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Research Article

The Impact of Automated Parcel Lockers on Public Space: A Literature Review Analysis of Benefits and Challenges

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Abstract

The rapid expansion of e-commerce has intensified last-mile delivery pressures and generated urban externalities such as congestion, noise, and air pollution. While parcel lockers (PLs) are increasingly deployed as a sustainable alternative to door-to-door delivery, their multifaceted effects on public space, urban accessibility, and governance remain insufficiently synthesized in academic literature. This study addresses this gap by performing a systematic literature review on Scopus and Web of Science databases through September 5, 2025. A total of 184 peer-reviewed articles were analyzed. The findings indicate that strategically sited parcel lockers adjacent to public transport, workplaces, dense retail areas and existing civic infrastructure can reduce courier vehicle-kilometres and CO_2 emissions while enabling parcel collection within routine trips. However, the evidence reveals that environmental gains are highly sensitive to consumer behaviour, as poorly planned locations often lead to oversupply, inequitable access, and a phenomenon described as "public-space invasion", which may paradoxically encourage private car use for parcel collection. The study concludes that parcel locker effectiveness is contingent on coordinated spatial planning, operator-municipality collaboration and policies that prioritise walkable, multi-modal access. These conditions are essential to ensuring that parcel lockers contribute to, rather than detract from, the quality of urban public spaces.

Keywords: parcel lockers, public space, urban logistics, systematic literature review

Introduction

Global digital transformation in the retail sector and the rapid growth of e-commerce, intensified by the COVID-19 pandemic, are causing fundamental changes in urban spatial organization and the economic geography of goods flows (Rosca et al., 2024). With these changes arises the need to reorganize and adapt urban space to new logistical requirements. This trend intensifies distribution problems and contributes to the emergence of negative externalities such as traffic congestion, accidents, noise, and air pollution, including CO_2 emissions. (Rosca et al., 2024; Sawik, 2024).

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In response to these challenges and to increase the efficiency and sustainability of delivery processes, innovative and economically effective logistics solutions such as automated parcel lockers are being sought (Schnieder, 2024; Sina Mohri, Nassir, et al., 2024).

Parcel lockers (PLs) are characterized as a group of publicly installed, secure, automated compartments that customers can use as parcel pickup points (Asdecker, 2021; Sawik et al., 2022). They are usually unattended objects, although within the broader category of pickup points, there can also be attended facilities (Sina Mohri, Ghaderi, et al., 2024; Sina Mohri, Nassir, et al., 2024). They constitute an important element of urban infrastructure, which can serve as a temporary storage location and mini-hub for crowdsourcing services (Oliveira et al., 2022).

Public space plays an increasingly important role in social development, especially in the context of the growing significance of urbanization (Azizah et al., 2025). Well-designed public space positively influences the quality of urban life and increases user satisfaction (Mouratidis, 2021).
The literature presents many definitions of public space, highlighting different aspects of this phenomenon (Azizah et al., 2025; Gibas, 2012; Mouratidis, 2021). In general, public space is an area accessible to everyone, whose character allows for chance social interactions and the implementation of various civic activities (United Nations, 2017; Wejchert, 1993).

Public space is an area accessible and useful for all members of the community, regardless of gender, race, ethnic origin, age, or socio-economic status, although access can be temporarily limited in some cases, such as shopping centers (Duivenvoorden et al., 2025; Hossain & Waliullah, 2024; Said & Tempels, 2025). It may be publicly or privately owned, provided it is accessible for public use. The literature distinguishes between internal spaces (e.g., libraries, cultural centers) and external spaces (e.g., parks, squares) (Duivenvoorden et al., 2025; Hossain & Waliullah, 2024; Said & Tempels, 2025). Public space consists of various spatial elements, including (Duivenvoorden et al., 2025; Kumar et al., 2025; Said & Tempels, 2025):

- Green elements (e.g., vegetation, parks, street trees, playgrounds),
- Open spaces (e.g., plazas, pedestrian zones, waterfronts),
- Gray spaces (e.g., streets, avenues, roads, bridges, tunnels, squares),
- Brown spaces (e.g., derelict lands, industrial sites),
- Blue spaces (e.g., water bodies, channels, lakes).

