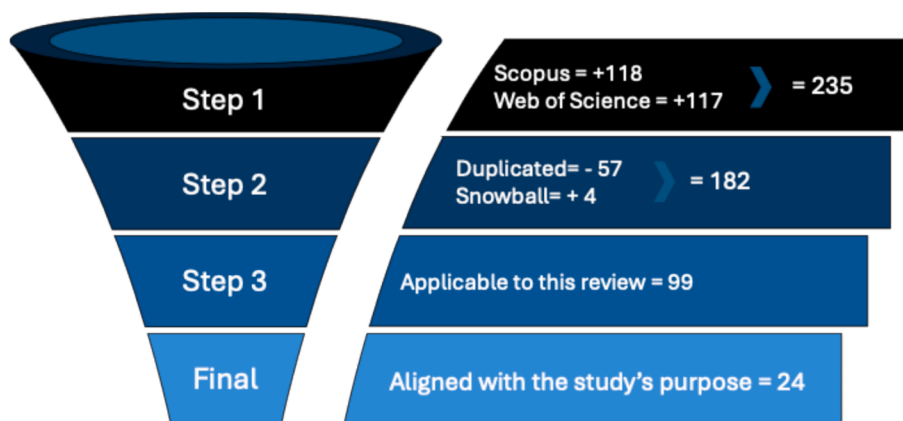


Fig. 4. Systematic literature review infographic.

2021; Smart Freight Centre, 2017; Orhan et al., 2024; Campisi et al., 2023; Chatziioannou et al., 2024; Oguz and Tanyas, 2024; Leerkamp et al., 2023). The aim is to develop effective solutions that create a comprehensive and inclusive transportation system for everyone.

Some studies also explore the impact of this emerging trend on mobility in the city planning and urban spaces (e.g. Bjørgen et al., 2021; Petterson et al., 2018; Bjørgen and Ryghaug, 2022; Navarro et al., 2021; Smart Freight Centre, 2017). Despite data-driven methods are recognised as crucial for improving urban logistics, significant gaps regarding the accessibility, quality, and standardisation of mobility and logistics data persist. These limitations frequently obstruct the development and evaluation of effective policies and technological innovations (Rześny-Cieplińska, 2023; Sochor et al., 2023).

Proposed solutions in the literature include car restrictions, eco-friendly vehicles, shifts toward soft travel modes (promoting walking, cycling, and public transport), local mobility hubs, increased parking, strategic planning, adjusted delivery schedules, and improved data access, with standardisation, and consistency. Table 4 reflects a detailed overview of papers emphasising these solutions.

Policies and regulations are key to provide changes that best suit these scenarios, and guarantee quality of life, safety and integrity to the population. With good policies and regulations, it is possible to best adapt to new solutions into the urban mobility scheme (Jaller et al., 2020),

enhance sustainability of Urban Freight Distribution together with the increased communication with logistics (Castillo et al., 2022), impose administrative measures that will limit in some extent the current scenario and provide advantage to innovative solutions that may help achieve sustainability, always having stakeholders involved (Lozzi et al., 2022), and make sure that last-mile delivery and e-commerce are mentioned on the municipal planning documents (Petterson et al., 2018). The Smart Freight Centre (2017) further stresses the need to integrate urban freight into transport, land use, and economic development strategies of cities, supported by sustainable freight policies to guide the development of appropriate activity, regulations and investments.

Sustainability, as a global warning, is mentioned in all papers. Sustainable last-mile delivery requires a holistic approach that considers environmental impacts, including reduced carbon emissions and the growth of e-commerce. This necessitates more efficient logistics, supported by the crucial role of urban planning in fostering sustainable transportation (Bjørgen et al., 2021; Castillo et al., 2022; Rai et al., 2020; Serrano-Hernandez et al., 2021; Bjørgen and Ryghaug, 2022; Petterson et al., 2018; Smart Freight Centre, 2017; Chatziioannou et al., 2024). Some papers further analyse key challenges to sustainable last-mile delivery, such as congestion, inefficiencies, and consumer behaviour, proposing solutions that include green technologies (electric vehicles, cargo bikes), optimised logistics, and sustainable urban freight strategies

Table 3
Literature review regarding last-mile under the scope of urban mobility.

