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Smart & Resilient Logistics Corridors Future Gateway to the Green Trade

REIMAGINING URBAN LOGISTICS IN RAPIDLY URBANISING CITIES: WALKABILITY, SHARED MOBILITY, AND GREEN LAST-MILE CORRIDORS

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ABSTRACT

There is an urgent need to decarbonise urban freight systems, which has fueled growing interest in sustainable models for last-mile delivery. This trend is especially pronounced in rapidly urbanising cities that face infrastructural, regulatory, and resource constraints. Concepts such as the 15-minute city, micro-consolidation centres (MCCs), and shared mobility platforms have each contributed to advancing urban sustainability. However, few frameworks integrate all these innovations into a single, unified logistics model that can adapt to diverse urban contexts. This paper presents the Green Urban Logistics Corridor (GULC) model - a modular, scalable framework centred on five core elements: walkable urban form, micro-consolidation infrastructure, low-emission last-mile fleets, shared logistics platforms, and governance-enabled data integration. By synthesising academic literature with a comparative case study of selected cities, this paper illustrates how both rapidly urbanising and developed cities are using parts of the GULC model to reconfigure their last-mile delivery systems. The findings indicate that the GULC model provides a flexible blueprint for integrating sustainability and accessibility into urban logistics, thereby supporting decarbonisation targets as well as broader livability goals. This study's primary contribution is to fill a gap in the research by articulating a comprehensive, theoretically grounded model that aligns logistics innovation with pedestrian-oriented city planning.

1. INTRODUCTION

Global urbanisation is intensifying pressure on urban logistics systems to become cleaner, more efficient, and more resilient. These pressures are especially acute in rapidly urbanising cities, where population growth and spatial transformation outpace infrastructure investment and regulatory capacity. Such cities must reduce congestion, emissions, and delivery inefficiencies while meeting rising demand for goods and services.

City logistics research has addressed these challenges for over two decades, emphasising freight surveys, stakeholder coordination, and integrated planning to reduce externalities [1], [2], [3]. Early studies stressed the importance of conducting systematic freight surveys and engaging in collaborative planning to mitigate urban freight externalities [1]. They also highlighted the need for integrated strategies to reconcile logistics efficiency with sustainability goals in cities [4]. The concept of Green Urban Logistics Corridors (GULC) has emerged as a promising pathway toward making cities more livable and functional. Building on this foundation, GULC frames last-mile delivery as part of the city's walkable and liveable public realm rather than as a separate technical subsystem.

This paper examines how GULC principles apply to rapidly urbanising cities by weaving together relevant theory (e.g., the 15-minute city and shared logistics systems) with empirical examples drawn from global best practices. Its central objective is to propose a modular, adaptable model for urban freight that supports green last-mile delivery, embedded within pedestrian-friendly infrastructure. In this context, "rapidly urbanising cities" refers to urban areas experiencing high population growth, shifting mobility patterns, and evolving infrastructure systems (often found in the Global South or in post-industrial economies). The selected cities show that key dimensions of the GULC framework (namely, walkability, shared logistics systems, and infrastructure for low-emission last-mile delivery) are already being implemented in various configurations. European cities, such as Paris and Utrecht, represent mature implementations of these concepts, whereas rapidly urbanising cities like Pune and Addis Ababa have begun actively integrating GULC elements, despite facing institutional and infrastructural limitations. Taken together, these cases suggest that the proposed model is both aspirational and adaptable.

