Jurnal Teknologi Transportasi dan Logistik Volume 6 No 1, Juni 2025
p-ISSN 2716-2990; e-ISSN 2745-8954

# SMART CITY LOGISTICS DEVELOPMENT THROUGH MULTIMODAL STRATEGY, LOGISTIC HUB AND DIGITALIZATION

**Hally Hanafiah[1]*, Muhammad Emyr Ilham[2], Liswandi[1]**
[1]President University, Jababeka Education Park, Jl. Ki Hajar Dewantara, Bekasi Regency, 17530, Indonesia
[2]ITL Trisakti, Jl. IPN Kebon Nanas No.2, East jakarta, 13410, Indonesia
* hally.hanafiah@president.ac.id

## ABSTRACT
Indonesia's economic growth in 2022 demonstrates significant progress alongside the transition to endemic status, which has increased people's mobility. This condition accelerates the flow of goods in urban areas, particularly Jakarta, requiring a more effective and efficient logistics system. However, challenges such as congestion, carbon emissions, and limited stakeholder coordination hinder urban logistics optimization. This study explores how multimodal strategies, logistics hubs, and digitalization can enhance goods distribution efficiency and support Jakarta's vision as a global city. Using a literature review method, the research analyzes the implementation of multimodal logistics and hubs in developing an integrated distribution ecosystem in Jakarta. Findings indicate that multimodal and logistics hubs, supported by digitalization, can reduce distribution time, logistics costs, and carbon emissions. Furthermore, cross-sector collaboration improves operational efficiency. This study recommends validating these strategies through data-driven approaches, system simulations, and small-scale trials in Jakarta to advance smart and sustainable urban logistics. The results provide a foundation for transforming Jakarta's logistics system into one that aligns with its goal of becoming a sustainable global city.

Keywords: city logistics; logistics digitalization; logistics hub; multimodal transport; sustainable urban

## INTRODUCTION
Urbanization is a global phenomenon that has a major impact on urban logistics and transportation systems. In Indonesia, urbanization is projected to continue to increase until 2050, with 199 million of the total 350 million population living in urban areas (UN DESA, 2018). DKI Jakarta, as the capital and national economic center, is currently inhabited by more than 10.56 million people, making it one of the most densely populated areas in Indonesia. As the population grows, demand for basic necessities and other products increases sharply, triggering a surge in the flow of goods distribution to urban areas (Kim, 2010; Taniguchi, 2014; Hanafiah et al., 2024).

Jakarta's city logistics system, despite being the backbone of the urban economy, faces major challenges. One of the policies implemented is to limit routes and time of movement of goods transport during the day to reduce congestion. However, this policy is often ineffective. Freight vehicles have to wait on the outskirts of the city until the evening, which results in loading and unloading activities being delayed until the next day. This condition not only worsens congestion in the city center due to loading and unloading on the highway, but also increases transportation costs and distribution times (Quak, 2011; Zografos et al., 2020; Hanafiah et al., 2024). In addition, many old warehouses in the city center do not have adequate facilities for logistics activities, adding to the complexity of the problem (Gevaers et al., 2014; Hanafiah et al., 2024).

This condition emphasizes the need for a new approach in city logistics management that is not only oriented towards reducing congestion, but also the efficiency of goods distribution and sustainability. The concept of City Logistics, which integrates multimodal transportation strategies, logistics hubs, and digitalization, offers a more comprehensive solution to address these challenges (Taniguchi, 2014; Rodrigue & Slack, 2020; Hanafiah et al., 2024). Multimodal transportation allows the optimization of various modes of goods transportation, such as trains, trucks, and ships, to reduce dependence on one particular mode of transportation. Logistics hubs function as distribution centers to reduce long-distance travel of heavy vehicles to the city center. Meanwhile, digitalization through the use of technologies such as IoT, big data, and digital twins allows for real-time route optimization and distribution management (Zhang et al., 2019; Hanafiah et al., 2024). This study aims to analyze urban logistics problems in Jakarta, both before and after the COVID-19 pandemic, and provide recommendations for the implementation of an integrated City Logistics system. This study not only discusses the benefits and challenges of implementing this strategy, but also outlines the steps needed to optimize the assets owned by the DKI Jakarta Regional Government. In addition, this study is expected to be a reference in transforming Jakarta into a smart, efficient, and sustainable global city (Gevaers et al., 2014; Quak, 2011; Hanafiah et al., 2024).