Authors	Year	Title	Journal
Bertolini et al.	2024	Sustainable Last-Mile Logistics in Economics Studies: A Systematic Literature Review	Sustainability
Bjørgen and Ryghaug	2022	Integration of urban freight transport in city planning: Lesson learned	Transportation Research Part D
Bjørgen et al.	2021	E-groceries: Sustainable last mile distribution in city planning	Research in Transportation Economics
Boggio-Marzet et al.	2023	Selection of policy actions for e-commerce last-mile delivery in cities: An online multi-actor multi-criteria evaluation	Transport Policy
Bucchiarone et al.	2021	Autonomous Shuttle-as-a-Service (ASaaS): Challenges, Opportunities, and Social Implications	IEEE
Campisi et al.	2023	Assessing the Evolution of Urban Planning and Last Mile Delivery in the Era of E-commerce	CSUM 2022, Springer Nature Switzerland AG
Castillo et al.	2022	COVID-19 Lockdown as an Opportunity to Rethink Urban Freight Distribution: Lessons from the Barcelona Metropolitan Area	Transportation Research Interdisciplinary Perspectives
Chatziioannou et al.	2024	Urban Environment's Contributory Factors for the Adoption of Cargo Bike Usage: A Systematic Literature Review	Future Transportation
Gruber et al.	2024	Car or Cargo Bike? Determinants for the Use of a Small Vehicle Type in Urban Logistics: A Stated Preference Survey Among Commercial Transport Operators	SAGE
Jaller et al.	2020	Automation, Electrification, and Shared Mobility in Urban Freight: Opportunities and Challenges	Transportation Research Procedia
Leerkamp et al.	2023	Delivery robots as a solution for the last mile in the city?	Springer
Lozzi et al.	2022	On-Demand Logistics: Solutions, Barriers, and Enablers	Sustainability
Malafaia et al.	2024	A Multi-Stakeholder Information System for Traffic Restriction Management	Logistics
Muriel et al.	2022	Assessing the Impacts of Last Mile Delivery Strategies on Delivery Vehicles and Traffic Network Performance	Transportation Research Part C
Navarro et al.	2021	Understanding urban logistics and consumer behavior in Sao Paulo city	Elsevier
Oguz and Tanyas	2024	Technological Applications in Sustainable Urban Logistics: A Systematic Review with Bibliometric Analysis	TeMA – Journal of Land Use, Mobility and Environment
Orhan et al.	2024	Disconnecting a city centre to prevent through traffic: An a priori evaluation with a focus on freight transport	Transportation Research Part A
Perboli and Rosano	2019	Parcel delivery in urban areas: Opportunities and threats for the mix of traditional and green business models	Transportation Research Part C
Pettersson et al.	2018	E-commerce and urban planning – comparing knowledge claims in research and planning practice	Urban, Planning and Transport Research
Raia et al.	2020	How are consumers using collection points? Evidence from Brussels	Transportation Research Procedia
Rześny-Cieplińska, J.	2023	Overview of the practices in the integration of passenger mobility and freight deliveries in urban areas	Case Studies on Transport Policy
Serrano-Hernandez et al.	2021	The Urban Freight Distribution in Medium Size Cities: Descriptive Data Taken From Pamplona (Spain) and Angers (France)	Transportation Research Procedia
Smart Freight Centre	2017	Developing a Sustainable Urban Freight Plan — A Review of Good Practices	Smart Freight Centre
Sochor et al.	2023	HALLO: Hubs for Last Mile Delivery Solutions in Barcelona and Stockholm	Transportation Research Procedia

Table 4
Proposed solutions by the literature related to strategic urban and mobility planning.