Despite extensive research on city logistics, walkability, and last-mile decarbonisation, these strands often remain fragmented in both theory and practice. Existing approaches typically treat pedestrian-oriented planning, shared mobility, and freight systems as parallel agendas, offering limited guidance on how they can be integrated into a single, adaptable model, particularly in rapidly urbanising cities facing institutional, financial, and data constraints. This paper addresses this gap by proposing the Green Urban Logistics Corridor (GULC) model: a modular framework that integrates walkable urban form, micro-consolidation infrastructure, low-emission last-mile fleets, shared logistics platforms, and governance-enabled data integration. The contribution is conceptual and analytical: it consolidates dispersed insights into a unified model and demonstrates how GULC elements already appear at varying maturity levels, across rapidly urbanising and developed cities

2. THEORETICAL BACKGROUND

In developing its conceptual approach, this paper draws on three interconnected ideas: the 15-minute city concept, walkability in urban design, and the integration of shared mobility and logistics. Together, these ideas underpin the Green Urban Logistics Corridor (GULC) model. A GULC can be understood as an urban zone where pedestrian infrastructure and logistics systems are coordinated in tandem to enable clean delivery networks, shared spaces, and spatial integration.

In this paper, walkability is treated as the presence and quality of pedestrian infrastructure, safety and comfort conditions, and the extent to which mixed-use accessibility supports short-distance trips. Green last-mile corridors refer to spatially concentrated delivery arrangements that prioritise low-emission modes (e.g., cargo bikes, electric vans, and foot couriers), supported by micro-consolidation and curb access management. Shared mobility integration captures platform-enabled coordination of delivery resources (shared fleets, crowd-based logistics, or cooperative schemes) and the institutional capacity to govern these systems through rules, incentives, and data integration.

Walkability constitutes a foundational condition for the GULC model, as it reshapes how space is allocated and facilitates short-distance movements. In the 15-minute city concept [5], essential services should be accessible within a short walk or bicycle ride, reducing reliance on motorised transport and associated emissions. Walkability, defined as the ease, safety, and comfort of pedestrian movement [6], supports public health, social interaction, and equitable access to services.

In rapidly urbanising cities, walkability is often constrained by car-centric planning and uneven investment. Nevertheless, targeted improvements (such as sidewalk continuity, safe crossings, lighting, and mixed-use activation) can also enable low-emission last-mile delivery by making foot-based logistics and cargo bike operations more feasible and reliable.

Walkable environments support public health, encourage social interaction, and promote equitable access to services. Moura and coauthors [7] further suggest that walkability can be assessed using participatory indicators tied to safety, accessibility, and comfort. In rapidly urbanising cities, car-centric planning and limited investment have traditionally hindered walkability. Even so, targeted improvements in pedestrian infrastructure can still foster greener logistics systems and make last-mile delivery more resilient [8].

Shared mobility, encompassing services such as carsharing, bike sharing, and shared logistics fleets, has become a pivotal component of the collaborative economy [9]. These systems are typically managed through digital platforms that boost efficiency and lower emissions [10]. In fast-growing cities, publicly supported digital tools that coordinate shared electric vehicle fleets and microhubs can enable cleaner logistics operations. Botsman and Rogers [11] underscore the potential of such models to optimise underused assets while also fostering community engagement and sustainability.

Green logistics corridors have traditionally been conceived at the inter-urban scale, but their principles can be adapted to last-mile logistics by combining walkable design, shared mobility, microhubs, and digital delivery tools. These intra-urban GULCs align freight activities with broader smart city and climate objectives, making logistics a visible part of the urban fabric instead of treating it as an externalised function.

The evolution of the GULC model reflects broader trends in the restructuring of urban freight. For example, large Urban Consolidation Centres (UCCs) have been shown to reduce inner-city traffic and emissions [4], [12]. However, UCCs often struggle with long-term viability unless they receive subsidies [13], [14]. In light of these challenges, Janjevic and Ndiaye [15] introduced the idea of micro-consolidation centres (MCCs) - smaller neighbourhood-level hubs. Field tests in the Netherlands indicate that MCCs can retain much of the efficiency of larger centres while also improving flexibility [16]. MCCs facilitate small-scale, sustainable deliveries by supporting cargo bikes and light EVs [17]. When paired with smart routing systems, they can also cut down CO_2 emissions and travel distances [18], [19].