Public space constitutes an essential component in the functioning of cities and the quality of life of their inhabitants (Duivenvoorden et al., 2025). It provides access to diverse functions through both above-ground and underground infrastructure (Hossain & Waliullah, 2024).The management of public space is of major importance for cities due to its social and infrastructural dimensions (Duivenvoorden et al., 2025).

The present study aims to provide a multifaceted assessment of the impact of parcel lockers on public space, taking into account both the benefits (logistical, environmental, and social) and the challenges associated with their location and use in urban, social, and operational contexts.

Methodology

The study was based on a systematic literature review (SLR) conducted in accordance with rigorous methodological standards. A total of 184 scientific articles from the Scopus and Web of Science databases were ultimately selected for in-depth analysis.

The process proceeded as follows:

1. Development of definitions and keywords, and formulation of the search string::
   TITLE-ABS-KEY ("APM" OR "OOHD" OR "Out-Of-Home Delivery" OR "PUDO" OR "agnostic locker*" OR "alternative delivery point*" OR "automated collection point*" OR "automated delivery locker*" OR "automated delivery station*" OR "automated parcel locker*" OR "automated parcel machine*" OR "automated parcel terminal*" OR "automated pick-up point*" OR "carrier-agnostic locker*" OR "click and collect" OR "collection and delivery point*" OR "delivery locker*" OR "lockbox*" OR "mobile parcel locker*" OR "multi-carrier locker*" OR "multi-operator locker*" OR "on-premises parcel locker*" OR "package locker*" OR "parcel collection point*" OR "parcel drop box*" OR "parcel kiosk*" OR "parcel locker*" OR "parcel station*" OR "parcel terminal*" OR "pick-up locker*" OR "pick-up point*" OR "reception box*"

OR "residential parcel locker*" OR "self-collection" OR "self-service delivery" OR "self-service locker*" OR "smart locker*" OR "smart parcel locker*")AND("city logistics" OR "crowdshipping" OR "crowdsourcing" OR "last mile" OR "last mile delivery" OR "last-mile" OR "last-mile logistics" OR "urban freight" OR "location" OR "location-routing" OR "network design" OR "optimisation" OR "optimization" OR "routing" OR "adoption" OR "consumer behavior*" OR "consumer behaviour*" OR "customer preference*" OR "customer satisfaction" OR "user acceptance" OR "carbon emission*" OR "environmental impact" OR "green logistics" OR "sustainab*");

2. Source retrieval: On September 5, 2025, sources were searched in the Scopus and Web of Science databases according to the keywords (in titles, abstracts, summaries, and keywords). The date range considered extended up to and including September 5, 2025.
3. Selection and verification of sources: During content analysis, articles not aligned with the research topic were excluded. Non-English articles and those without open-access full texts were also removed. Finally, duplicates across both databases were eliminated. The final selection included 184 scientific articles.

This study analyzed only the selected publications that directly address the topic of parcel lockers in public spaces.

Impact of Automated Parcel Lockers on Public Space: Benefits and Challenges

The importance of the location of parcel lockers in public space should be emphasized: it is a critical and decisive factor influencing a range of logistical, economic, social, and environmental aspects (Boom-Cárcamo et al., 2024; Bruno et al., 2025).

