



URBAN PARCEL LOCKERS: SPATIAL DISTRIBUTION AND INSIGHTS

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Abstract: The rapid growth of e-commerce has increased the importance of alternative parcel delivery solutions, particularly parcel lockers and parcel shops. This paper examines their role and spatial accessibility in the City of Novi Sad. The research combines survey analysis and a GIS-based approach in order to explore user preferences and analyze the spatial distribution of parcel locker and parcel shop networks. The study focuses on evaluating the accessibility of these delivery points in different local communities and identifying spatial differences in network coverage. The results contribute to a better understanding of the role of alternative delivery infrastructure in urban logistics and last-mile delivery systems.

Keywords: Parcel locker, parcel shop, survey, GIS, spatial distribution.

1. INTRODUCTION

The contemporary development of logistics and digital technologies is significantly transforming the way goods are distributed and delivered to end customers, particularly in urban environments. The rapid growth of e-commerce over the past decade has substantially stimulated the expansion of parcel locker networks, i.e., automated devices that enable customers to receive and send parcels without direct contact with an operator. This delivery model represents an alternative to traditional home delivery, which often faces the problem of unsuccessful delivery attempts due to the recipient's absence. Such situations may result in repeated delivery attempts, increased operational costs, and a greater number of kilometers traveled (Moroz & Polkowski, 2016). Customers are often unable to receive parcels at their home address, as the delivery time is usually not precisely defined but rather indicated within approximate time intervals (e.g., during the day). Consequently, parcel lockers and parcel shops are increasingly used as an alternative delivery solution.

The efficiency of parcel lockers and parcel shops largely depends on the appropriate selection of their locations and their accessibility to customers. Therefore, the spatial analysis of the distribution of parcel lockers and parcel shops represents an important aspect of planning

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logistics infrastructure in urban environments. The application of Geographic Information Systems (GIS) enables the analysis of the spatial distribution of parcel lockers and parcel shops, the identification of areas with different levels of accessibility to these services, as well as the examination of their relationship with the structure of urban space.

The subject of this research is the analysis of parcel lockers and parcel shops as alternative points for receiving parcels in the area of the City of Novi Sad. The aim of this paper is to determine, based on the results of a conducted survey, customers' opinions and experiences regarding the use of parcel lockers and parcel shops. In addition, by applying GIS-based analyses, the study examines the parcel locker network in the largest and the smallest local communities in Novi Sad, with the aim of assessing their spatial distribution and accessibility to customers.

2. PARCEL LOCKERS AND THEIR ROLE IN MODERN PARCEL DELIVERY SYSTEMS

With the intensive development of postal infrastructure and the expansion of logistics networks across Europe, parcel lockers have become an important component of the modern parcel delivery system, particularly in the e-commerce segment. The growth of customer trust and acceptance further contributes to their integration into standard postal and logistics flows.

The most pronounced growth has been observed in countries such as Poland, as well as in the Nordic countries and Germany, where parcel lockers have become a widely accepted option for parcel delivery within the e-commerce system. Their use is based on high operational efficiency, reduced delivery costs, greater temporal flexibility for customers, and lower CO₂ emissions compared to the traditional home delivery model (Calviño, 2025).

According to research (Calviño, 2025), in 2023, 44% of European online customers used Out-of-Home (OOH) parcel pickup options, including parcel lockers and parcel shops. By the end of the same year, there were nearly 155.000 parcel lockers in Europe, representing a 29% increase compared to 2022, while the number of parcel shops exceeded 349.000 locations (Calviño, 2025).

Poland represents one of the most developed parcel locker systems in Europe. The company InPost delivered more than one billion parcels in 2024, and nearly 47.000 parcel lockers were operational in the country. Germany plans to expand its Packstation network to 30.000 units by 2030, while the Nordic countries demonstrate high parcel locker penetration, with parcel lockers being the most popular parcel pickup method in Finland. In France, the development of the postal network includes plans for the installation of solar-powered parcel lockers (Calviño, 2025).

2.1. Types of parcel lockers

Public and private parcel lockers: Parcel lockers can be installed on either public or private locations. Installation on public locations requires approval from the local authorities, i.e., the municipal or city administration, including the relevant urban planning and public works departments. The majority of parcel lockers are located on private locations, such as supermarket parking lots, gas stations, entrance lobbies of commercial buildings, or company premises. Parcel lockers also differ in terms of accessibility: public lockers are available to the general population, whereas others are restricted to specific customers (Zurel et al., 2019).