Green last-mile fleets, such as e-cargo bikes, electric vans, and even foot couriers, are becoming increasingly viable thanks to stronger regulatory support and improvements in charging infrastructure [20],[21]. Studies suggest that these alternatives could substitute for as much as 51% of van trips in dense urban areas [22], while also reducing lifecycle emissions by over 80% [23].

Shared logistics platforms, including models such as crowdshipping and decentralised delivery networks, are also emerging as promising solutions, especially in areas where formal logistics services are weak or absent. These platforms utilise digital tools to integrate deliveries into existing mobility flows [24]. Prause [25] notes that crowdshipping, in particular, can reduce idle vehicle time and enhance delivery responsiveness. However, strong governance and trust mechanisms remain essential to ensure the reliability of such systems [26].

A robust digital infrastructure and supportive governance are critical underpinnings for GULC. Effective logistics policy must address zoning, curbside access, and delivery regulations, while also utilising real-time tools such as freight dashboards and digital twins to manage operations [23], [27]. Moreover, a participatory approach to governance helps ensure that logistics reforms stay aligned with the needs of informal economies and the wider public [28], [29].

Finally, cities with limited budgets or fragmented governance structures can implement the GULC model gradually. They might start with modest pedestrian infrastructure upgrades, then introduce neighbourhood micro-consolidation hubs and digital integration in stages, allowing for a scalable and adaptive logistics reform process [30]. Overall, the GULC model provides a flexible framework for decarbonising mobility while also supporting equitable access to services. Figure 1 illustrates the modular structure and interdependence of the five GULC elements, highlighting how cities can implement components incrementally while strengthening alignment through governance and data integration.

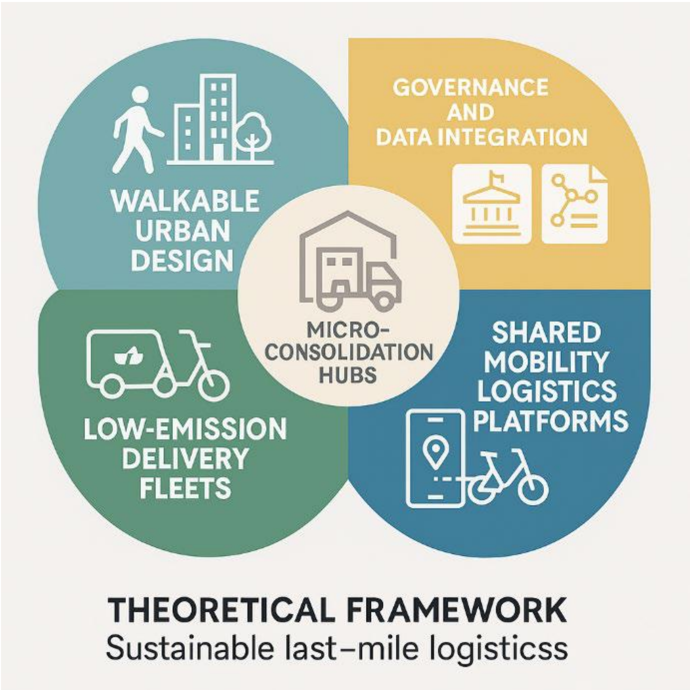

Figure 1: The Green Urban Logistics Corridor (GULC) model and its core components.

From an economic perspective, the GULC model aligns with core supply chain economics objectives such as cost efficiency, asset utilisation, and value creation. Neighbourhood-level consolidation and mode shifts toward cargo bikes or electric fleets can reduce vehicle-kilometres travelled, failed deliveries, and curbside search time - drivers of last-mile cost escalation. While initial investments (e.g., microhub space, charging access, pedestrian upgrades) can be a barrier in rapidly urbanising cities, a phased approach allows cities to prioritise low-cost regulatory and spatial interventions first, while building capacity for more capital-intensive elements over time.

3. METHODOLOGY

This research employs a comparative multiple-case study approach, utilising qualitative analysis to examine urban logistics practices in selected international cities through the lens of the Green Urban Logistics Corridor (GULC) model. The study draws on multiple data sources, including peer-reviewed academic literature, online available institutional reports (such as ITDP), and other relevant online sources.

