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A review of collaborative strategies in last-mile logistics from an urban sustainability perspective

Kentsel sürdürülebilirlik perspektifinden son adım lojistikte iş birlikçi stratejilere yönelik bir inceleme

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Abstract

In recent years, globalization, technological developments, and the growth of e-commerce transactions have increased the demand for logistics activities. Increasing demands affect logistics activities at all stages of supply chains, particularly the final stage, where delivery to customers occurs in urban areas. This stage, known as last-mile logistics, is not only the most expensive and inefficient part of supply chains, but also causes many problems, including increased freight mobility in urban areas, traffic congestion, parking issues, air and noise pollution, and carbon emissions. Reducing these economic and environmental costs is important for sustainable urban development. The sustainability of a city depends on its economic self-sufficiency, the living standards of its population under equal and fair conditions, and sensitive practices in environmental and waste management. Today, in addition to the traditional last-mile logistics practices of delivering the package to the customer's home/office, there are many new practices (delivery via parcel locker, drone delivery, robot delivery, micro-depot usage, urban consolidation center usage, pick-up/drop-off point, click-and-collect, crowd-sourcing, etc.) to overcome the mentioned drawbacks and manage the process more effectively and efficiently. Collaborative applications for these novel delivery methods are increasing day by day in order to minimize the costs of logistics service providers, facilitate customers' access to service, and thus improve customer satisfaction. In this study, we investigate different novel last-mile logistics methods in the literature and in practice that have been implemented with collaborative strategies. Among the 43 studies reviewed, urban consolidation centers, parcel lockers, and PUDO points emerged as the most frequently considered collaborative models. The advantages of the collaboration strategies and the barriers to their development are presented, and researchers, practitioners, and city managers are guided in developing new policies and strategies.

Keywords: Last-mile logistics, Crowd-sourcing, Collaboration, Review

Öz

Son yıllarda küreselleşme, teknolojik gelişmeler ve e-ticaret işlemlerinin büyümesi lojistik faaliyetlerine olan talebi artırmıştır. Artan talepler tedarik zincirlerinin tüm aşamalarındaki lojistik faaliyetlerini, özellikle de müşteriye teslimatın kentsel alanlarda gerçekleştiği son aşamayı etkilemektedir. Son adım lojistiği olarak bilinen bu aşama, tedarik zincirlerinin yalnızca en pahalı ve verimsiz kısmı olmakla kalmayıp, aynı zamanda kentsel alanlarda artan yük hareketliliği, trafik sıkışıklığı, park yeri sorunları, hava ve gürültü kirliliği ve karbon emisyonları gibi birçok probleme de neden olmaktadır. Bu ekonomik ve çevresel maliyetleri azaltmak sürdürülebilir kentsel kalkınma için önemlidir. Bir kentin sürdürülebilirliği, ekonomik olarak kendi kendine yeterliliğine, nüfusunun eşit ve adil koşullar altında yaşam standartlarına ve çevre ve atık yönetimindeki duyarlı uygulamalara bağlıdır. Günümüzde, paketi müşterinin evine/ofisine teslim etme şeklindeki geleneksel son adım lojistik uygulamalarına ek olarak, bahsedilen dezavantajları aşmak ve süreci daha etkili ve verimli bir şekilde yönetmek için birçok yeni uygulama (kargo dolabı ile teslimat, drone teslimatı, robot teslimatı, mikro depo kullanımı, kentsel konsolidasyon merkezi kullanımı, alma/bırakma noktası, tıkla ve topla, kitle kaynak kullanımı vb.) bulunmaktadır. Lojistik hizmet sağlayıcılarının maliyetlerini en aza indirmek, müşterilerin hizmete erişimini kolaylaştırmak ve böylece müşteri memnuniyetini artırmak amacıyla bu yeni teslimat yöntemlerine yönelik işbirlikçi uygulamalar her geçen gün artmaktadır. Bu çalışmada, literatürde ve uygulamada işbirlikçi stratejilerle uygulanan farklı yeni son adım lojistik yöntemleri araştırılmaktadır. İncelenen 43 çalışma arasında kentsel konsolidasyon merkezleri, kargo dolapları ve PUDO noktaları en sık ele alınan iş birliği modelleri olarak ortaya çıkmıştır. İş birliği stratejilerinin avantajları ve geliştirilmelerinin önündeki engeller sunulmakta ve araştırmacılara, uygulayıcılara ve şehir yöneticilerine yeni politikalar ve stratejiler geliştirmede rehberlik edilmektedir.

Anahtar kelimeler: Son adım lojistik, Kitle kaynak kullanımı, İş birliği, İnceleme

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1 Introduction

With globalization, trade has become easier, and customers have the opportunity to shop without leaving their homes. More and more customers adopt e-commerce applications every year [1]. This situation leads to a change in the way businesses operate. The demand for urban freight transportation has increased significantly with the increase in the use of e-commerce and technological developments [2], and last-mile logistics has become a focal point for both academics and practitioners. Last-mile logistics is driven by increasing urbanization, population growth, e-commerce development, sustainability concerns, changing customer behaviors, and technological innovations. It can be explained as "the part concerned with the final stage of the supply chain from the final distribution center to the buyer's preferred destination". Last-mile logistics activities occur in the final stage of supply chains, typically in city centers, and directly impact the sustainability of urban areas. These activities contribute to the economy of city centers and the welfare of their inhabitants; however, on the other hand, they make it difficult to manage them in an environmentally friendly and effective manner. Therefore, e-retailers, local governments, and logistics service providers (LSPs) aim to lower the carbon footprint and expenses of last-mile logistics so as not to adversely impact the sustainability of cities. Since the last-mile is the most inefficient, expensive, and unsustainable part of the supply chain [3], it causes some externalities such as air and noise pollution, climate change, traffic congestion, accidents, and infrastructure wear and tear in the transport sector [4].

Recently, it has become increasingly common to apply collaborative strategies in last-mile logistics activities to reduce the mentioned externalities and economic and environmental costs. Collaborative strategies provide an appropriate tool to overcome the obstacles faced in last-mile logistics networks due to continued intense competition, very low profit rates, and changing environmental regulations. Collaborative practices in last-mile logistics can enable retailers to achieve triple profitability efficiencies and other business benefits [5]. Applying collaborative strategies is an emerging concept where LSPs temporarily lease assets to other providers, enabling sequential utilization of resources through leasing rather than ownership [6]. It offers many advantages to stakeholders. Besides the operational benefits, third-party organizations can facilitate collaboration by using information and communication technologies. In the context of last-mile logistics, collaborative use may manifest as shared physical resources, including delivery vehicles and courier services. Moreover, this approach can extend to the integration of non-traditional actors, such as volunteer pedestrians or vehicle owners, to supplement official courier networks.