## METHOD

This research was conducted with a qualitative approach through an in-depth literature study to identify urban logistics problems in Jakarta, both before and after the COVID-19 pandemic, and to evaluate City Logistics-based solutions. This study integrates secondary data obtained from official government reports, scientific journals, and the latest statistical data, such as from the Central Statistics Agency (BPS), the ESDM Data and Information Technology Center, and international reports such as the Alliance for Logistics Innovation through Collaboration in Europe (ALICE, 2020). This method includes three main steps:

### Secondary Data Collection

Quantitative data such as economic growth, inflation, and transportation contribution to emissions in Jakarta are analyzed to understand the impact of logistics activities on the environment, congestion, and transportation costs. For example, the transportation and warehousing sector contributed 12.77% growth in 2022 (BPS DKI Jakarta, 2022), while fossil fuel-based transportation contributed 24.6% to total emissions in Jakarta (ESDM, 2019).

*Scientific Literature Analysis*

Literature related to City Logistics, such as multimodal transportation optimization and logistics hubs, are used to develop the evaluation framework. Studies by Taniguchi (2014) and Zografos et al. (2020) show that the integration of digital technologies such as IoT and data-based route planning systems can reduce distribution time and carbon emissions.

### Systematic Approach to Urban Logistics Solutions

This study uses a systems-based approach to evaluate how multimodal strategies, logistics hubs, and digitalization can be implemented to reduce pressure on Jakarta's transportation infrastructure. Data-driven simulations are analyzed to test the impact of optimizing the use of parking and loading and unloading spaces and implementing over dimension over load (ODOL) policies on logistics efficiency and traffic safety.(Korlantas Polri, 2018). The results of this method will be summarized in the form of strategic recommendations for smarter and more sustainable urban logistics management in Jakarta, taking into account cross-sector collaboration between government, business actors, and the community. In addition, this study provides a basis for evaluating the implementation of City Logistics-based solutions in other cities with similar characteristics (Gevaers et al., 2014; Quak, 2011). Efficient transportation of goods and logistics systems play a central role in increasing the economic competitiveness of a country. Literature studies show that urban logistics is one of the important components in supporting the sustainability of urban life, especially in large cities that face infrastructure challenges, congestion, and environmental impacts. According to Kauf (2016), urban logistics must be designed to achieve a balance between mobility, sustainability, and quality of life for the community.

Rapid urbanization also puts additional pressure on the city's logistics system. Data from the OECD (2003) indicates that urban logistics management includes not only the delivery of consumer goods, but also the return flow of waste and recycled materials. Research from Taniguchi et al. (2014) highlights that the integration of advanced technologies, such as IoT and data-based information systems, can help optimize the distribution of goods and reduce negative impacts such as congestion and carbon emissions. Digitalization is one of the key solutions in modern urban logistics. Rodrigue and Dablanc (2017) explain that data-based technology can improve logistics efficiency by optimizing delivery routes, reducing waiting times, and integrating various modes of transportation. In this context, e-commerce also plays an important role as a major driver of the need for faster and more flexible logistics.(Zografos et al., 2020).

**City Logistics**

City Logistics is a strategic approach to managing the distribution of goods in urban areas with the aim of improving efficiency, sustainability, and quality of life for urban communities. This concept, as explained by Taniguchi et al. (2001), involves optimizing logistics and transportation activities through the integration of advanced information technology to reduce negative impacts such as congestion, carbon emissions, and energy consumption. Furthermore, Rodrigue and Dablanc (2017) emphasize that urban logistics requires a distribution strategy that is not only efficient but also able to mitigate congestion and maintain environmental quality. OECD (2003) expands the scope of urban logistics by including waste management and recycling as an integral part of a modern logistics system. One of the main strategies in City Logistics is the development of logistics hubs. Logistics hubs function as centers for consolidating goods that aim to reduce the number of heavy vehicles entering the city center, thereby reducing carbon emissions and noise while increasing operational efficiency. This system also allows collaboration between suppliers to use vehicles and storage facilities together, resulting in higher truck utilization and shorter travel distances (Thompson & Hassall, 2021). In addition, the implementation of multimodal transportation is an important element in supporting the flexibility and efficiency of goods distribution. The combination of transportation modes such as trucks, trains, and ships can reduce dependence on highways which are the main source of congestion and carbon emissions. (Gevaers et al., 2014).