Parcel lockers are typically situated in high-traffic and easily accessible locations such as supermarkets, train stations, gas stations, residential neighborhoods, and shopping centers (Alves et al., 2019; Beckers & Verhetsel, 2021; Cheng et al., 2024; Cieśla, 2023; Corejova et al., 2022). Research shows that locating parcel lockers near workplaces, schools, or public transport stops positively affects user satisfaction and enhances service efficiency (Boom-Cárcamo et al., 2024; Chaberek, 2021; Cieśla, 2023; Corejova et al., 2022). Authors emphasize that the appropriate distribution and accessibility of parcel lockers in public space is crucial for the effectiveness and quality of delivery services, impacting delivery times, greenhouse gas emission reductions, and overall customer satisfaction (Boom-Cárcamo et al., 2024; Čižiūnienė et al., 2025).

Proper placement of parcel lockers is also crucial for achieving environmental benefits and reducing unnecessary customer travel. Locating parcel lockers in well-planned locations, among other advantages, allows users to collect parcels during their daily activities, thereby reducing the need for additional, special trips (Alves et al., 2022). The authors indicate that poorly planned locations for these machines can lead to increased private vehicle trips, which exacerbates traffic congestion and negatively impacts public spaces, including urban environments, and consequently the environment as a whole (Alves et al., 2022). As noted by Orhan & Wallace (2025), urban policy should promote parcel lockers to be easily accessible by foot or bicycle, in line with the X-minute city concept, which would reduce residents' dependence on car transportation for parcel collection (Orhan & Wallace, 2025).

For example, in the case study of Saint Petersburg, the author (Aksenov, 2023) emphasizes that parcel lockers, primarily located in retail and office areas, are creating a new spatial hierarchy within urban development. They influence both the organization of public space and the flow of goods and people. The author explains how the principles of locating collection points compel the largest online retailers to compete within urban spaces with small offline retail vendors. Two opposing trends are observed: the transfer of commercial functions to non-retail spaces and the relocation of non-retail functions into commercial premises (Aksenov, 2023). In summary, the key conclusion is the transformation of the competitive landscape in cities, where e-commerce infrastructure is vying for physical space with traditional retail and business sectors- an unprecedented phenomenon in the history of urban development. Furthermore, the author highlights the increasing penetration of e-commerce in Russia, which necessitates significant administrative decisions regarding the adaptation of urban spaces, the implementation of innovative regulatory policies

that account for alternative transportation methods and routes, and the reorganization of urban flow of goods (Aksenov, 2023).

A study conducted in the city of Belo Horizonte, Brazil, analyzes the accessibility of parcel pickup points (CDP) in the context of sustainable urban transport and e-commerce. The authors presented a spatial analysis method assessing the distribution of points across various commercial establishments such as pharmacies, post offices, gas stations, supermarkets, and shopping malls, as well as their accessibility for users of different transport modes. The results showed that pharmacies and post offices exhibit the most efficient distribution in Belo Horizonte, enabling access to nearly 99% of the city's population due to their locations in densely populated areas and near major transport routes. Pharmacies represent an optimal starting point for expanding the CDP network. Supermarkets and malls, although located in higher-income areas, are fewer in number and more attractive to private investors. According to the authors, the optimal distribution of pickup points promotes sustainable mobility by reducing home deliveries, thereby lowering congestion and pollution emissions. A diverse network of locations counteracts negative effects such as pollution and failed deliveries while supporting shorter walking distances. Studies (Alves et al., 2019) indicated that the average distance traveled by customers to delivery lockers (DL) in Belo Horizonte ranged from 1.2 km to 1.6 km. This is an important factor because additional traffic generated by customers using private vehicles to pick up parcels is an undesirable consequence of developing DL networks. In this context, the authors emphasize the need to integrate urban transport policies with CDP location planning to enhance service efficiency and equitable access (Alves et al., 2019).