Category	Number of Papers	References
Strategic plan	16	Bjørgen et al., 2021; Bjørgen and Ryghaug, 2022; Lozzi et al., 2022; Muriel et al., 2022; Pettersson et al., 2018; Serrano-Hernandez et al., 2021; Oguz and Tanyas, 2024; Bertolini et al., 2024; Boggio-Marzet et al., 2023; Campisi et al., 2023; Chatziioannou et al., 2024; Leerkamp et al., 2023; Sochor et al., 2023; Rześny-Cieplińska, 2023; Orhan et al., 2024; Malafaia et al., 2024
Car restriction	5	Bjørgen et al., 2021; Bjørgen and Ryghaug, 2022; Malafaia et al., 2024; Orhan et al., 2024; Campisi et al., 2023
Parking strategies	6	Bjørgen and Ryghaug, 2022; Lozzi et al., 2022; Muriel et al., 2022; Perboli and Rosano, 2019; Chatziioannou et al., 2024; Gruber et al., 2024
Local mobility hubs	7	Bjørgen et al., 2021; Lozzi et al., 2022; Muriel et al., 2022; Bertolini et al., 2024; Boggio-Marzet et al., 2023; Sochor et al., 2023; Rześny-Cieplińska, 2023
Adjust delivery schedules	4	Lozzi et al., 2022; Muriel et al., 2022; Pettersson et al., 2018; Boggio-Marzet et al., 2023
Ecofriendly vehicles	14	Bjørgen et al., 2021; Bjørgen and Ryghaug, M, 2022; Lozzi et al., 2022; Perboli and Rosano, 2019; Pettersson et al., 2018; Serrano-Hernandez et al., 2021; Oguz and Tanyas, 2024; Bertolini et al., 2024; Campisi et al., 2023; Chatziioannou et al., 2024; Leerkamp et al., 2023; Sochor et al., 2023; Orhan et al., 2024; Gruber et al., 2024
Improving data access	4	Bjørgen et al., 2021; Bjørgen and Ryghaug, 2022; Rześny-Cieplińska, 2023; Sochor et al., 2023

(Lozzi et al., 2022; Navarro et al., 2021; Muriel et al., 2022; Perboli et al., 2019; Boggio-Marzet et al., 2023). The crucial element is the integration of urban freight transport into city planning.

Parking places, traffic congestion, and infrastructure needed for the working force of the last-mile delivery and the ordinary population is another topic stressed in some of the papers. Perboli and Rosano (2019) covers the difficulties in finding parking places and the time spent to do it, generating more CO₂ emissions. Castillo et al. (2022) points out the need for reducing traffic congestion and adapting public spaces to the needs of the sustainable future. Muriel et al. (2022) focus on the lack of parking infrastructure for loading zones, emphasising the last-mile delivery and urban planners' problems with traffic conditions and conflicts

of road users. Rai et al. (2020) states the importance of the type of transport mode chosen to pick up missing deliveries and the peculiarities caused by them, generating an awareness to the quality of public and green transportation offered in the city. Navarro et al. (2021) highlights the problem of couriers with the lack of infrastructure regarding road conditions, security, adequate cargo loading area and parking spaces.

Research gaps

Despite the growing body of literature on last-mile delivery, several critical gaps remain in understanding its integration with urban mobility. According to the reviewed literature, one major gap is the

limited connection between last-mile logistics and urban mobility planning. Specifically, there's a scarcity of research examining how delivery systems are integrated within comprehensive city-wide strategies (Pettersson et al., 2018; Bjørgen et al., 2021; Rzeźny-Cieplińska, 2023). Successful urban logistics and last-mile delivery depend heavily on strong stakeholder engagement and collaborative governance. However, this vital aspect is frequently neglected. Municipalities, logistics companies, and residents are often excluded from the planning and execution of delivery solutions. This lack of involvement obstructs comprehensive and efficient planning, underscoring both the inadequate stakeholder participation and the absence of well-coordinated governance (Lozzi et al., 2022; Bjørgen and Ryghaug, 2022; Bertolini et al., 2024; Sochor et al., 2023).

While green transport modes are frequently promoted, few studies explore their integration with public and active transport networks, which is essential for reducing car dependency and promoting modal shift (Rai et al., 2020). Environmental assessments tend to focus on immediate benefits of green technologies, such as electric vehicles, but neglect the long-term sustainability concerns, particularly the lifecycle impacts of battery production and disposal. The regulatory frameworks are also underdeveloped, lacking policies that can foster innovative and sustainable delivery systems (Jaller et al., 2020; Smart Freight Centre, 2017; Leerkamp et al., 2023). Furthermore, infrastructure needs—such as dedicated loading zones and lanes, parking spaces, and road access—are insufficiently addressed, despite their importance in ensuring delivery efficiency (Muriel et al., 2022; Navarro et al., 2021; Castillo et al., 2022; Leerkamp et al., 2023; Malafaia et al., 2024). Despite their vital influence on shaping sustainable urban mobility, behavioural and social factors – like consumer preferences, public acceptance, and incentives for modal shift – remain areas that need more investigation (Castillo et al., 2022; Banister, 2008). Lastly, the existing literature also highlights that the absence of standardized data and limited access to delivery metrics hinders the assessment and improvement of last-mile logistics (Bjørgen et al., 2021).