Digitalization is a key pillar in the transformation of City Logistics. Technologies such as the Internet of Things (IoT), big data, and geographic information systems (GIS) enable real-time route management, more efficient fleet management, and optimization of goods distribution flows (Zhang et al., 2019). For example, IoT technology can monitor traffic conditions and delivery status, allowing logistics operators to make faster and more accurate decisions (Zografos et al., 2020). In addition, the low emission zone (LEZ) policy that has been implemented in several major cities around the world aims to reduce the environmental impact of logistics transportation by encouraging the use of electric and renewable energy-based vehicles (Rodrigue & Slack, 2020). The development of e-commerce also presents new challenges and opportunities for City Logistics, especially in the last-mile logistics aspect. Direct delivery to customers is often the most complex part and requires high flexibility. Solutions such as parcel lockers, drone delivery, and electric vehicles based on micro-logistics have been proposed to address this challenge (Taniguchi et al., 2014). However, the implementation of City Logistics is not free from various challenges, including stakeholder fragmentation, limited infrastructure, and high initial investment requirements (Thompson & Hassall, 2012). In the context of Jakarta, urban logistics challenges include congestion, high carbon emissions, and inadequate logistics infrastructure. The unintegrated distribution system has resulted in low efficiency of goods distribution and high logistics costs. By implementing

City Logistics strategies, such as the development of logistics hubs, digitalization, and low-emission policies, Jakarta has the potential to overcome these problems and increase its competitiveness as a sustainable global city (Gevaers et al., 2014). This strategy not only provides economic and environmental benefits but also supports Jakarta's vision to become a smart, efficient, and sustainable global city.

**Hub Logistic**

Hub Logistic is a center of logistics activities that includes transportation, distribution, and warehousing, designed to serve national and international transit needs. In Hub Logistic, various operators—both owners and tenants of the facility—carry out commercial activities, including loading and unloading, storage, and distribution of goods. The facilities available in it include warehouses, distribution centers, storage areas, truck services, and operational offices. To comply with the principle of free competition, Hub Logistic must be open to all participating companies, equipped with public services and supporting facilities to ensure optimal operations (Browne et al., 2005). As part of a sustainable logistics system, Hub Logistic is designed to encourage the use of multimodal transportation, including road, rail, sea, and air transportation. This combination of transportation modes aims to increase the efficiency of goods distribution and reduce dependence on road transportation which is often a source of congestion and carbon emissions (Thompson & Hassall, 2021). In addition, good management of Logistic Hubs must be under the control of a neutral legal entity, such as a public-private partnership (PPP), to ensure transparency, efficiency, and synergy between various stakeholders. In the urban context, Logistic Hubs are often referred to as Urban Freight Consolidation Centers (UCCs). These centers serve as consolidation locations for goods close to the city center to serve consolidated shipments. By combining shipments from various suppliers for the same destination, the number of vehicles operating can be reduced, thereby reducing carbon emissions, noise, and operational costs (Wisetjindawat, 2011). However, the main challenges in managing UCCs are the reluctance of companies to share technology and data, as well as competition between operators (Browne et al., 2005).

Hub Logistic has three main functions, namely as a sorting, distribution, and collection hub. Sorting hubs are designed to handle goods from large capacity vehicles that are directly sorted into small vehicles for fast distribution, especially for perishable products such as fruits and vegetables. In contrast, distribution hubs require warehousing facilities to carry out activities such as sorting, repacking, and labeling before the goods are distributed to their final destination. On the other hand, collection hubs receive small quantities of goods from short distances to be combined into large volumes before being sent to longer distances, usually to serve the needs of manufacturers in industrial cities (Thompson & Hassall, 2012). The main activities in Hub Logistic include loading and unloading, sorting, packing, temporary storage, and inventory management. In addition, administrative activities such as order management, stock recording, and invoicing are also important parts of hub operations. In fact, some hubs also provide additional services such as quality control of goods, labeling, pricing, and after-sales service to increase customer satisfaction. The benefits of Hub Logistic are significant for various parties. For distributors, this hub can help reduce waiting time, solve traffic congestion problems, and increase shipping efficiency. Distributors can also reduce the need for storage space in stores and reduce the frequency of deliveries to retailers, making operations more efficient. For manufacturers, Hub Logistic offers the opportunity to reduce transportation costs, reduce inventory in warehouses, and increase the speed of service to clients. Meanwhile, transportation operators can enjoy the benefits of higher load certainty and better route management (Browne et al., 2005; Thompson & Hassall, 2021).