The use of collaborative strategies in last-mile logistics activities has attracted the attention of researchers, practitioners, and policymakers in recent times because of its superiorities. Although many studies have been carried out in this field, there is a lack of review studies that can guide researchers for future research as well as help practitioners and policymakers in their decision-making. This study aims to reveal the studies that examine the strategies based on cooperation and sharing economy in last-mile logistics applications from different perspectives in the literature from the past to the present. The study seeks to answer the question of how effective collaborative practices are reducing the externalities from the perspective of urban sustainability in last-mile logistics. Further research is necessary to fully understand the potential benefits and challenges of implementing collaborative models in urban logistics systems. For this purpose, a comprehensive review of the relevant literature handling last-mile logistics operations with collaborative applications is presented. The aim is to explore how collaborative strategies are conceptualized and applied in last-mile logistics within the framework of urban sustainability. Although some previous studies, such as Silva et al. [1], have reviewed collaborative logistics in general terms, to our knowledge, no study has systematically classified these strategies based on their physical delivery infrastructure in the urban last-mile context. The study includes both systematic and bibliometric analysis approaches in order to take advantage of the superior aspects of both methods, as in the [7] that focused on autonomous vehicle storage and retrieval systems. The systematic literature review tools are used for an in-depth examination of collaborative approaches focusing on the shared use of facilities in last-step delivery activities, while bibliometric literature review tools are used for the general structure and visual and quantitative information on this topic.

2 Material and methods

This section presents the methodology adopted to carry out the proposed research. A literature review of studies about collaborative strategies in last-mile logistics from the perspective of urban sustainability is carried out with the aim of evaluating and integrating the studies related to the subject. Studies have been collected through an extensive search with electronic databases such as Scopus, IEEExplore, ScienceDirect, Researchgate, Web of Sciences and Google Scholar. Collaborative strategies involving the shared use of a physical space with stakeholders in the literature and practice applied in last-mile logistics activities are shown in Table 1. The strategies given in the table showing shared organizations are researched with words addressing cooperation, such as sharing, collaborative, crowd-sourcing, and crowd shipping when reviewing the literature. Visualizations were created using Microsoft Excel, Scimago Graphica, and The Free Word Cloud Generator.

Table 1. Collaborative Strategies and Associated Keywords for Last-mile Logistics Literature Review

Shared Facilities for Collaborative Strategies	Keywords
Urban Consolidation Center (UCC)	'sharing'
Micro Depot (MD)	'collaborative'
Micro Hub	'cooperation'
Collection Point	'crowdsourcing'
Collection and Delivery Point (CDP)	'crowd-sourcing'
Pick-up Point (PP)	'crowd shipping'
Pick-up Drop Off Point (PUDO)	'crowd-shipping'
Parcel Locker	'common'

This study aims to review the literature to answer the following three questions about collaborative strategies in last-mile logistics from an urban sustainability perspective:

- *RQ1*. How is the literature on the collaborative use of organizations in last-mile logistics structured?
- *RQ2*. What are the main trends in collaborative strategies in last-mile logistics from an urban sustainability perspective?
- *RQ3*. What might be future research options?

The most important research topics, authors, and academic studies that contributed to 43 fields published in the last 12 years were included and evaluated in this study. The data in the study were collected from conferences, peer-reviewed scientific journals, and book chapters. The aim is to provide a precise and comprehensive understanding of the concept of the sharing economy and the collaborative use of organizations in last-mile logistics. A meticulous literature review has been conducted to provide a summary of the existing literature and contribute to the creation and accumulation of information. In particular, Section 2 presents the research methodology, while Section 3 presents the examination of 43 studies on collaborative strategies in last-mile logistics between 2012 and 2024. The literature structure is based on different units of analysis such as authors, publication year, subject area, study location, publication journal or book. The literature review is based on keywords, titles, and abstracts, and identifies the main trends in collaborative strategies used in last-mile logistics. The main trends are organized around 8 physical areas.

The aim of the study is to identify a consistent publication example that addresses the sharing economy in last-mile logistics and collaborative work in the physical field in the literature review. The protocol started with 85 articles and resulted in a final dataset of 43 articles determined through a stepwise procedure [8];

- *Step 1 – database*. Studies have been collected through an extensive search with electronic databases. The focus was on studies included in Scopus, IEEExplore, ScienceDirect, Researchgate, Web of Sciences, and Google Scholar. They were tailored to examine interdisciplinary approaches in logistics and engineering.
- *Step 2 - topic choice.* To ensure relevance, keywords of the articles were searched for collaborative strategies that included shared organizations in their titles and abstracts, along with words that addressed collaboration, such as sharing, collaborative, cooperation, crowd-sourcing, common, and crowd shipping. (For example, sharing urban consolidation center and common parcel locker.)
- *Step 3 - additional topics.* Based on the definitions given in the introduction of the study, it was checked whether the terms "last-mile logistics" and "urban sustainability" were included in the studies.
- *Step 4 - type of publication.* The review was limited to academic studies such as journals, conference proceedings, book chapters and master's theses. In order to be consistent, it was preferred that the studies be conducted in English, the most commonly used language.
- *Step 5 - editorial choices.* No specific period, and no filter.
- *Step 6 - coherence*. In the study, missing citations and duplicate studies were eliminated. Several elimination criteria were determined. Studies with irrelevant abstracts, studies without abstracts, and studies with irrelevant titles and keywords were excluded from this study.
- *Step 7 – verification*. After the first 6 steps were applied, the abstracts of the remaining studies were read, and the eligibility of the studies was verified.
- *Step 8 - consolidation.* In order to ensure general integrity and relevance, all remaining works were read.

The results were created by reading the studies one by one and by a literature review based on textual data analysis. The analysis of the study used basic indicators such as authors, publication date, journal or book chapter, and the subject area. These indicators were used in quantitative measurements. After a thorough reading, four more papers were disqualified because they did not meet the selection criteria given in Table 2. Some of the excluded papers were used to provide information on the historical evolution of changes in last-mile logistics activities in cities, and the evaluation of the transport externalities, particularly in urban areas. The literature analysis provided quantitative results that shed new light on scientific research in the sharing economy, and collaborative work in organization in last-mile logistics. During the screening process, studies that did not involve collaborative strategies based on shared physical infrastructure were excluded. This includes publications focused solely on technical optimization (e.g., drone routing, autonomous vehicles, warehouse automation) without addressing stakeholder collaboration or shared facilities. In addition, studies set in non-urban, military, or humanitarian contexts were removed due to their lack of relevance to urban sustainability. The final selection included only those studies in which collaboration was explicitly tied to physical locations, such as parcel lockers, micro-depots, PUDO points, and urban consolidation centers. For instance, from the crowd shipping literature, only four studies that involved physical interaction points were retained for analysis.