The case selection followed a purposive, theory-driven logic rather than a statistical representativeness approach. Cities were selected because they exhibit documented evidence of at least one GULC element and because they facilitate contrastive learning across diverse development contexts. Rapidly urbanising cities (e.g., Addis Ababa, Jakarta, Pune, Bogotá) were included to reflect diverse combinations of infrastructure gaps, informality, governance capacity, and mobility patterns. Developed European cities (Paris, Hamburg, Utrecht) serve as benchmark cases where institutional coordination and regulatory instruments have enabled more comprehensive integration of GULC elements. This design facilitates an analytical comparison of pathways and constraints, rather than direct performance ranking.

In the analysis, the presence, implementation, and interaction of all five core GULC components across the selected cities were mapped. Each urban case was evaluated along three analytical dimensions: (1) the extent of walkability and the incorporation of 15-minute city principles; (2) the adoption of shared or electric last-mile delivery solutions; and (3) the presence of institutional and logistics innovations (for example, new public-private coordination mechanisms or the establishment of micro-logistics hubs).

Next, qualitative coding using a structured matrix was applied to assess each city across the five GULC components. For each component, two dimensions were captured: (1) presence or absence (a binary coding), and (2) operational maturity, categorised as pilot stage, partial implementation, or full deployment. These assessments were then synthesised to derive an overall integration score (Low, Moderate, High, or Very High) based on the combination and institutional depth of implemented components. Coding was conducted using a structured city-by-component matrix. For each city, sources were reviewed to identify explicit evidence for each of the five GULC elements; evidence was then coded as present/absent and assigned a maturity level (pilot, partial, or full deployment). Where sources differed, triangulation was used to confirm the most defensible classification. The overall integration category (Low to Very High) reflects not only the number of elements present but also the degree of institutionalisation and cross-component alignment (e.g., microhubs linked to green fleets and supported by governance tools). Table 1 summarises these findings across the selected cities.

To strengthen the validity of the findings, data triangulation was employed by systematically comparing multiple sources, including strategic urban planning documents, international best-practice compendiums, and peer-reviewed urban logistics studies. This approach enabled cross-verification of city-level interventions, thereby reducing the risk of bias that can arise from relying on a single type of source. Overall, the methodology supports both theory-driven comparison and the inductive refinement of the GULC model across diverse urban contexts.

4. EMPIRICAL INSIGHTS

To test the applicability of the Green Urban Logistics Corridor (GULC) model in various urban settings, this section presents a comparative analysis of cities that differ in terms of economic development, governance maturity, and logistics infrastructure. The selection of these cities ensures a spread of geographies and different stages of GULC readiness. In examining each city, particular attention is paid to evidence of improvements in walkability, the deployment of micro-consolidation centres, the use of low-emission last-mile fleets, and the integration of shared mobility or digital governance solutions. The aim is to examine how individual GULC components, or combinations of them, have been implemented, and to derive insights on how the model can be adapted to each context.

In Guangzhou, China, the Liuyun Xiaoqu neighbourhood serves as an exemplary case study of transforming a car-centric space into one that supports green logistics. A formerly gated residential block was opened up and redesigned as a pedestrian-oriented area with added greenery, benches, and local retail. This transformation made it easier to run e-bike deliveries and also enabled the installation of parcel lockers in public areas. All of these changes closely align with GULC principles by enhancing walkability, re-purposing space for people, and enabling pedestrian-based last-mile logistics [30].

In Jakarta, Indonesia, the Sunter Jaya district has applied transit-oriented development principles to reshape the neighbourhood's urban fabric. The area introduced narrow pedestrian lanes, more active street frontages, and improved lighting and pavement quality. These changes not only made the district more walkable but also enabled informal shared last-mile deliveries using electric carts [30]. This example demonstrates how the GULC pillars of walkable urban form and shared mobility can collaborate to create a low-emission logistics ecosystem, even in a densely populated Southeast Asian city.