Electronic and mechanical parcel lockers: Electronic parcel lockers combine physical compartments with digital systems, enabling parcel tracking, automatic customer notifications, and the generation of delivery confirmations, thereby increasing efficiency and security in

parcel management. Mechanical parcel lockers operate manually, using physical locks or basic PIN codes for access, and may feature a “soft drop” mechanism for the secure insertion of parcels. However, they do not offer digital functionalities such as automated notifications or centralized tracking (Zurel et al., 2019).

Stationary and mobile parcel lockers: Stationary parcel lockers are fixed units installed at a single location, where customers can collect or send parcels. They constitute a standard component of postal and logistics infrastructure and are widely distributed in European cities. Mobile parcel lockers, in contrast, are movable units that can be relocated as needed, providing greater flexibility and accessibility for customers in urban environments. The broader use of mobile parcel lockers is still largely in the testing phase (Rod, 2023).

3. FRAGMENTATION OF THE POSTAL MARKET AND THE DEVELOPMENT OF PARCEL LOCKER AND PARCEL SHOP NETWORK

The global postal sector has undergone significant transformations in recent years due to the rapid growth of e-commerce and the digitalization of postal processes. One of the key consequences of these changes is the fragmentation of the global postal network, in which formerly relatively centralized transport flows are replaced by a more complex system involving a larger number of routes and operators.

Before the COVID-19 pandemic, international parcels primarily moved through 30 to 50 main logistics corridors, whereas today distribution occurs via more than 150 different routes. This network structure leads to increased transportation costs, more complex customs procedures, and reduced access to international markets, particularly for small exporters. At the same time, the fragmented network exhibits lower resilience to global disruptions, such as pandemics, geopolitical crises, or congestion at transport hubs (UPU, 2025).

Under such conditions, alternative distribution models play an increasingly important role, particularly parcel lockers and parcel shops. Parcel lockers enable automated parcel collection and delivery, while parcel shops represent partner locations within retail outlets where customers can drop off or collect parcels. These solutions contribute to the optimization of the last-mile delivery phase, increase the accessibility of postal services, and reduce the burden on courier networks (UPU, 2025).

The development of the postal sector is unequal at the global level. Industrialized countries achieve the highest levels of postal system development, whereas many countries in Africa and Latin America remain at lower levels of postal infrastructure development. However, certain countries, such as Estonia, Thailand, and Mauritius, have made significant progress thanks to targeted investments in network modernization and service quality improvement. In contemporary business conditions, the combination of modern postal solutions, such as parcel lockers and parcel shops, service diversification, and the maintenance of an adequate network density represents a key factor in enhancing the efficiency and competitiveness of postal operators (UPU, 2025).

According to a 2017 study by IPC, 11% of all postal items are delivered via parcel lockers, while 9% of returned items also pass through parcel lockers. Parcel lockers are most popular in Finland (43%), Denmark (41%), and China (33%), highlighting the growing importance of modern delivery solutions in improving the efficiency and accessibility of postal services (IPC, 2017).

The IPC Domestic E-Commerce Shopper Survey (2025) indicates that parcel lockers are becoming an increasingly popular delivery option. About 35% of online shoppers include them among their top three preferred delivery locations, while home delivery remains dominant,

with over 90% of shoppers choosing it. These results suggest that parcel lockers are becoming an increasingly important alternative to traditional home delivery (IPC, 2025).

The Chinese online retailer Temu has significantly increased its presence in cross-border e-commerce, rising from less than 1% in 2022 to 24% in 2025, becoming one of the most frequently used cross-border e-commerce platforms alongside Amazon. At the same time, Shein has maintained stable market penetration over the past two years, while Wish, eBay, and AliExpress have experienced a significant decline. Regarding delivery, more than half of cross-border orders were delivered within 2 to 7 days, while the most common delivery times were 4–5 days (19%) and 10–14 days (20%). The share of items arriving in 15 or more days decreased from 29% in 2020 to 7% in 2025 (IPC, 2026).

Home delivery was the most common delivery method (44%), while parcel lockers accounted for 13% of deliveries and delivery to mailboxes for 12%. The use of parcel lockers increased significantly in 2025, indicating the growing popularity of alternative and flexible parcel collection methods (IPC, 2026).