Table 2. Inclusion and exclusion criteria adopted for the literature review

Inclusion Criteria	Exclusion Criteria
Full journal and conference proceedings	Lectures
English language	Non-English language
Peer-reviewed	Not peer-reviewed
Focus on last-mile logistics	Focus on the mobility of people
Focus on urban areas	Focus on rural areas
Focus on last-mile logistics externalities	Focus on all externalities
Focus on collaborative applications	Focus on individual application
Focus on studies in the last 12 years	Focus on studies before the last 12 years

In the initial search process, 85 records were identified across multiple databases. After duplicate removal and the application of inclusion/exclusion criteria, 39 studies were selected for full-text review. Subsequently, during thematic gap analysis, an additional targeted search was conducted to address underrepresented areas—particularly studies involving crowd shipping with physical delivery points. This led to the identification and inclusion of 4 additional studies, bringing the total number of reviewed articles to 43. The entire selection process is illustrated in a PRISMA-style flow diagram (Figure 1). From an initial pool of 85 studies, a series of exclusion steps based on relevance, duplication, and eligibility criteria led to a final dataset of 43 articles.

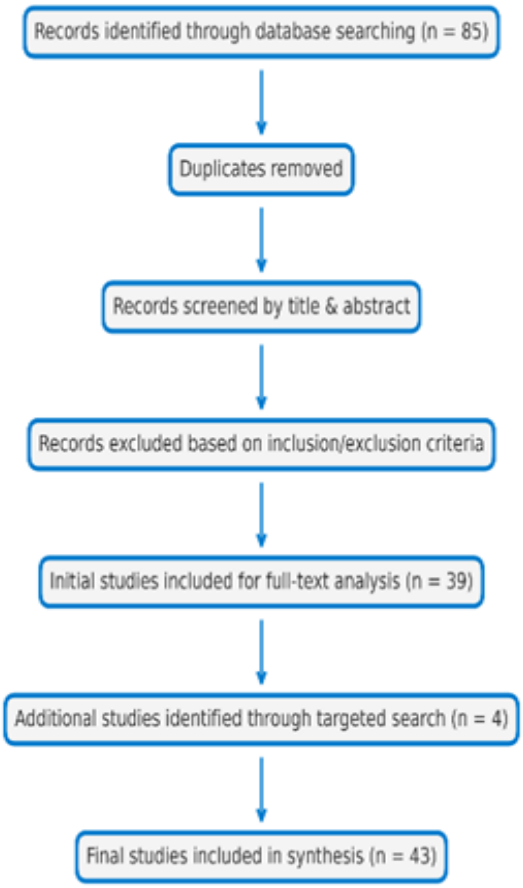

Figure 1. PRISMA-style flow diagram

3 Collaborative strategies in last-mile logistics

One of the biggest challenges in last-mile logistics is that distribution centers are far away from destination points, and demand points in urban areas are in extremely dense areas [9]. Collaborative strategies can improve cost efficiency to solve the challenges in last-mile logistics. They can also play an important role for LSPs in reducing environmental externalities within urban areas as well as increasing efficiency in delivery [10]. The main concept of the collaboration strategy is to use the resources, vehicles, infrastructure, and physical spaces in a common way within the urban area for last-mile logistics operations with the aim of advantages such as increasing the efficiency of delivery within the city, better use of resources, management, and investment cost savings [4]. In this study, only the common use of organization in a collaborative manner in last-mile logistics is focused on. In addition, last-mile logistics studies in which both organizations use collaboratively and crowd shippers use collaboratively are also included in this scope. The studies on these special areas, which are located close to or in city centers and used with a collaborative approach, are grouped and explained in the following sections.

3.1 Urban consolidation center (UCC)

An UCC is defined as a logistics facility that serves an entire city, a specific district, or a more specific area (e.g. a shopping mall) and is generally located on the urban fringes, relatively far from the city center [11]. This facility includes a wide range of value-added services such as temporary storage, handling, sorting, classification, and load consolidation. The main purposes of using the UCC can be stated as reducing the number of commercial vehicles entering the urban area and increasing operational efficiency by turning partial loads into consolidated loads at the last-mile step [12]. Another important aim of UCC can be expressed as helping to reduce urban environmental externalities by making up the vehicle fleet, which is distributed from the facility to the city center, mostly from environmentally friendly vehicles that work with electric and natural gas [13]. Although the main actors using the UCC are often LSPs, a specialized consolidation center structure for retailers and shippers can be practiced [11]. UCCs are integrated into the city, mostly by local public authorities as a legal obligation; however, it can also be seen that they are used by companies to provide a competitive advantage. Studies in the last-mile logistics literature where UCCs are handled with collaborative strategies involving the joint use of different stakeholders are mentioned below.

Roca-Riu et al. [14] proposed a strategy that supports cooperation between freight carriers through the use of UCC to reduce operating costs in urban distribution. The system without a consolidation center was compared with the proposed system. With the results obtained, the benefits such as savings in time, distance, cost, and environmental externalities by using UCC were emphasized. Battaia et al. [15] presented a methodology for estimating the activity level of collaborative networks using the example of UCC. The study was conducted using real cases and used game theory and operational research techniques. This study was tested in Saint-Etienne, France. Roca-Riu et al. [16] examined the logistics cost savings of UCC when implemented in a dense area of the city. In the UCC strategy, freight flows from intercity carriers were consolidated and transferred to the last-mile carrier to consolidate final deliveries with the goal of decreasing the last-mile fleet size and average distance cost. The model, which was created in the study, focused on continuous analytical models for the general situation of carriers with different market shares. Handoko et al. [17] conducted a study on collaborative urban logistics in Singapore. The study recommended the use of the UCC, like the Tenjin Joint Distribution System in Fukuoka Japan. Privacy protection and cost reduction have made carriers look favorably on consolidating last-mile