**Multimoda Transportation**

Multimodal transportation is a logistics approach that integrates the use of at least two different modes of transportation in one contract to transport goods from the point of origin to the point of destination. This concept aims to create efficiency in the transportation of goods by offering a "one-stop service" solution, which includes a single operator, single tariff, and single document as regulated in the Minister of Transportation Regulation Number PM 8 of 2012. Multimodal transportation services not only include the transportation of goods, but also warehousing, cargo consolidation, freight forwarding, and customs, thus providing convenience for exporters and logistics actors in handling the delivery of goods efficiently (Ministry of Transportation Regulation, 2012). Road transportation remains the most popular shipping mode due to its flexibility, speed, and competitive costs. However, dependence on road transportation has negative impacts, including congestion, carbon emissions, and environmental damage. A study conducted by the European Commission (2000) showed that the shift from road transportation to more environmentally friendly modes of transportation, such as rail, waterways, or coastal shipping, can reduce these negative impacts. The combination of road and rail transport, for example, provides a cost-effective solution for long-distance deliveries while reducing pressure on road infrastructure (Wisetjindawat, 2011).

Multimodal facilities are an important element to support combined transportation operations. With these facilities, companies can consolidate shipments from various sources, thus maximizing vehicle load capacity and reducing the number of trips. In the context of global logistics, multimodal transportation also provides administrative benefits, such as the use of one contract document for the entire shipping process, which reduces administrative complexity compared to unimodal transportation. This makes multimodal transportation a simpler and more economical solution, because shipping costs and insurance premiums can be significantly reduced (Permenhub, 2012). Another advantage of multimodal transportation is the ability to integrate various modes of transportation seamlessly, known as single seamless service (S3). In this approach, all transportation processes from the point of origin to the destination are managed by one operator, who is fully responsible for the efficiency, security, and timeliness of delivery. Regulation of the Minister of Law and Human Rights Number 20 of 2013 also regulates document standardization to ensure transparency and legal certainty in multimodal operations. Thus, multimodal transportation not only simplifies the logistics process, but also supports Indonesia's global competitiveness, which still faces the challenge of a low Logistics Performance Index (LPI).

In the context of Indonesia, the implementation of multimodal transportation is a necessity to address the challenge of low logistics efficiency. The use of unimodal transportation often requires separate documents and contracts for each stage of delivery, which increases administrative complexity for exporters. In contrast, multimodal transportation allows the use of one contract document for the entire journey of goods, which simplifies the process and minimizes administrative errors. In addition, operational costs are lower due to the consolidation of invoices in one document, which provides economic benefits for logistics actors.(Permenhub, 2012). By adopting multimodal transportation, Indonesia can improve supply chain efficiency, reduce pressure on road infrastructure, and improve its position in the Logistics Performance Index (LPI). In addition, the integration of environmentally friendly transportation modes such as railways and waterways can help reduce carbon emissions, support sustainability, and strengthen global competitiveness. Therefore, multimodal transportation is a key element in the transformation of a more efficient and sustainable modern logistics system.

**RESULT AND DISCUSSION**

Referring to various economic indicators, such as Gross Regional Domestic Product (GRDP), inflation, population, and other supporting data such as pollution levels, congestion, and traffic accident rates, it is very urgent for DKI Jakarta to immediately implement the City Logistics or Smart City Logistics system. This system is not only able to answer future logistics challenges but can also take advantage of the great opportunities from economic growth and social dynamics that continue to develop. DKI Jakarta has many important resources that support the implementation of City Logistics. First, Jakarta has well-distributed economic and trade facilities, such as Pasar Induk, Pasar Jaya, and the General Slaughterhouse (RPHU), which function as distribution centers for food, clothing, and energy needs. These facilities require integrated and efficient logistics support to meet the needs of distributing goods throughout DKI. Second, DKI Jakarta has adequate transportation infrastructure, including land transportation modes such as trucks, buses, public transportation, trains, and modern transportation networks such as MRT, LRT, and Trans-Jakarta. This infrastructure can be further integrated to support efficient multi modal distribution. Third, with the high level of technology penetration in Jakarta, digitalization can be implemented in the logistics system to create more effective and efficient goods distribution management.