In the Republic of Serbia, electronic parcel lockers are used by various postal and courier operators. The most widespread systems are operated by Post of Serbia, D Express and Ananas, enabling the collection of postal items at numerous locations across the country. Parcel lockers are most commonly located in places with high customer traffic, such as petrol stations, supermarkets, and shopping centres, and many of them are available to users 24 hours a day, seven days a week. In addition to the aforementioned operators, parcel locker networks are also being developed by other courier services, such as BEX Express, City Express, and Milšped One.

3.1. Examples of parcel locker use in selected countries

In Belgium, bpost significantly expanded its parcel locker network in 2024, installing over 1,260 units, a 40% increase compared to the previous year. This expansion, averaging roughly one new installation per day, improved accessibility and convenience, as parcel lockers are available 24/7 and consistently receive the highest customer satisfaction ratings among all bpost delivery options. The network is set to grow further in 2025, with plans to add 1,200 more lockers, effectively doubling the total number to 2,500. The newer units are larger and more efficient, which will triple the number of locker doors from 50,000 to 150,000, further enhancing capacity and service quality (IPC, 2024).

In the Czech Republic, private parcel delivery companies GLS (General Logistics Systems B.V.) and DPD (Dynamic Parcel Distribution) have established a strategic partnership that enables mutual access to their parcel locker networks. Through this cooperation, GLS customers are able to use a network of around 800 DPD parcel lockers, while DPD users have access to approximately 1,300 GLS lockers, thereby increasing delivery flexibility and reducing congestion at high-traffic locations. In recent years, GLS has significantly expanded its parcel locker network, which, according to available data, has grown by more than 400%, making it the third-largest carrier-operated locker network in the country. This collaboration reflects a broader trend among private logistics providers toward sharing infrastructure in response to the growing demand for convenient locker-based delivery solutions. At the time the data were reported, the total number of parcel lockers in the Czech Republic exceeded 13,000, although demand for this delivery option continues to grow (Parcel and postal technology international, 2025).

In Rome, young e-consumers exhibit a clear preference for parcel lockers over traditional home delivery, primarily due to convenience, 24/7 accessibility, and fewer failed delivery attempts. Research indicates that distance to the locker and ease of access are the main

factors influencing user choice. Parcel lockers are increasingly recognized as an effective solution for urban logistics, contributing to reduced congestion and improved operational efficiency. Overall, these findings highlight the growing demand for parcel lockers among urban consumers, underlining their potential role in the future of e-commerce delivery systems (Iannaccone et al., 2021).

The company Omniva, part of the national postal operator Eesti Post in Estonia, has implemented two innovative solutions to optimize its parcel locker network and improve the customer experience. The first solution allows consolidation of multiple parcels into a single locker for one customer, using the mobile phone number for identification, which speeds up parcel handling and reduces network congestion. The second solution is a mobile parcel locker housed in a transportable trailer, with all the functionalities of a standard locker, which can be relocated based on operational needs. It serves as a temporary or additional postal point at high-volume locations, during events, or when a standard locker is unavailable (PostEurop, 2023).



Figure 1. Parcel lockers (PostEurop Innovation Booklet, 2023)

Mobile parcel lockers provide additional flexibility and efficiency in parcel distribution, especially in situations where standard parcel lockers or postal units are insufficient. Their main advantages include (PostEurop, 2023):

- Increasing capacity at locations with high parcel volumes
- Temporary availability at new locations or when a post office is closed
- Replacement of parcel lockers in case of malfunction or maintenance
- Support during public events and promotional activities
- Training and upskilling of staff to operate parcel lockers

The global smart parcel locker market was valued at USD 1,140 million in 2025 and is projected to reach USD 2,970 million by 2034, with a compound annual growth rate (CAGR) of 11.1%. North America accounted for 33.3% of the global market in 2025, with the United States representing the largest share. The U.S. market alone is expected to reach USD 421.2 million by 2032, driven by the adoption of advanced technologies by leading e-commerce companies and growing demand for flexible, locker-based delivery solutions. These trends highlight the increasing importance of parcel lockers in modern logistics and last-mile delivery, both globally and in the U.S., and underscore the need for continued research on their impact on urban logistics and consumer behaviour in different regions (Fortune business insights, 2026).

The following table provides an overview of parcel locker implementations in selected European countries, illustrating how these trends are reflected regionally.