Discussion

The aim of this paper was to conduct an analysis, from journal articles and grey literature, of what it is been sheltered under the scope of urban mobility and last-mile delivery. It seeks to understand the range of literature covering the impact and implications of last-mile delivery on urban mobility, focusing on the planning, infrastructure, innovation, and policies.

From the analysis it was possible to highlight that the great majority of papers focus on tools, technologies and solutions (e.g.: Nürnberg, 2019; Jaller et al., 2020; Samouh et al., 2020; He et al., 2022; Gonzalez-Calderon et al., 2022; Villa and Monzón, 2021; Franco et al., 2020, among others). These papers primarily examine innovative technologies or solutions that may revolutionise the last-mile delivery sector and bring outcomes such as sustainability, cost efficiency, and delivery time reduction under the microscope, considering how these advancements can improve transport efficiency and make use of alternative fuels or

renewable energy sources. Some of the new technologies emphasised include drones, cargo-bikes, autonomous vehicles, and robots. Also, the literature mentions some tools (e.g. transport modelling tools) or KPIs that can improve the sector. New sciences and technologies are at the forefront to influence changes in the current world: they have the ability to call the attention and incentivise the involvement of business stakeholders as a cost reduction in transportation is one of their key goals, also to provide services in sensitive places within the cities, like residential areas, and to promote less pollution with the adoption of alternative fuel vehicles.

However, there are challenges and problems that need to be acknowledged. The change of fossil-fuel vehicles to battery/hybrid/H2 mode vehicle/objects is good for the index of pollution generation, as they are seen as green modes, but the battery disposal and waste generation remain largely unaddressed in the literature, and it can become a major issue in a few years. The policies surrounding these new solutions are another concern, as there are none, so far, and this can open space for a problem difficult to overcome. The infrastructure to support these technologies is barely mentioned, together with the maintenance and the changes generated in the environment. Table 5 highlights the most frequently discussed and significant technologies in the reviewed literature, their intended benefits and the challenges and limitations behind it. It enables readers to rapidly understand dominant trends, understand the areas of intense focus, potentially identify promising avenues for future study or development within the broader subject matter, and readily discern the advantages and disadvantages associated with them.

It is widely recognised that new approaches and technologies are more appealing to stakeholders, as they offer profit opportunities and can satisfy customers demand for innovative solutions. However, technologies and solutions may not always be necessary. Many problems can be addressed through better planning and improved urban structures (such as dedicated parking spaces, wider lanes to facilitate and speed up deliveries, green corridors, well-designed policies, etc.). At the same time, when implementing such measures, their implications for other mobility flows (e.g., pedestrian or cycling traffic, public transport) must also be considered.

From documents that directly or indirectly emphasised the importance of urban mobility planning in the context of last-mile delivery and its impacts, it becomes clear that with appropriate planning strategies, cities can be designed to provide both high-quality accessibility and high-quality environment (Banister, 2008). The scenario where people will not need or will not choose to have a car can be sustained by quality designed cities, even though this set-up is a long-term objective.

One concept widely used today are the shared vehicles and shared mobility, which can benefit from the last-mile problems and challenges, and propose a solution that can reduce traffic congestion and air pollution, as it can take advantage of a journey that someone is already making (Bucchiarone et al., 2021). Combining existing mobility capabilities with emerging mobility services can provide an integrated, efficient and sustainable mobility ecosystem. From another perspective shared mobility can be done via public transport, if it is supported by an outstanding network, that covers the entire city or that offers green solutions to the remaining stretch of the journey.

Table 5
Technology benefit and challeng.

Technology	Intended Benefits	Challenges and Limitations
Drones	Fast delivery, reduced road congestion (He et al., 2022)	Airspace regulation, limited payload, weather dependency, traffic management (He et al., 2022; Samouh et al., 2020)
Autonomous Vehicles	Labor cost reduction, continuous operation, perform critical areas with narrow streets (Bucchiarone et al., 2021)	Safety concerns, regulatory barriers, infrastructure needs (Bucchiarone et al., 2021; Jaller et al., 2020a)
Electric Cargo Bikes	Low emissions, low investments, suitable for dense urban areas, perform critical areas with narrow streets (Aiello et al., 2021; Gonzalez-Calderon et al., 2022)	Limited cargo capacity, battery range, weather exposure (Gonzalez-Calderon et al., 2022; Nürnberg, 2019)
Parcel Lockers	Flexible pickup, reduced failed deliveries (Freightwaves, 2022; van Duin et al., 2020)	Specific regulations, accessibility issues, location optimization, user adoption (Lagorio and Pinto, 2020; Lozzi et al., 2022)
Crowd-shipping	Utilizes existing travel patterns, cost-effective (Lozzi et al., 2022, Le and Ukkusuri, 2019)	Platform reliability, legal liability, coordination complexity (Lozzi et al., 2022; Le and Ukkusuri, 2019)