deliveries. The auction mechanism is proposed to maximize the cost savings achieved by carriers by combining their orders. In the proposed model, last-mile logistics in urban areas was seen to care about the people, the planet, and profitability. Paddeu [18] investigated the experiences of retailers using shared UCC established in Bristol in 2002. The study was conducted at the Bristol-Bath Urban Consolidation Centre, which provides services for electric vehicles. The study assessed the benefits of shared last-mile freight services by focusing on the perspectives of retailers using shared UCC. Gonzalez-Feliu et al. [19] studied resource sharing and multi-stakeholder collaboration. They determined the complexity of the stakeholders that will collaborate. The study focused on UCC to be used for collaboration, partnerships in transportation, collaborative decision making, multi-stakeholder collaboration and its barriers, urban congestion and traffic forecasting. As a result, the study aimed to add value not only to theoretical aspects but also to methodological and technical issues. The study proposed by Hezarkhani et al. [20] includes a model for collaboration in UCC. The authors examined collaboration cases involving several carriers with time-sensitive deliveries that can consolidate their cargo to save money. The class of dispatch consolidation game was introduced, and efforts were made to distribute savings fairly among carriers. The UCC operator had solved a selection and dispatch problem to maximize the total savings of players in the system. Nataraj et al. [21] analyzed different scenarios where both the location of UCCs and players in different supply chain processes simultaneously exhibit various levels of cooperation. The low collaboration situations where all decisions were made in a decentralized way and also where warehouse capacities were shared but customers were still served by each company's vehicle fleet; semi-cooperative situation based on centralized route planning decisions; fully collaborative situation where routing plans, and facility location decisions were made through collaboration among all participants were considered as different scenarios. A metaheuristic algorithm was proposed to address the combined location and routing problem under different collaborative scenarios to estimate the benefits of strategies. The results show the benefits of the proposed algorithm. Gatta et al. [22] investigated the feasibility of out-of-hours deliveries in Rome. The analysis of the study was created both by face-to-face interviews and multi-criteria decision making. The results of the study revealed that stakeholders wanted to make out-of-hours deliveries using more than one UCC. The study showed that stakeholders wanted to make this out-of-hours delivery, which would be done collaboratively, in a heterogeneous way. And lastly, Kaspi et al. [23] conducted a study focusing on changes in business models, such as urban micro-consolidation centers, crowd-sourcing logistics, and vehicle autonomy. The study also explored literature on some of the UCCs sharing space with retail businesses in the city.

3.2 Micro-depot (MD)

MDs are places where LSPs take the packages from here to transport to the final consumer, where loading, unloading, sorting, storage, and delivery are carried out. It is usually located near or within an urban area. MDs have been used by large LSPs since 2010 [24]. Moreover, MDs can be mobile or fixed in cities [25]. An MD is used for storage in the form of a usable property in an urban area or as a transfer in a container. The location of the establishment of MD is important. MD should be suitable for the use of cargo bikes and walking couriers and should be located close to customers. However, the supply vehicle must also comply with the infrastructure conditions to deliver to the MD without creating congestion. Parcels are supplied from a central warehouse to MD with a single vehicle and delivered to customers from MDs on foot, by cargo bike or by electric vehicles. Customers also have the opportunity to come and pick it up [26]. The studies in the literature addressing the problem of using MDs with a collaborative approach since 2012 are described below.

Rosenberg et al. [24] proposed the idea of a shared MD network with parcel lockers by expanding existing MD networks. This shared network idea optimized the use of urban space while minimizing the individual cost of LSPs. The study examined the use of shared networks in the cities of Helmond and Helsinki as a case study. In addition, it provided a framework for ancillary businesses that could benefit from this shared network. The success criteria for shared networks were determined considering sustainable goals. Hörsting et al. [27] introduced the idea of integrating freight deliveries with existing public transport infrastructures such as light rail. This study considered a shared public transport stop used for transfers, which acts as an MD with limited storage capacity. The system proposed a large neighbor search algorithm to calculate the sensitivity to the capacity of the MDs and vehicles. Alejandra Maldonado Bonilla et al. [28] developed a taxonomy that enables the design of the last-mile logistics network to investigate the reasons for failures in sustainable last-mile delivery. A systematic literature review was used to collect data in the study. The study contributed to the understanding of the last-mile logistics network and provided sustainable strategies. According to the results of the study, the importance of the implementation of shared MD, electric vehicles, collection and delivery points was presented.

3.3 Micro-hub

Micro-hubs are locations within cities where shipments are classified and delivered to customers using emission-free methods such as cargo bikes [29]. It can be used as a PUDO point for online shopping. Customers can pick-up products brought to the nearest micro-hub by local stores in a short time [30]. Below is a description of the research that has been done from the past to the present on the issue of employing micro-hubs collaboratively.

Hribernik et al. [31] considered joint micro-hubs and horizontal collaboration as a solution to the last-mile distribution problem experienced in the courier, express, and parcel (CEP) industry. However, they thought that the data exchange and trust problem between CEP carriers could be solved by blockchain decision technology and presented a blockchain decision framework. In another study done in

2020, Ballare et al. [32] compared the performance of crowd shipping with micro-hub delivery approaches with the performance of traditional delivery. The crowd shipping with the micro-hub delivery method proposed in the study aimed to reduce operating costs, fuel consumption, and the number of delivery vehicles and crowd shippers. Ackva et al. [33] proposed collaborative distribution within cities using shared vehicles and micro-hubs for same-day delivery. Consistent routes between micro-hubs increase trust among stakeholders and facilitate distribution. Shared vehicles deliver the product from the store to the micro-hub closest to the customer. In doing so, a two-stage stochastic model is proposed for planned same-day delivery. The first stage determines vehicle schedules, while the second stage optimizes the order flow. According to the analysis, costs have decreased.

3.4 Collection point

One of the alternative places used to reduce the costs in last-mile delivery is the collection point. Collection points can be set up in frequently visited locations without adding additional travel costs [34]. Collection points are used in operations in the goods distribution process at the micro level [35]. Information on the studies conducted in the literature on the collaborative use of collection points is given below.

Pan et al. [36] based on the concept of crowd-sourcing and physical internet to collect returned goods within the framework of sustainability. It aimed to transfer e-commerce returns from final consumption points to retailers by taking advantage of continuous mobility and the extra loading capacity of taxis. On the one hand, e-retailers would have the opportunity to outsource this task; on the other hand, taxi drivers would be motivated to earn money from this extra shipment. This study used open databases of store locations in a large city in China and taxi GPS data. Two collection strategies were proposed with an optimization-based simulation model, and their feasibility was evaluated from a managerial perspective. De Meyer et al. [37] investigated the impact of two collaboration strategies within the "Rural Parcel Delivery" project. The first is the outsourcing of parcel delivery to a neutral third party using a common distribution center. The second is the establishment of a shared collection point between carriers. A parcel delivery chain model was developed to evaluate the effectiveness of this collaboration strategy. The study was conducted in the Walloon region of Belgium and resulted in a 60% reduction in carbon emissions and a 35% reduction in costs.

3.5 Collection and delivery point (CDP)

CDPs are third-party locations that provide delivery and pick-up of products purchased by customers online [38]. The CDP concept was developed to take precautions against unsuccessful deliveries. Grocery stores, post offices, and gas stations can be designated as CDPs for customers to receive deliveries [39]. The studies in the literature handling the problem of using CDPs collaboratively since 2012 are described below.