The study by Di Gangi et al. (2023) focuses on optimizing goods distribution on small islands by integrating maritime services with automated parcel lockers (PL) to improve last-mile logistics efficiency. The case study selected is the island of Lipari (Aeolian Islands archipelago, Italy), where deliveries are critical due to exclusive dependence on maritime connections. The study's results showed that implementing parcel lockers significantly improves last-mile delivery efficiency. The average waiting time for parcel pickup was reduced to approximately 11.86 hours, compared to 20.58 hours for door-to-door deliveries. Optimization by a genetic algorithm allowed planning four different ferry routes, using one parcel locker per route over five days. Compared to traditional delivery, the authors state this solution saves about 78.5 km of vehicle travel per week, translating into an annual reduction of around 4,000 km. This implies potential cost savings and reduced environmental impact (Di Gangi et al., 2023).

Cheng et al. (2024) discuss the role of public spaces in the context of parcel lockers in Copenhagen, with particular emphasis on their location at public transport (PT) stations and the function of these sites within a PT-based crowdshipping system. Simulations in their study demonstrated that PT-based crowdshipping can substantially reduce the total vehicle kilometers traveled (VKT) by courier vehicles, the total driver working time, and the number of vans required for last-mile deliveries. Compared to the baseline home delivery (HD) scenario, the average total operational costs in the PT-based crowdshipping scenarios were reduced by 8%, 13%, and 24% respectively on weekdays. In scenarios which involved the use of parcel lockers alone without crowdshipping at share levels of 10%, 20%, and 30%, total costs were reduced by 1%, 3%, and 4%, respectively. Based on these results, the authors infer that the PT-based crowdshipping solution potentially offers greater cost reduction than the sole implementation of parcel lockers. They argue that such a solution contributes to alleviating urban traffic congestion and reducing environmental pollution in city areas. The principal operational challenge, according to the authors, is ensuring a sufficient number of crowdshippers. To achieve this, various strategies can be employed, including increasing monetary incentives and promoting public transport use, which in turn encourages passengers to carry more parcels along their routes. The authors regard achieving a 30% share of shipments handled in this manner as feasible from a demand perspective (Cheng et al., 2024).

In the case of Belgium, the authors highlight the need for collaboration between courier companies and municipal authorities to ensure that pickup points, including parcel lockers, are both accessible to users and functionally integrated into the urban fabric, thereby avoiding excessive dispersion and issues such as illegal parking or noise. They also propose solutions such as agnostic (multi-carrier CDPs) pickup points, which could more effectively utilize public space while simultaneously reducing negative urban impacts. According to the authors, there is significant overlap in the coverage areas of individual operators' points in Belgium (approximately 75%), indicating the potential for

creating shared CDPs - points jointly used by multiple operators - which could enhance the efficiency and accessibility of the network and increase its positive environmental impact. The authors observe that, so far, operator strategies have focused on the number rather than the quality of points, leading to the selection of less optimal locations, often small shops with limited space and opening hours (Beckers & Verhetsel, 2021).

Chaberek's (2021) study, using Gdańsk as a case example, analyzes the extent to which strategic placement of parcel pickup points, such as parcel lockers and kiosks, can reduce individual car traffic. The authors assessed the accessibility of these points in the context of sustainable transport modes, including walking and cycling routes. The results showed that parcel lockers are often located in places convenient for drivers, which encourages car travel (approximately 47% of respondents walk to parcel lockers, while 46% drive to them) instead of alternative forms of transport. Moreover, some parts of the city are poorly served by parcel lockers, limiting accessibility for pedestrians and cyclists. The survey revealed that some residents combine parcel pickup with other daily trips, which may contribute to reduced car traffic. The authors emphasize the need to optimize the location of pickup points in the context of sustainable mobility, support the development of flexible parcel lockers, and integrate them with non-motorized transport infrastructure. According to the authors, cities should implement policies to reduce excessive car use by incorporating parcel pickup into transport and spatial planning (Chaberek, 2021).