Table 1. Parcel Lockers Used in Selected European Countries (Yanik, 2024)

Country	Ownership	Number of Parcel Lockers	Access by Third Parties
Austria	Austrian Post	524	Yes
	A1	90	Yes
	MyFlexBox	360	Yes
Belgium	Bpost	375	Yes
Czech Republic	Česká pošta	9.000 (ParcelShop and Lockers)	No
	OX Point	150	Yes
	Alza	2 600	Yes
	Zásilkovna	3 650	No
	PPL	4 000 (ParcelShop and Lockers)	No
	DPD Pickup	3 000 (ParcelShop and Lockers)	No
Denmark	Post Danmark	1 740	No
Finland	Naerboks	3 194	No
	Posti (EHS)	1 902	No
	Pakettipiste	600	Yes
France	La Poste	500	No
	Amazon	-	No
Germany	Deutsche Post DHL	11 500	No
Ireland	An Post	170	No
Italy	Poste Italiane	350	No
Luxembourg	Post Luxembourg	133	No
Netherlands	PostNL	500	Yes
Norway	DHL (De Buren)	109	Yes
	Posten Norge	1 688	No
	PostNord	1 500	No
	Instabox	41	No
Poland	Poczta Polska	182	No
	InPost	20 228	Yes
	DHL	1 200	Yes
	Allegro	2 700	Yes
	PKN Orlen	2 000	No
Portugal	CTT	508	No
Spain	Correos	2 852	No
	Citibox	22 500	No
	Amazon	120	No
	SEUR	500	No
	Cainiao (AliExpress)	200	No
Sweden	PostNord	1 800	No
United Kingdom	Budbee	1 628	No
	Royal Mail	-	No
	Amazon	5 000	No
	InPost	4 800	Yes

4. SURVEY RESULTS ON PARCEL LOCKER AND PACKAGE SHOP USAGE

This chapter presents the results of a survey on consumer preferences and usage of parcel lockers and package shops, highlighting trends in last-mile delivery and factors influencing delivery choices.

The survey was conducted through a Google questionnaire and included 113 respondents from across Serbia. The dominant age group was between 19 and 45 years (a total of 93.8%), while the female population accounted for 67.3% of respondents. Most respondents

live in urban and semi-urban areas, which provides insight into the habits of users from different types of territories.

The results show that home delivery remains the most commonly used option (75.2%), while parcel lockers (22.1%) and parcel shops (1.8%) represent secondary forms of parcel collection. Most parcel locker users utilize them occasionally or rarely (71.6% in total), while nearly half of the respondents (46.9%) do not use parcel shops (Figure 2, Figure 3). The reasons for using parcel lockers include 24/7 availability, proximity of location, speed, and ease of collection, while parcel shops are most often used due to location proximity and assistance from staff.

The largest percentage of respondents are willing to walk 5–10 minutes to reach a parcel locker (39.8%) or parcel shop (23%), which roughly corresponds to a distance of 300 to 700 meters. If a parcel locker and a parcel shop are located at the same distance, 84.1% of respondents would choose the parcel locker, indicating a clear preference for automated and self-service parcel collection options. More than half of the respondents (54%) believe that further expansion of the parcel locker and parcel shop network is needed, while 22.1% support expanding only parcel lockers.

The survey results indicate a demand for greater availability of parcel lockers and parcel shops and confirm the relevance of GIS spatial coverage analysis, particularly in larger and more dispersed territorial units where a significant portion of the area currently remains uncovered.