Collins [40] investigated customer evaluation of CDP usage, through a survey, and estimated a random parameter error component logit model. The CDP locations examined went far beyond traditional delivery methods, including CDP modes and ways in which collection, and delivery could be integrated into existing trips. Integrating CDP with walking, cycling, and driving and using it collaboratively had been shown to significantly reduce environmental impacts. Wang et al. [41] established sustainable vehicle routing optimization to adopt a cooperative strategy and multiple shared usage among logistics networks. They constructed a multi-center vehicle routing problem with simultaneous pick-up and drop-off to reduce operating costs and vehicle count. It was envisioned that the pick-up and delivery points would allow the network to share vehicles and customers to improve efficiency and maximize profit. K-means and Non-dominated Ranking Genetic Algorithm-II were combined and used to solve the vehicle routing problem using shared pick-up and delivery points. Akeb et al. [42] proposed a collaborative approach to collect, and distribute products from CDPs using neighbors. In this study, the number of crowd shippers (neighbors) and the number of packages needed were tried to be estimated. The case study was done in the 12th district of Paris. The proposed system worked with a reward mechanism, and the results encouraged the implementation of the collaborative system. Mancini et al. [43] proposed a hybrid delivery model that innovatively combines traditional home delivery and shared delivery points. For each customer who had chosen a shared delivery point, the company paid compensation if the service quality was perceived to be reduced. Two mathematical models were proposed for this decision problem. When the researchers conducted a comprehensive case study, they found that the shared delivery point model outperformed the traditional home delivery model. Lastly, Li et al. [44] wanted to examine the CDP network sharing strategy of express companies with CDP networks, which is a new sharing mode in last-mile delivery. Based on this, they examined express companies with CDP networks and express companies without CDP networks. It was always beneficial for the CDP provider for companies with CDP networks to share this network. However, interestingly, this sharing mode, which provides so many advantages, was harmful to the CDP user. Therefore, the study suggested that the company that is the CDP provider can offer usage fees that increase the incentive for shared use. As a result of the study, even if CDP sharing had negative situations, it could provide double the profit.

3.6 Pick-up point (PP)

A PP is one of the out-of-home delivery alternatives that is rapidly becoming widespread in Europe. PPs are places where products offered for sale in the online marketplace are left for individual customers to pick up. These points consist of local businesses (florists, dry cleaners, etc.) operating often six days a week. They provide flexibility by offering consumers the option to pick-up at a time that suits them [45]. In the transportation literature, PPs are defined as a more convenient, more sustainable, more flexible, and safer service option for stakeholders [46]. In the last-mile literature, PPs serve the same purpose as the collection point. According to Ranieri et al. [47], PPs were created using the concept of CDPs. In the literature, the same concept is also

used for service. Studies addressing PPs with a collaborative approach were examined, and three studies were found in this context.

Zhu et al. [48] proposed PPs that facilitate road traffic pattern management. A case study based on real trip source data was conducted to validate the proposed approach. The study consisted of three steps. In the first step, the driver's waiting time was examined and the walking distance for passengers was defined. In the second step, the spatial distribution characteristics of the point where taxi demand was high were analyzed and candidate PPs were identified. In the last step, the most suitable PP for traffic management was selected by fuzzy Analytic Hierarchy Process (AHP). Justiani et al. [49] evaluated the benefits of collaborative PPs in urban distribution. The study proposed a multi-vehicle routing problem. A case study was conducted in Pekanbaru, Indonesia. The results showed that sustainable development was possible in the city and concluded that economic benefits were obtained from collaboration. Zhang et al. [50] designed a PP recommendation strategy based on a user incentive mechanism. In the first step, a four-dimensional crowd-sourcing model was established. In the second step, a suitable pick-up mechanism was designed to encourage the user to walk based on the cost. In the third step, a forward ratio concept was proposed to reduce the time. The task cost and the maximum walking distance limit were used to calculate the PP.

3.7 Pick-up drop-off point (PUDO)

PUDOs are areas located on roads or in parking areas that provide pick-up and drop-off services. PUDOs can be found temporarily in roadways, curbs, and public parking lots [51]. In the last-mile literature, PUDO often serves the same purpose as the CDP. Studies addressing the use of PUDO in the last-mile logistics literature between 2012 and 2024, and addressing it in combination with a collaborative strategy, are examined below.

Maricˇic et al. [52] investigated the operating cost and service level of PUDO locations when comparing the pricing of ridesharing with door-to-door ridesharing and private ridesharing. The study, conducted in Amsterdam, Netherlands, established a matching model for ridesharing with PUDO. When the discount rate for ridesharing with PUDO was higher compared to door-to-door ridesharing, total vehicle hours could be reduced by 2.2%, and total passenger benefits could be improved by 2%. Zhu et al. [53] evaluated the sustainability and mobility impacts of a demand-side cooperative shared automated mobility service. The trip matching problem was solved using Urban Mobility Simulation. The objective was to maximize the profit of shared automated mobility services. The case study was implemented in a district of the New York City network. The proposed model significantly reduced the operating costs in terms of vehicle energy consumption, vehicle hours, and vehicle miles, and the demand-side cooperative strategy provided a 4%-10% advantage in terms of sustainability and mobility. In another study in 2021, Zhu et al. [54] designed a system where customers are asked to walk to PUDOs. The formulation and heuristics to solve a large sample were modeled. It was tested with Manhattan taxi trip data consisting of 9970 requests in an hour. The study found that users going to or arriving at the most demanded areas were more likely to need to walk. Again in 2021, Gunawan et al. [55] used walking distance and minimum demand data to generate a PUDO layout using a genetic algorithm and included the spatiotemporal distribution of mobility on demand. In the study, a genetic algorithm is used to determine the location placement by taking into account the customer's demand and walking distance. Li et al. [56] focused on the preference diversity of passengers according to PUDO ride-sharing plans. A case study was conducted as a survey on the PUDO preferences of passengers in Shanghai. Factor analysis was conducted on the preference diversity of passengers. The distribution type of passengers' preferences was determined using K-means and Linear Discriminant Analysis. The relationship between passengers' gender and PUDO preference was revealed by Levene's Test and T-Test. In addition, a mixed multinomial logistic model was established to formulate the passengers' decision function. D'Orso et al. [57] investigated the comparison of micro and macro indicators to assess walkability for micro transportation in suburban neighborhoods. The optimum locations for placing PUDO stops for micro transportation service were determined. A case study was conducted in three neighborhoods in the city of Palermo, Italy. The study was conducted with the created GIS database. As a result, a walkability index was developed that shows the attractiveness of certain locations in terms of walkability. Silva et al. [50] proposed a method to generate PUDO for shared autonomous vehicles. The method was applied to provide the main findings and demonstrate its feasibility. Three results were obtained when the study was applied. First, if the willingness of users to walk increased, the number of PUDOs decreased. Second, 83% of curbside parking spaces could be reused within a three-minute walk, while 100% of curbside parking spaces could be reused within a ten-minute walk. Third, 55% of curbside parking spaces could be utilized within a ten-minute walk, and private parking spaces could be accessed without the need for PUDO. In another study conducted in the same year, authors proposed taxi ride sharing with shared PUDOs. Rideshare customers could walk a short distance to the PUDO. Similar studies discussed the advantages of lower fuel consumption, lower emissions, and shorter travel times. This study was designed to maximize the sharing ratio and rejection efficiency. A case study with real data was conducted in New York City and Porto [58].