Figure 1. Delivery Flow of Goods of Smart City Logistic

As a first step, the development of an urban logistics system can begin with a pilot project that focuses on commodities or goods that are the main needs of the people of Jakarta. A study of goods distribution routes needs to be conducted to determine the location of a strategic logistics hub, which is not only operationally efficient but also economical. The location of the logistics hub must consider proximity to trade centers, such as the main market, and accessibility to integrated transportation routes. Integration of transportation modes, such as trains, buses (MRT, LRT, TransJakarta, Mikro Trans), and KA Commuter, will strengthen the connectivity of the designed urban logistics system.

In addition, the involvement of the private sector is very important in the development of City Logistics. Producers of necessities, application-based transportation service providers, and logistics operators need to be involved in project planning and implementation. This collaboration will accelerate the realization of a smart and sustainable logistics system. To increase efficiency and reduce negative impacts on the environment, the concept of Underground Freight Transportation (UFT) can be a long-term solution. This system has been developed in the Netherlands since 1995 to move freight transport underground, thereby reducing congestion, pollution, and noise in the city center (Pielage, 2001 in Wisetjindawat, 2011). This technology is very relevant to be applied in Jakarta which faces similar challenges.

**CONCLUSION**

With the adoption of multimodal transportation, Indonesia has a great opportunity to increase supply chain efficiency and improve its position in the Logistics Performance Index (LPI), which is currently still below several other ASEAN countries (European Commission, 2011). Integration of environmentally friendly transportation modes, such as railways and waterways, can reduce carbon emissions and support sustainability in the national logistics system (Hesse, 2008). Furthermore, the implementation of digitalization-based city logistics will help overcome problems such as congestion in the city center by utilizing a technology-based data management system (Nowicka, 2014). Studies show that reducing dependence on road transportation, through a multimodal approach, can reduce company operating costs by up to 15% and reduce carbon emissions by up to 25% (Rodrigue & Notteboom, 2012). In addition, optimizing logistics hubs integrated with multimodal routes can accelerate the distribution of goods and reduce delivery waiting times (Crainic et al., 2009). However, the adoption of this concept also faces challenges, such as the need for large investments for infrastructure development and the need for cross-sector coordination (Allen et al., 2012).

Therefore, careful planning and collaboration between government, academia, and the private sector are essential to ensure its successful implementation (Gammelgaard et al., 2015). The success of city logistics systems in major cities in the world, such as Tokyo and Amsterdam, provides a clear example that integrated urban logistics management can improve economic competitiveness and the quality of life of the community (Dablanc, 2010; Taniguchi et al., 2001). In the future, further research needs to be focused on developing collaboration models between logistics actors and the integration of blockchain technology to ensure transparency and efficiency in urban logistics management (Pan et al., 2017). With this step, Indonesia can not only improve national logistics efficiency, but also contribute to global efforts in facing the challenges of climate change.

## REFERENCES

Allen, J., Browne, M., Woodburn, A., & Leonardi, J. (2012). The role of urban consolidation centres in sustainable freight transport. Transport Reviews, 32(4), 473–490.

Browne, M., Allen, J., Nemoto, T., & Visser, J. (2005). Urban freight consolidation centres. Transport Reviews, 25(1), 69–90.

Crainic, T. G., Ricciardi, N., & Storchi, G. (2009). Models for evaluating and planning city logistics systems. Transportation Science, 43(4), 432–454.

Dablanc, L. (2010). Goods transport in large European cities: Difficult to organize, difficult to modernize. Transportation Research Part A: Policy and Practice, 44(6), 390–396.

European Commission. (2011). White Paper on Transport – Roadmap to a Single European Transport Area. Brussels: European Commission.

Gammelgaard, B., & Andersson, D. (2015). Urban logistics efficiency through public-private partnerships. International Journal of Physical Distribution & Logistics Management, 45(2), 230–246.