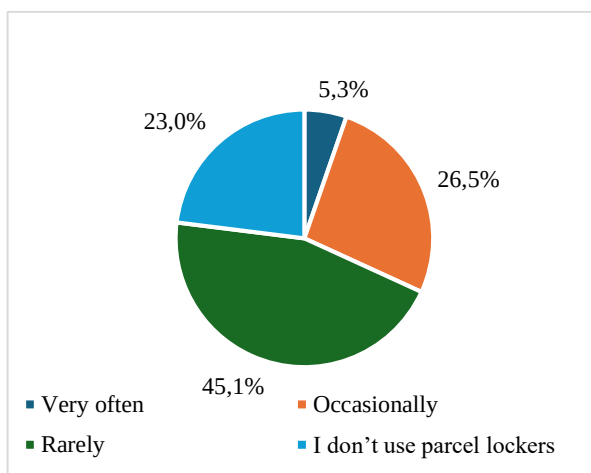


Figure 2. Frequency of using parcel lockers

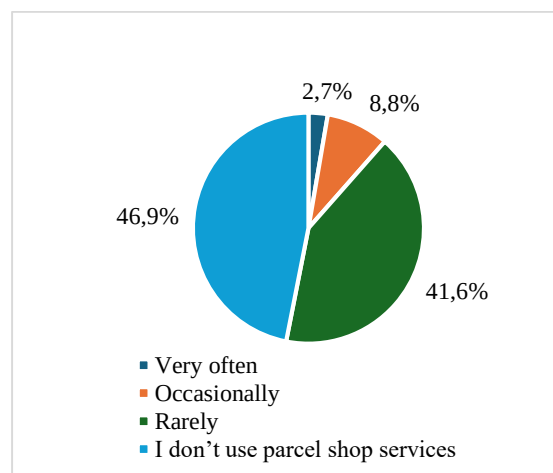


Figure 3. Frequency of using parcel shops

5. ANALYSIS OF SPATIAL AVAILABILITY OF PARCEL LOCKERS AND PARCEL SHOPS

In the analysis of the spatial accessibility of parcel lockers and parcel shops in the territory of the City of Novi Sad, a GIS approach was used to visualize and analyze their spatial distribution. All identified locations of parcel lockers and parcel shops operated by private postal operators were included in the database, including D Express, Ananas, AKS Express, City express and BEX Express. Parcel lockers operated by Post of Serbia were not included in the analysis, as this is a state-owned operator with a different infrastructure development model and different network planning principles. The focus of the research was therefore on the networks of private operators, which develop their infrastructure largely in accordance with

market principles and user demand, enabling a more realistic insight into contemporary trends in the development of alternative delivery channels in the courier services sector.

Based on the results of the conducted survey, it was determined that the largest percentage of respondents are willing to walk 5 to 10 minutes to reach a parcel locker, which approximately corresponds to a distance of 300 to 700 m. Accordingly, buffer zones within these radii were defined in the GIS analysis in order to assess the spatial accessibility of the parcel locker and parcel shop network in relation to the actual preferences of users.

In order to obtain a more detailed insight into spatial coverage, the local communities with the largest and smallest areas within the territory of the city – Klisa (Figure 5) and Ivo Andrić (Figure 4) - were analyzed. The Klisa local community represents the largest analyzed territorial unit, with a total area of 13,336 km². The results of the analysis show that within the 300 m buffer zone, the intersection area between the territory of Klisa and the accessibility zones of parcel lockers amounts to 0.278 km², while 13,058 km² remains outside the coverage zone. When the accessibility radius is increased to 700 m, the covered area increases, resulting in an intersection of 1,508 km², while 11,829 km² of the territory still remains uncovered. These results indicate a relatively low level of spatial accessibility of parcel lockers within this local community, which is likely a consequence of its large area and the spatial dispersion of settlements.

On the other hand, the Ivo Andrić local community, as the smallest analyzed territorial unit with an area of 0.203 km², shows a significantly higher level of coverage. Within the 300 m buffer zone, the intersection area with the parcel locker network amounts to 0.198 km², while only 0.005 km² of the territory remains outside the accessibility zone. When considering the 700 m buffer zone, the entire territory of the local community (0.203 km²) lies within the accessibility zone, meaning that no uncovered area remains.

The obtained results indicate significant differences in the level of parcel locker accessibility between territorially large and small local communities. While smaller and spatially more compact territories achieve almost complete coverage with the existing infrastructure, larger local communities retain substantial uncovered zones even when a larger accessibility radius is considered. The results also show that increasing the accessibility radius from 300 m to 700 m contributes to an increase in the covered area; however, in territorially larger local communities this is not sufficient to achieve a satisfactory level of accessibility without additional expansion of the parcel locker and parcel shop network. It should also be noted that there are currently no parcel shops at all in the analyzed local communities of Klisa and Ivo Andrić, which further highlights the importance of developing the parcel locker network in order to improve the spatial accessibility of services.