3.8 Parcel locker

Parcel lockers are delivery machines located in frequently visited locations that do not require surveillance. A parcel locker is available 24 hours a day, every day of the week and it provides both package reception and delivery [59]. Parcel lockers are also known as shared reception boxes. They have locks with variable opening codes [60]. Parcel lockers, along with PUDO, are the most common collaborative use case in the last-mile logistics literature.

Mohamed et al. [61] wanted to use crowd-sourcing to complete the last-mile delivery. Using a citizen pool, products were delivered to the doorstep of consumers from lockers distributed all over the city. Deliveries were made within the specified time interval for each customer, considering the availability and capacity of the drivers. Two integer linear programming models were proposed to minimize the wages paid to the employees through optimal routing for each driver and optimal assignment of packages to the drivers. The proposed models were solved with Lingo software, and the running times were compared. The Variable Neighborhood Search Algorithm was also developed in the local search phase, and the C++ programming language was used to solve large-sized problems faster. A correlation was found between some parameters and the total delivery cost, but others did not give definite results. Mousavi et al. [62] studied three different crowd shipping problems. The authors studied the behavioral patterns of crowd shippers and customers to measure their dependence on delivery charges and the locations of parcel lockers. The problem was modeled as a mixed integer linear programming model. The results obtained showed that higher profits can be achieved. The second problem proposed a two-stage stochastic model for tactical decisions regarding the assignment of customer packages to mobile depots and mobile lockers to stopover points. Advanced decomposition algorithms were formulated to solve real-life problems. The third problem proposed a dynamic model where customers in the store were crowd shippers and orders were delivered within a few hours. The proposed model was built as a Markov decision stage for operational decisions. Juvik et al. [63] investigated a solution method for the problems encountered with the increasing number of automatic parcel lockers (APLs) in Bergen, Norway. The study focused on the participation of postal companies in collaborative applications related to APLs by sharing the APLs, the terminal, and both. Different scenarios were created to minimize the cost of delivering parcels with APLs. A mixed integer linear programming model was proposed. Zhuang et al. [64] proposed a study to integrate decentralized parcel lockers into crowd shipping operations. A mixed integer programming model was developed to optimize driver-parcel matching and routing using decentralized parcel locker transfers. By strategically utilizing underutilized decentralized lockers, a case study with 300 parcels and 900 crowd drivers demonstrated the potential of crowd shipping for economical last-mile urban distribution. As a result, 12.1% cost minimization was achieved. Zhang et al. [65] conducted a study on crowd shipping operations that recruit regular drivers and crowd shippers in an online environment. A city crowd logistics network was designed as a parcel locker location assignment problem to meet the logistics demand. The authors tried to determine the location of parcel lockers to minimize the total cost to help logistics companies develop an effective business strategy for a hybrid crowd shipping operation system. Pang et al. [66] proposed a parcel locker sharing model in which LSPs with parcel locker facilities and LSPs without parcel lockers share parcel locker capacity to avoid financial problems caused by demand fluctuations. The model allowed LSPs with parcel locker facilities to rent the lockers they do not use to others for a rental fee. LSPs without parcel lockers rented parcel lockers to minimize costs. The authors also proposed a price range and an optimum rental price for renting. Ozyavas et al. [67] proposed a system where parcel lockers are used as both a transfer point for delivery companies and a collection point for customers. They presented a variation of the location-routing problem. A case study was conducted in Groningen, the Netherlands. The study found that the common role of parcel lockers is important. The results showed that this common use reduced the probability of customers driving to the parcel locker, significantly reduced the travel distance of delivery vehicles, and was suitable for coping with the potential future increase in parcel collection demand. Wyrowski et al. [68] proposed a crowd shipping application where public transport users pick up parcels from parcel lockers, take them during their subway journey, and drop them off at the other parcel lockers. The optimization model involving parcel lockers aimed to meet the crowd shipping supply and demand. The platform provider, receivers, crowd shippers, and carriers are the main stakeholders with different goals. The study evaluated the relationship between these stakeholders' goals. The efficiency loss of a more restricted matching policy, where only a single crowd shipper could be assigned to the full path of each parcel between origin and destination, was measured. The impact of delays was also investigated. In the same year, Zhang et al. [69] proposed a study where public transport passengers were intended to serve as crowd carriers. In the study, outlier packages were identified as suitable for crowd transportation. These outlier packages were matched with crowd carriers who picked up packages from selected parcel lockers. The study also investigated whether crowd transportation was feasible with real-world data. The performance of a crowd carrier and a scenario without one were compared in the study. As a result, it was found that the carrier's carbon emissions and distance traveled could be reduced by 20%.

4 Results

The results of the study contribute to the concept of crowd-sourcing and logistics science. It is consistent with the studies conducted on the sharing economy in recent years. This study on organizational collaboration and the sharing economy seeks answers to some questions asked in the context of sustainability in the logistics sector regarding last-mile logistics activities.

At the end of the data collection, 85 studies were determined with the general results methodology steps 1 to 5 given in Section 2. The number of these studies was reduced to 39 after performing steps 6 to 8. Later, after general readings, 4 more studies were added that were considered relevant and contributed to the study, reaching 43 studies. These 43 studies cover the years between 2012 and 2024, and were composed of 31 different journals, conference papers, book chapters, and master theses. And the studies included the work of 136 authors.

4.1 *Yearly number of publications*

Time analysis since the pioneering article by Roca-Riu et al. [14], a steady increase has been observed in the research on collaborative strategies in organizations used in last-mile logistics until 2023, reaching its peak in 2024 (9 studies) (Figure 2). The study by Roca-Riu and Estrada, presented at The Seventh International Conference on City Logistics, also focuses on the relevant and promising technical aspects of last-mile logistics: collaboration of LSPs with equal market shares, and urban collaborative physical space (UCC). These concepts have led to the idea of the type of collaboration used in urban physical spaces in last-mile logistics and the idea of collaborative strategies that provide sustainable benefits. The peak of the studies in 2024 is an indication of the increasing academic interest in collaborative strategies in recent years. This situation can be related to the increase in costs and environmental concerns in LSPs due to the increase in online commerce. LSPs can access physical distribution assets, skills, and services that they do not own. For this reason, interest in collaboration strategies in last-mile logistics has been increasing since 2021 (Figure 2). Figure illustrates the growing academic interest in urban sustainability and the growing popularity of collaborative solutions to address the operational challenges posed by the last-mile delivery.