The boom in e-commerce has fuelled a demand for last-mile delivery, but this subject still lacks data and studies. Consequently, urban and mobility planners struggle to determine the most effective strategies to surpass this evolving problem. It is an open space for a debate and underline critical questions on how to best approach what is likely to become one of the most pressing problems in urban mobility in the following years.

To ensure meaningful and sustainable change, all stakeholders, especially individuals and companies, must be actively involved in every aspect of green infrastructure, policy, and network improvements. Such involvement is essential not only for understanding of the rationale behind changes but also to foster behavioural shifts, pinpoint effective actions or approaches that can tackle obstacles and leverage possibilities in resolving complex challenges (Banister, 2008; Boggio-Marzet et al., 2023; Sochor et al., 2023).

Collaborative governance must be urgently pursued by integrating freight considerations and stakeholder engagement in city planning processes. This includes securing political anchorage and geographical scope to achieve a more effective and sustainable transport and freight systems in urban environments (Bjørngen and Ryghaug, 2022). One way of showing industries that it is important for them to participate in this debate, is by displaying that the time lost in congestion is costing business money, and the improvement in infrastructure that will facilitate their work will be profitable, as it will encourage greater efficiency in the transport system. From peoples' perspective it is important to give them voice to understand the improvements they are willing, so they can feel as part of the process, and to consolidate their understanding of change in behaviour and daily choices to encourage modal shift to reduce the car usage.

One recommendation to strengthen stakeholder engagement and move beyond fragmented coordination can be the adoption of the Living Lab approach as a real-world experimentation with participatory methodology for co-creating and testing last-mile delivery solutions in real urban environments. Living Labs provide a framework for collaborative governance by bringing together public authorities, logistics providers, researchers, and citizens to co-design, implement, and evaluate innovations in situ, as communication will challenge them to navigate difficulties and disagreements to unlock value for long-term sustainability transitions. This method facilitates iterative learning, contextual adaptation, foster collaborative decision-making, and strongly supports the development of actionable urban planning strategies. In the context of urban logistics, Living Labs have been successfully applied to pilot sustainable delivery models, assess user acceptance, and inform policy development, offering a structured pathway to embed co-creation practices into last-mile planning (Garus, et al., 2023; Bussey et al., 2023; Falco and Kleinhans, 2018; Karakikes et al., 2025; Lember et al., 2019; Lindholm and Michael, 2013; Puerari et al., 2018).

Partnerships between specialists, researchers, practitioners, land use, environment, ecologist, policy makers, engineering, green modes, public transport and many others, foster meaningful debate on sustainable mobility. A new approach to transport policy measures can promote walking and cycling, and sustainable means of transport by slowing down urban traffic, reallocating space to public transport and green mobility, promoting parking controls, making public transport attractive, efficient and easy to use, and encouraging modal shift.

Urban delivery presents a significant urban planning challenge due to fluctuating traffic, lack of e-commerce and last-mile delivery regulations, and limited data availability. This situation creates a considerable gap between last-mile optimization strategies and broader transport network research.

Conclusion

The body of literature on the urban mobility implications of last-mile delivery is still limited but steadily gaining traction, with most articles published after 2020. The existing literature on last-mile delivery is heavily focused on the development and integration of technologies and solutions, and the promotion of sustainable practices. This overarching trend, when viewed through the lens of urban mobility, reveals a

particular emphasis on strategic planning and the deployment of eco-friendly vehicles, highlighting an increasing awareness on the need for holistic and environmentally conscious strategies in shaping the future of urban logistics, while merging strategic urban mobility planning with comprehensive logistics strategies to ensure efficiency, sustainability, and overall urban well-being.