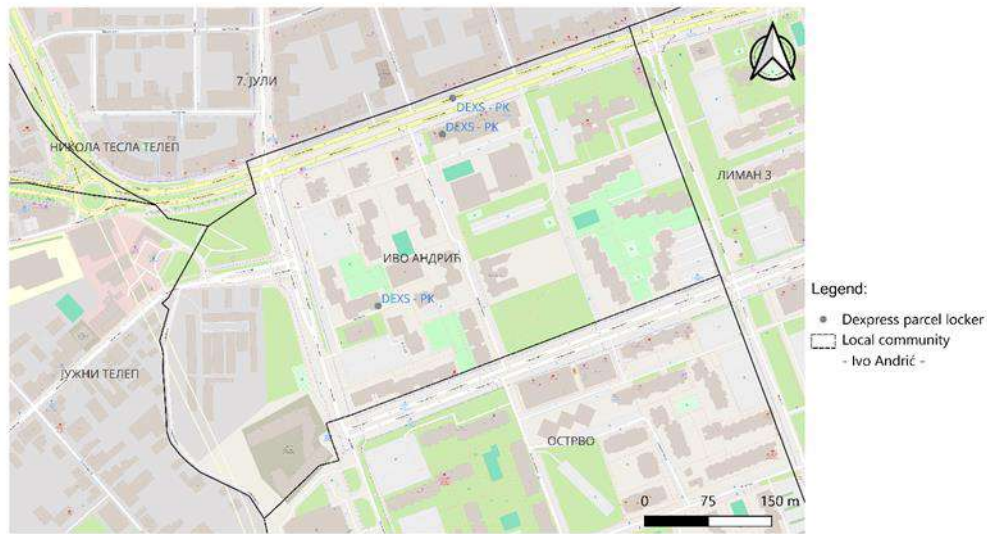


Figure 4. Local community Ivo Andrić

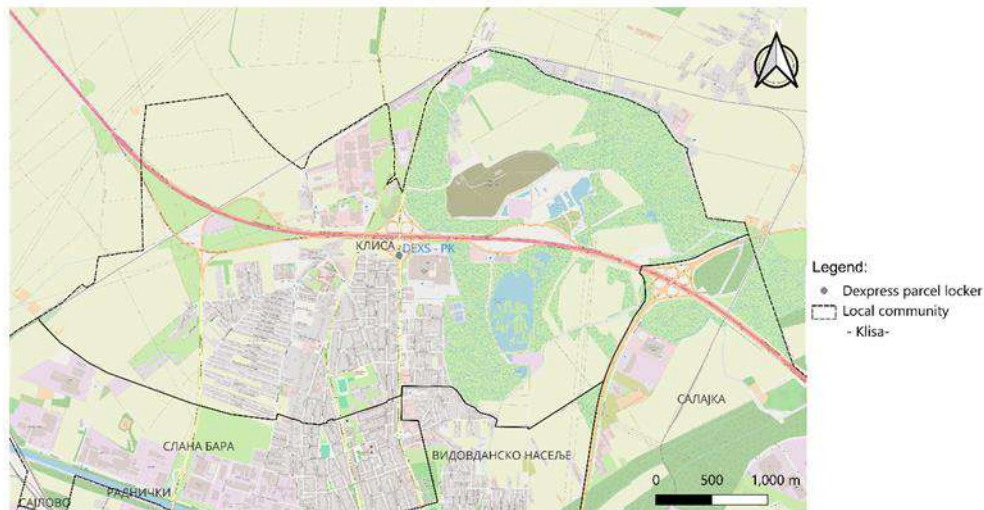


Figure 5. Local community Klisa

6. CONCLUSION

The development of e-commerce and digital logistics solutions has significantly increased the importance of alternative parcel delivery methods, particularly parcel lockers and parcel shops. The results of the conducted survey indicate that home delivery remains the most commonly used delivery option, while parcel lockers and parcel shops are increasingly recognized as convenient alternatives due to their accessibility and flexibility. Most respondents indicated that they are willing to walk 5 to 10 minutes to reach a parcel locker or parcel shop, highlighting the importance of spatial proximity in the use of these services. The GIS analysis of the parcel locker and parcel shop network in the City of Novi Sad revealed significant differences in spatial accessibility between territorially larger and smaller local communities. While smaller and more spatially compact areas achieve a high level of coverage, larger territorial units remain largely outside accessibility zones. These findings indicate the need for further expansion of the parcel locker and parcel shop network in order to improve service accessibility.

Future research could extend the spatial analysis to a larger number of cities and regions in order to compare the accessibility of parcel locker and parcel shop networks in different urban environments. Further studies may also integrate demographic characteristics and e-commerce activity data in order to support more efficient planning and optimization of parcel locker and parcel shop locations. In addition, future research could examine the potential impact of parcel locker and parcel shop networks on urban logistics efficiency, traffic congestion, and CO₂ emissions in last-mile delivery.

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