The study by Ding, Ullah, et al. (2023) analyzed the evolution of parcel locker (PL) distribution in Tianjin, China, before and after the COVID-19 pandemic, in the context of a rapid increase in e-commerce and the implementation of contactless delivery methods. The number of PLs rose from 51 in 2019 to 479 in 2022, reducing the ratio of residents per PL from 80,280 to 8,793. This expansion was primarily focused on residential areas, which increased their share from 92.2% to 97.7%. The authors also observed a shift in the spatial pattern from dispersed to concentrated, aligning with the city's urban development trends, including those along the Haihe River (Ding, Ullah, et al., 2023). They emphasize that the rapid, uncontrolled growth in the number of SPLs (smart parcel lockers) and their suboptimal locations have led to public space management issues, described as an "invasion of public space". A significant imbalance between supply and demand was identified, with only 25.21% of neighborhoods exhibiting equilibrium, while 44.78% experienced oversupply and 30.01% undersupply. Furthermore, residents' preferences for PL accessibility fall within a radius of approximately 300 meters, whereas most devices are located between 300 and 600 meters from homes (Ding, Ullah, et al., 2023).

The authors (Ding, Song, et al., 2023) assessed the supply-demand alignment for smart parcel lockers (SPL) at the residential neighborhood level in the central metropolitan region of Tianjin, China. The primary objective was to analyze how the current location and number of PLs correspond to residents' needs, aiming to prevent inefficient resource use, public space wastage, and social inequalities. The authors point out that inappropriate placement leads to occupation and waste of public space and exacerbates disparities in service accessibility. They highlight the lack of urban planning guidelines and the necessity of involving urban planners in the placement of PLs. According to their study, in 2023, only 25% of residential neighborhoods in Tianjin exhibited a supply-demand balance; 45% had an oversupply, and 30% faced a shortage. Residents prefer lockers within a radius of up to 300 meters, whereas most lockers are located farther, leading to dissatisfaction with their locations. The authors recommend collaboration among planners, operators, and policymakers to optimize the network by removing surplus parcel lockers and installing them in deficit areas, thereby making better use of public space (Ding, Song, et al., 2023).

To avoid installing an excessive number of parcel locker machines, González-Varona et al. (2020) proposed the potential use of the existing network of press kiosks in the center of Valladolid, Spain, as parcel pickup points to optimize last-mile logistics and reduce negative environmental impacts. According to the authors, utilizing adapted kiosks could significantly reduce the distance traveled by couriers from 4,137.2 km (door-to-door model) to 406.4 km per day, resulting in a decrease in CO_2 emissions from 608.2 kg to 59.5 kg, or approximately 90%. This reduction, the authors emphasize, could substantially contribute to alleviating traffic congestion and parking issues in the city center. Based on their findings, the authors recommend that pickup points be shared among different courier operators to increase system efficiency

and benefits for residents. They propose implementing pilot programs in cooperation with kiosk owners and logistics operators to determine the optimal configuration and location of parcel lockers. Furthermore, they stress the need to adapt municipal regulations and concession systems to support the transformation of kiosks for new functions, considering the city's aesthetic and planning objectives (González-Varona et al., 2020).

Kedia et al. (2019), in their study of Christchurch, New Zealand, examined the utilization of existing retail outlets such as supermarkets, gas stations, pharmacies, local convenience stores (dairies), and traditional post offices as parcel pickup points. The findings revealed that supermarkets are the most preferred type of pickup location among consumers, due to the convenience of combining parcel collection with daily shopping trips and perceived security. Pharmacies and post offices are regarded as important despite their limited opening hours, while local convenience stores, although less preferred, play a crucial role in sustainable development owing to their dense distribution near residential areas, which encourages active modes of transport such as walking and cycling. Achieving sustainability hinges on customers collecting parcels by foot or bicycle. Although New Zealand exhibits a high dependence on automobiles, with 95% of shopping trips made by car, over 54% of respondents indicated a willingness to use active transport modes (walking or cycling) for parcel collection points (CDPs). Despite their lower preference, local convenience stores were identified as the most promising from a sustainability perspective. Their dense proximity to residential neighborhoods, according to the authors, gives them the greatest potential to encourage customers to walk or cycle for parcel collection, thereby reducing vehicle kilometers traveled (VKT) by customers. The authors emphasize that the efficiency and success of CDP systems depend on the proper spatial density of these points within the urban environment. Local authorities and courier companies should promote the development of active transport infrastructure around pickup points and take into account operational variables, such as outlet opening hours, which may affect service accessibility (Kedia et al., 2019).