Our analysis highlights several gaps that have not been explicitly addressed in previous research, thereby outlining a clear agenda for future work. First, much of the existing literature focuses on technologies, solutions, or tools as the answer for the majority of the last-mile problems, disregarding the urban mobility infrastructure and planning as main players in last-mile delivery systems. Second, it highlights green transport modes, but it does not consider it in an integrating approach with public transportation, green infrastructure, parking places, restricted policies and user acceptance. Third, a lot has been mentioned about transport modes that are using power battery as a more sustainable manner, but the battery discharge and waste generation has been ignored so far. Finally, despite the widespread support for combining passenger and freight transportation systems to improve urban efficiency and sustainability, the literature reveals persistent regulatory, technical, and contextual barriers. Furthermore, there is a significant shortage of real-world studies and consistent methods for measuring the long-term consequences of such integration.

From a policy perspective of the urban mobility implications of last-mile delivery, and based on the analysed literature, it is crucial to implement changes in city planning and planning practices, as they are increasingly and continuously affected by freight and logistics on the last-mile stretch. To achieve this, more knowledge must be developed and more data made accessible. This will enable local authorities to take the lead in identifying the best ways to address these challenges and to provide up-to-date and effective sustainable urban mobility plans and policies. Sustainable city development requires the integration of city logistics and freight as a strategic priority within urban mobility planning and policy. To achieve this, proactive strategies must be developed to address the impact of e-commerce, ensuring that planning and regulations cover both ordinary and freight mobility, and actively involve stakeholders throughout the process, highlighting promising avenues for future research. In practice, this means that cities should place greater emphasis on freight and goods movement within sustainable urban mobility plans, providing a better balance with people's mobility and elaborating corresponding sustainable urban logistics plans. Furthermore, there is a growing consensus on the need for interdisciplinary studies to fully grasp the complexities of last-mile delivery and its effects on urban mobility and urban planning.

It is important to emphasise that this paper analysed the literature available at the moment of its submission and that the topic is on a high demand. It is not the intention of the authors to strict the results as a final state, but to raise questions about current and future approaches, in order to better obtain results for people and the environment.

CRedit authorship contribution statement

Amanda Oliveira Mesquita: Writing – original draft, Visualization, Methodology, Investigation, Data curation, Conceptualization. **Zsolt Matyusz:** Writing – review & editing, Methodology. **András Munkácsy:** Writing – review & editing, Methodology.