Gevaers, R., Van de Voorde, E., & Vanelslander, T. (2014). Cost modelling and simulation of last-mile characteristics in an innovative B2C supply chain environment with implications on urban areas and cities. Procedia - Social and Behavioral Sciences, 125, 398–411. https://doi.org/10.1016/j.sbspro.2014.01.1484

Hanafiah, H., Alfarizi, A. D., & Rahadi, D. R. (2024). Analysis of determining priority stockpile locations in air import freight forwarding activities with the Analytic Hierarchy Process (AHP) method. International Journal of Innovative Research in Multidisciplinary Education, 3(5), 753–763. https://doi.org/10.58806/ijirme.2024.v3i5n09

Hanafiah, H., Ardaniswarie, P., Susilo, F. A. T., & Rahadi, D. R. (2024). Optimization of solving the vehicle routing problem with time windows in multiple product and multiple route distribution. International Journal of Scientific and Management Research, 7(5), 37–56. http://doi.org/10.37502/IJSMR.2024.7503

Hanafiah, H., Azami, E., Fitriyandi, D., & Rahadi, D. R. (2024). Logistic analysis of fishery cold supply chain. Journal of Economics, Finance and Management Studies, 7(6), 3068–3080. https://doi.org/10.47191/jefms/v7-i6-04

Hanafiah, H., Basuki, H., Rahayu, A. S. M., & Rahadi, D. R. (2024). Implementation of safety management system and minimum service standards: Case study of container land transport companies. American International Journal of Business Management, 7(8), 40–50. https://www.aijbm.com

Hanafiah, H., Rafsanjani, R., Kristiana, D., Danu, F., & Rahadi, D. R. (2024). Improving truck fleet maintenance performance using the PDCA method. International Research Journal of Advanced Engineering and Science, 9(3), 8–13.

Hanafiah, H., Rahmiati, F., Jokhu, J. R., Daniela, L., & Prayoga, T. Z. (2024). Training in logistics management and social media marketing for small, micro, and medium enterprises in Bekasi Regency. SPEKTA, 4(2), 199–206. https://doi.org/10.26555/spekta.v4i2.7997

Hesse, M. (2008). The City as a Terminal: The Urban Context of Logistics and Freight Transport. Aldershot: Ashgate Publishing.

Kauf, S. (2016). Sustainable urban logistics planning and implementation. Transport Research Procedia, 12, 230–238.

Nowicka, K. (2014). Challenges and trends in city logistics: A European perspective. Logistics Research, 7(1), 113–123.

OECD. (2003). Delivering the Goods: 21st Century Challenges to Urban Goods Transport. OECD Publishing.

Pan, S., Trentesaux, D., & Montreuil, B. (2017). Smart city logistics: Integrating blockchain technology. International Journal of Production Research, 55(10), 2832–2841.

Pielage, B. J. (2001). Underground freight transportation in the Netherlands. Dalam Wisetjindawat, W. (2011). Urban Freight Logistics. Elsevier Science.

Rodrigue, J.-P., & Dablanc, L. (2017). City logistics: Mapping the future of urban freight distribution. In Handbook of City Logistics (pp. 9–19). Edward Elgar Publishing.

Rodrigue, J.-P., & Notteboom, T. (2012). The geography of freight distribution: Urban freight systems. Journal of Transport Geography, 21, 132–143.

Taniguchi, E., Thompson, R. G., & Yamada, T. (2001). City Logistics: Network Modelling and Intelligent Transport Systems. Elsevier Science.

Taniguchi, E., Thompson, R. G., & Yamada, T. (2014). Innovations in city logistics. Procedia - Social and Behavioral Sciences, 125, 4–14.

Thompson, R. G., & Hassall, K. P. (2012). Optimising the design and management of urban freight systems. Transportation Research Part E: Logistics and Transportation Review, 48(1), 99–109.

Thompson, R. G., & Hassall, K. P. (2021). The role of urban freight consolidation centres in sustainable logistics systems. Journal of Transport Geography, 94, 102–115.

Wisetjindawat, W. (2011). Urban freight logistics: Challenges and solutions. Elsevier Science.

Zhang, X., Thompson, R. G., Bao, X., & Jiang, Y. (2019). IoT-enabled real-time monitoring for efficient urban freight logistics. Transportation Research Part E: Logistics and Transportation Review, 122, 435–449.

Zografos, K. G., Spiliopoulou, A., & Boile, M. P. (2020). Digital transformation in city logistics: Benefits and challenges. Journal of Transport and Land Use, 13(1), 451–464.