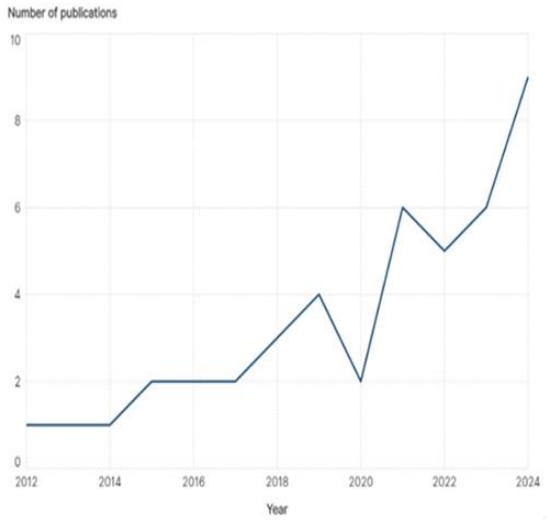

Figure 2. Number of publications per year

4.2 *Subject areas and structure of the literature*

In order to understand the interest in a popular topic in the rapidly growing package delivery industry, a number of scientific studies on that topic have been examined. Several scientific disciplines support studies on collaborative strategies in organizations in last-mile logistics. The subject diversity of 43 studies in this field was determined using Scimago (www.scimagojr.com). In the analyses conducted, it was seen that the most effective fields in which collaborative strategies were studied in environmental sciences, transportation, social sciences, engineering, computer science, business, and mathematics. The most dominant categories were social sciences, transportation, and industrial engineering. This studies can be categorized as multidisciplinary and interdisciplinary.

4.3 *The most productive journals*

As environmental concerns are incorporated into current practices in last-mile logistics, collaborative approaches to create more sustainable solutions are becoming increasingly important. The analysis reveals that no single journal holds a dominant position in this field; however, several journals contribute substantially by publishing a noteworthy number of studies on the topic (Figure 3). The shared use of organizations in last-mile logistics has contributed to the development of a new collaborative paradigm. This collaborative use assumes the shared use of facilities and the sharing of access to operational capabilities in these areas.

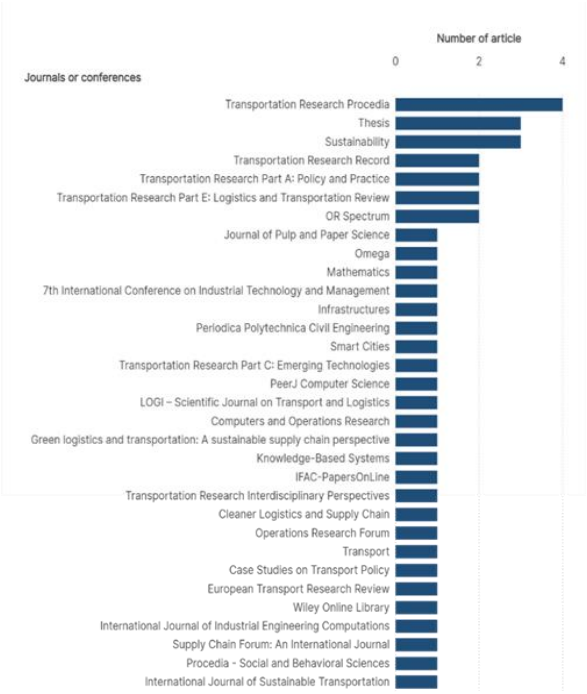

Figure 3. Number of studies by journal

4.4 *Most prominent authors*

There are 136 authors in total who contributed to 43 studies. As can be seen in Figure 4, there is a tendency towards co-authorship. Furthermore, a study is considered an international partnership if collaboration is present.

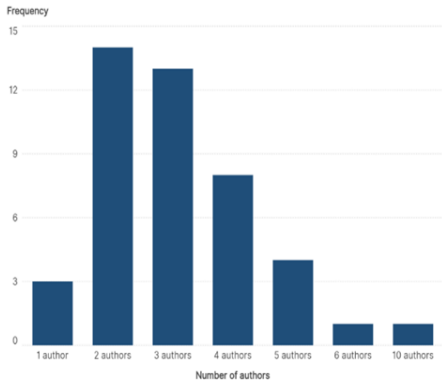

Figure 4. Distribution of studies by author numbers

4.5 Linguistic analysis to identify trends in collaborative strategies in last-mile logistics

In the study, the Free Word Cloud Generator program was used to analyze the words in the titles, abstracts, and keywords of 43 examined articles. The frequency of word associations is used to create word clouds that show the main themes in this field and the relationships between these themes [8]. The program analyzed 9897 words generated from the studies. The results of the analysis are shown as a word cloud in Figure 5. This analysis showed that collaborative practices in last-mile logistics are related to urban areas, delivery of consolidated parcels in collaboration through the shared economy to reduce environmental and economic costs, and also different practices and organizations. Instead of automated clustering, thematic codes were developed through full-text analysis, focusing on infrastructure type, stakeholder roles, and service models.

Figure 5. Word cloud and frequency of representative words

5 Discussion

The transformation of business models in last-mile logistics with the increasing use of e-commerce attracts the attention of both LSPs and researchers. Collaborative strategies are an important new business model supporting sustainability in last-mile logistics activities. In this study, collaborative strategies are defined as the shared use of urban delivery infrastructure. In other words, they aim to support sustainability by using excess delivery center capacity for deliveries without adding a new physical space to the network. A successful collaborative application makes life easier for urban residents by reducing the number of delivery points. LSPs could reduce delivery costs and maintain the same level of service. However, these positive results may not always be realized in practice. For example, with the increasing number of shipments required by households during the COVID-19 pandemic, the capacity of delivery points may not be suitable for shared use, and there may not always be crowd shippers who can support delivery in a planned manner [69]. As all actors involved in a collaborative approach want to reduce costs, the correct allocation of costs and benefits is crucial to its success. Stakeholders need to develop a more effective understanding of urban areas in economic, environmental, social, and technical areas. Therefore, it is necessary to identify the unexpected difficulties and consequences as well as the opportunities in this collaborative use. Based on the information obtained from the 43 studies examined, some negative aspects have been revealed, as well as many positive aspects. While the collaborative use of organizations provides several advantages in terms of last-mile logistics operations, some disadvantages can also arise if the process is not managed correctly and effectively. The collaborative practices will increase the demand for fast and cheap deliveries by end users, thus preventing LSPs from trying to compete by being exposed to high delivery costs. However, very large retail companies have not yet conducted such a study and obtained data. In addition, crowd shippers who contribute to this sector may have concerns about income. Companies that implement collaborative strategies do not have systems such as overtime pay or minimum wage. In addition to these concerns, parking fees, fuel costs, bridge or highway tolls, and delays caused by these are added to the concerns. Beyond identifying publication trends and methodological features, this review synthesizes key collaboration strategies and highlights the most shared infrastructures in last-mile logistics activities and the positive and negative aspects of these collaboration strategies. These insights can inform the design of future research frameworks and help practitioners align logistics innovations with sustainability goals.