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Appendix 1

Authors	Year	Title	Source title	New technologies/ Solutions	Sustainability	Urban Plan	Urban mobility/ Mobility plan	City logistics	Shared mobility/ Economy	Crowdsourcing/ Crowde- shipping	Parking spaces	Regulations/ Policies	Pollution (air/noise)	Profitability/ Operational cost
Bertolini, M., De Matteis, G., & Nava, A.	2024	Sustainable Last-Mile Logistics in Economics Studies: A Systematic Literature Review	Sustainability	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bjorgen A., Bjerkan K.Y., Hjelkrem O.A.	2021	E-groceries: Sustainable last mile distribution in city planning	Research in Transportation Economics	✓	✓	✓	✓	✓			✓	✓	✓	
Bjorgen, A; Ryghaug, M	2022	Integration of urban freight transport in city planning: Lesson learned	Transportation Research, Part D: Transport and Environment		✓	✓	✓	✓			✓	✓	✓	
Boggio-Marzet, A., Villa-Martinez, R., & Monzón, A.	2023	Selection of policy actions for e-commerce last-mile delivery in cities: An online multi-actor multi-criteria evaluation	Transport Policy	✓	✓	✓	✓	✓			✓	✓	✓	✓
Bucchiarone, A; Battisti, S; Marconi, A; Maldacea, R; Ponce, DC	2021	Autonomous Shuttle-as-a-Service (ASaaS): Challenges, Opportunities, and Social Implications	IEEE Transactions on Intelligent Transportation Systems	✓	✓	✓	✓	✓	✓				✓	✓
Campisi, T., Russo, A., Bashas, S., Politis, I., Bouhours, E., & Tesoriere, G.	2023	Assessing the Evolution of Urban Planning and Last Mile Delivery in the Era of E-commerce	Lecture Notes in Intelligent Transportation and Infrastructure	✓	✓	✓	✓	✓				✓	✓	✓
Castillo C., Viu-Roig M., Alvarez-Palau E.J.	2022	COVID-19 lockdown as an opportunity to rethink urban freight distribution: Lessons from the Barcelona metropolitan area	Transportation Research Interdisciplinary Perspectives	✓	✓	✓	✓	✓	✓			✓	✓	
Chatziioannou, I., Bakogiannis, E., Karolemeas, C., Koumpa, E., Papadaki, K., & Vlastos, T.	2024	Urban Environment's Contributory Factors for the Adoption of Cargo Bike Usage: A Systematic Literature Review	Future Transportation	✓	✓	✓	✓	✓				✓	✓	
Gruber, J., Plener, M., Damer, L., & Dubernet, I. (2024).	2024	Car or Cargo Bike? Determinants for the Use of a Small Vehicle Type in Urban Logistics: A Stated Preference Survey Among Commercial Transport Operators	Transportation Research Record	✓	✓		✓	✓			✓		✓	✓
Jaller M., Otero-Palencia C., Pahwa A.	2020	Automation, electrification, and shared mobility in urban freight: Opportunities and challenges	Transportation Research Procedia	✓	✓		✓	✓				✓	✓	✓
Leerkamp, B., Soteropoulos, A., & Berger, M.	2023	Delivery robots as a solution for the last mile in the city?	AVENUE21. Planning and Policy Considerations for an Age of Automated Mobility	✓	✓		✓	✓				✓	✓	✓
Lozzi G., Iannaccone G., Maltese I., Gatta V., Marcucci E., Lozzi R.	2022	On-Demand Logistics: Solutions, Barriers, and Enablers	Sustainability	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Malafaa, M. I., Ribeiro, J., & Fontes, T.	2024	A Multi-Stakeholder Information System for Traffic Restriction Management	Logistics	✓	✓	✓	✓	✓				✓	✓	✓
Muriel J.E., Zhang L., Fransoo J.C., Perez-Franco R.	2022	Assessing the impacts of last mile delivery strategies on delivery vehicles and traffic network performance	Transportation Research Part C: Emerging Technologies	✓	✓	✓	✓	✓			✓	✓	✓	
Navarro, HAR; Vieira, JGV; Fransoo, JC	2021	Understanding urban logistics and consumer behavior in Sao Paulo city	Case Studies on Transport Policy		✓	✓	✓	✓			✓	✓		
Oguz, S., & Tanyas, M.	2024	Technological applications in sustainable urban logistics: a systematic review with bibliometric analysis	TeMA Journal of Land Use, Mobility and Environment	✓	✓	✓	✓	✓	✓	✓		✓	✓	
Orhan, C. C., Soman, J., & Wallace, S. W.	2024	Disconnecting a city centre to prevent through traffic: An a priori evaluation with a focus on freight transport	Transportation Research Part A: Policy and Practice		✓	✓	✓	✓			✓	✓	✓	
Perboli G., Rosano M.	2019	Parcel delivery in urban areas: Opportunities and threats for the mix of traditional and green business models	Transportation Research Part C: Emerging Technologies	✓	✓		✓	✓		✓		✓	✓	✓
Pettersson, F., Winslott Hiselius, L., & Koglin, T.	2018	E-commerce and urban planning - comparing knowledge claims in research and planning practice	Urban, Planning and Transport Research		✓	✓	✓	✓				✓	✓	
Rai, H. B., Cetinkaya, A., Verlinde, S., & Macharis, C.	2020	How are consumers using collection points? Evidence from Brussels	Transportation Research Procedia	✓	✓		✓	✓					✓	
Rześny-Cieplińska, J.	2023	Overview of the practices in the integration of passenger mobility and freight deliveries in urban areas	Case Studies on Transport Policy	✓	✓	✓	✓	✓	✓			✓	✓	✓
Serrano-Hernandez A., Gougeon T., Cadarso L., Juan A.A., Faulin J.	2021	The Urban Freight Distribution in Medium Size Cities: Descriptive Data Taken from Pamplona (Spain) and Angers (France)	Transportation Research Procedia	✓	✓	✓	✓	✓					✓	
Smart Freight Centre	2017	Developing a Sustainable Urban Freight Plan—A Review of Good Practices	Smart Freight Centre	✓	✓	✓	✓	✓			✓	✓	✓	✓
Sochor, J., Fenton, P., de Bode, A., de Azpiazu, M. C., Borraz, R. L., & Gasparin, P.	2023	HALLO: Hubs for Last Mile Delivery Solutions in Barcelona and Stockholm	Transportation Research Procedia	✓	✓	✓	✓	✓	✓			✓	✓	✓

Data availability

Data will be made available on request.

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