Gobir et al. (2024) investigated the role of smart lockers in public spaces from a medical perspective through a descriptive cross-sectional study conducted in Nigeria in 2021. The study focused on assessing the preferences of patients with chronic illnesses and healthcare workers (HCWs) regarding the use of smart parcel lockers for accessing and dispensing medications. A total of 405 healthcare workers and 728 patients from five Nigerian states-Adamawa, Akwa Ibom, Cross River, Benue, and Niger-participated in the study. The results indicated that both groups strongly preferred placing lockers within medical facilities such as hospitals and clinics, due to the perceived security, privacy, and reduced risk of stigmatization, particularly for patients with conditions like HIV. The placement of smart lockers in non-medical public locations, such as bus stops or religious sites, received less acceptance. Medical facilities offer the advantage of 24-hour access, which was considered important by 65.4% of healthcare workers and 52.6% of patients. The study demonstrated that deploying smart lockers could effectively reduce waiting times for medication, lower transportation costs to medical facilities, while also alleviating staff workloads and reducing overcrowding in healthcare centers. The greatest benefits were observed among patients living with HIV and individuals aged 18-40 years. Preferences for medication availability notifications favored phone contact, and responsibility for restocking lockers was assigned to pharmacists or pharmacy staff. Both patients and healthcare workers rated personalized counseling as the most effective form of instruction for using these devices (Gobir et al., 2024).

Summary and Conclusions

The conducted systematic literature review encompassed 184 scientific publications from the Scopus and Web of Science databases, enabling a comprehensive analysis of the impact of automated parcel lockers on public space. The study revealed the complex nature of this phenomenon, characterized by both benefits and significant challenges that require strategic planning and regulatory interventions.

The literature analysis confirms that strategically located parcel lockers offer substantial environmental and operational advantages. The example from Valladolid, Spain, documents a reduction in daily courier travel from 4,137.2 km to 406.4 km by utilizing existing kiosk infrastructure, leading to approximately a 90% decrease in CO_2 emissions-from 608.2 kg to 59.5 kg. Similar benefits were observed on the island of Lipari, where the implementation of parcel lockers saved around 4,000 km of vehicle routes annually. Research from Christchurch, New Zealand, indicated that over 54% of respondents expressed willingness to use active transport

modes to access pickup points, which is crucial for sustainable development.

Concurrently, the literature identifies challenges including uncontrolled parcel locker expansion. The case study from Tianjin, China, highlights a "public-space invasion" issue, where a sharp increase in lockers from 51 in 2019 to 479 in 2022 resulted in a marked imbalance between supply and demand. Only 25% of neighborhoods exhibited equilibrium, while 45% experienced oversupply and 30% shortages. Improper locker placement further undermines environmental gains. A study from Gdańsk shows 46% of customers drive to lockers while only 47% walk. Residents prefer lockers within 300 meters of their homes, though most are located 300-600 meters away.

Maximizing the positive impact of parcel lockers on public space requires an integrated approach combining logistical and urban planning, alongside regulatory policies promoting sustainable mobility. It also demands a holistic perspective on last-mile logistics, of which parcel lockers are a component.

Further research is recommended on predictive models and alternative logistics concepts, such as crowdshipping, mobile lockers, agnostic locker networks, and leveraging existing infrastructure to enhance utilization potential in public spaces. Investigations should extend beyond major cities to include suburban and rural areas to address diverse settlement patterns, contexts and issues.

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