Among the 43 studies reviewed, UCCs, parcel lockers, and PUDO points emerged as the most frequently discussed collaborative models. This finding is also reflected in our synthesis, as these three physical infrastructures are considered essential for last-mile collaboration due to their operational flexibility and ease of user access.

While many of the analyzed studies focus on digital coordination or technological platforms, relatively few explore physical infrastructure as a core component of collaboration. Our review addresses this gap by introducing a structured classification of eight distinct physical collaboration spaces, which has not been comprehensively presented in prior reviews.

In addition, most studies tend to emphasize the environmental benefits of collaboration, whereas socio-economic dimensions and policy implications remain underexplored. This contrast underscores the need for more holistic approaches, and our conclusions aim to support further research in that direction.

6 Conclusion

The purpose of this study is to present a review of studies on collaborative shared use of organizations in last-mile logistics. It covers 43 studies from 2012 to 2024, reviewed from six databases. The scientific analysis addressed the following research questions from an urban sustainability perspective:

RQ1. How is the literature on the collaborative use of organizations in last-mile logistics structured?

A1. The study is seen to be an interdisciplinary subject with contributions from environmental sciences, transportation, social and behavioral sciences, engineering, computer sciences, decision sciences, business, management, accounting, mathematics, and economics. The

most dominant category is social sciences, followed by engineering sciences. Studies in this field include research, modeling, and case studies. As of 2021, the increase in collaborative joint use of organizations in last-mile logistics can be explained by the demand for e-commerce and the increasing customer expectations on cost and delivery speed.

RQ2. What are the main trends in collaborative strategies in last-mile logistics from an urban sustainability perspective?

A2. The frequently used words in the literature are delivery, urban, consolidation, shared, and parcel. Collaborative practices in last-mile logistics are related to urban areas, delivery of consolidated parcels in collaboration through the shared economy to reduce environmental and economic costs, and also different practices and organizations.

RQ3. What might be future research options?

A3. According to the 43 studies reviewed, the results show that studies on the collaborative use of places such as PUDOs and parcel lockers have increased in recent years. Further research will provide a better understanding of AI business models and their integration into the system. Future studies may not only share distribution areas but also customer data. Moreover, due to limited land, citizens can use their own homes or apartments as micro-distribution areas. In this way, eco-friendly distribution systems can be created. The widespread use of collaborative strategies in last-mile logistics operations that support the sustainability of urban areas depends on the success of the practices, which in this case can only be possible through optimized decisions. In this respect, there is a need for more studies that approach the problem from an operations research perspective and include real-life applications.

Consequently, although last-mile logistics operations contribute greatly to the employment and economy of urban areas, they also bring many negative impacts such as traffic congestion, parking problems, air and noise pollution. On the other hand, the last-mile logistics activities, which take place at the final stage of the supply chain, have special importance in terms of customer satisfaction as they take place at the stage where direct contact with the customer is ensured. Moreover, customers are only one of the last-mile logistics stakeholders, and compromise solutions to the conflicting objectives of many stakeholders are essential. While customers desire fast, cost-effective, and damage-free delivery of their orders, LSPs want to gain a competitive advantage by focusing on optimizing their networks to fulfill their responsibilities at the lowest cost. Local authorities need to develop policies, make infrastructure investments, and implement incentive mechanisms to ensure that last-mile logistics activities are organized in a way that does not increase the urban carbon footprint and does not affect the well-being of urban residents. The use of collaborative applications in last-mile logistics emerges as an important tool in achieving all these conflicting goals. In this study, collaborative strategies implemented in the last-mile logistics literature from the perspective of sustainability of urban areas were investigated, and the advantages provided by collaborative applications and the challenges encountered in implementation were evaluated. It is hoped that the obtained results will guide researchers in their future studies and help policymakers and practitioners in their decisions. Rather than presenting a simple list of studies, this review offers strategic insights into how and in which facilities collaboration in last-mile logistics networks is most likely to thrive. The identified gaps and future directions aim to guide researchers in developing models that are not only operationally efficient but also aligned with long-term urban sustainability objectives. These conclusions are based on recent studies that emphasize the role of smart platforms and digital ecosystems in facilitating shared logistics operations. As the use of AI and real-time data exchange increases, future models may involve not only shared infrastructure but also collaborative use of customer data under strict privacy frameworks.

To the best of our knowledge, this is the first comprehensive literature review that specifically investigates collaborative strategies in last-mile logistics through the lens of physical urban delivery infrastructure. Unlike previous studies that approach collaboration from broader or conceptual angles, this study categorizes and analyzes eight distinct types of shared physical spaces—such as parcel lockers, micro-depots, PUDO points, and urban consolidation centers—used in collaborative logistics. By doing so, it not only identifies policy-relevant trends and future research opportunities but also offers a unique typology that can serve as a foundation for academic and practical advancements in sustainable last-mile delivery.

One limitation of this study is the reliance on publicly accessible databases, which may omit gray literature or unpublished industrial reports. In future work, expanding the dataset to include practitioner insights may enrich the analysis.

Looking ahead, future research can explore how crowdsourcing models—particularly those involving citizen couriers operating through shared physical locations—can improve the efficiency, flexibility, and responsiveness of last-mile logistics systems. Notably, in four of the studies included in this review, such models were already implemented, indicating an emerging but under-researched trend.

As real-time data technologies advance, collaborative systems that integrate human and digital resources (e.g., AI-based matching platforms, dynamic routing) may become more viable. Moreover, secure and ethical data sharing between stakeholders, when aligned with privacy regulations, could play a critical role in optimizing delivery networks and enhancing service quality. Socio-economic evaluations of these models in diverse urban contexts remain an open and valuable avenue for future research.

Conflict of interest

The authors declare that there is no conflict of interest.

Similarity rate (iThenticate): 20%

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