Latin American and African cities exhibit varying degrees of GULC readiness. Bogotá, Colombia, stands out as a case where GULC elements are almost fully realised. Bogotá's long-running Ciclovía initiative has nurtured a strong cycling culture and compact neighbourhoods. The city's BiciCarga program further supports cargo-bike deliveries by coordinating them through municipal digital platforms [24]. In contrast, Kigali, Rwanda, has demonstrated a clear policy commitment to non-motorised transport, yet its urban logistics systems remain only modestly diversified. Meanwhile, Lagos, Nigeria, grapples with severe congestion and weak infrastructure, resulting in a fragmented logistics landscape. Even so, Lagos shows potential for crowd-based delivery solutions, thanks to its robust informal mobility sector [18].

In Europe, by contrast, cities show a high level of GULC maturity by integrating all five components, bolstered by strong institutional coordination. Hamburg, Germany, for instance, has piloted micro-consolidation hubs in its city centre, from which logistics companies like DHL conduct final deliveries using electric cargo bikes. This approach has helped cut emissions and eased congestion in the urban core. Paris, France, guided by its 15-minute city strategy, has converted curbside parking spaces into dedicated delivery zones and has actively promoted cargo-bike delivery fleets, an example of pedestrian-first logistics in action. Similarly, Utrecht, Netherlands, has implemented "autoluw" (car-restricted) policies in its city centre, using cycle couriers operating from mini-hubs to handle deliveries. Collectively, these European cases demonstrate that re-purposing urban space for logistics - such as turning parking lanes into loading zones or installing micro-hubs on underutilised sites - can be achieved without sacrificing walkability [31], [32]. Moreover, alongside these physical interventions, robust governance measures and public-private partnerships have been key in enabling advanced GULC integration [21], [33].

Table 1 offers a comparative overview of how ten selected cities rate in their integration of the five GULC components. It summarises the extent to which each city has embedded walkability, micro-consolidation, low-emission fleets, shared logistics, and data-enabled governance in its logistics system. The cities are rated from "Low" up to "Very High" based on a qualitative assessment of public strategy documents, documented pilot projects, and the spatial integration of logistics infrastructure. As the table shows, cities such as Paris and Utrecht have achieved a "Very High" level of integration across all five GULC elements. By contrast, some rapidly urbanising cities, such as Belgrade and Lagos, exhibit only minimal alignment, especially in areas like shared logistics and data-driven governance. This cross-case mapping of GULC readiness helps to pinpoint both best practices and remaining gaps across different urban contexts.

Table 1. Comparative Assessment of GULC Element Integration Across Selected Cities

City	Walkability & Urban Form	Green Last-Mile Logistics	GULC Model Integration
Guangzhou	Car-free corridors, mixed-use transformation	E-bike delivery, parcel lockers	High - spatial + infrastructure alignment
Jakarta	Narrow pedestrian lanes, TOD-based street activation	Shared carts, informal delivery networks	Moderate - space adaptation, low regulation
Addis Ababa	Sidewalk redesign, market-focused pedestrian upgrades	Pushcart logistics, foot-based delivery	High - walkability leveraged for delivery
Pune	Smart street design, NMT prioritisation	Microhubs, decentralised delivery points	High - integrated MCC and walkability
Bogotá	Cycling culture, compact neighborhoods (Ciclovía)	BiciCarga program, city-supported cargo bikes	High - policy and mobility convergence
Kigali	Clean pedestrian zones, NMT-supportive policy	Informal couriers, limited electrification	Emerging - governance in place, limited tech
Lagos	Underdeveloped pedestrian space, high density	Crowd logistics potential, severe congestion	Low - fragmented, but high reform potential
Hamburg	Historic centre, traffic restrictions, pedestrian zones	DHL microhubs, e-cargo bikes	Very High - MCC + green fleet coordination
Paris	15-minute city zoning, active mobility investments	Cargo bikes, shared delivery platforms	Very High - all GULC layers implemented
Utrecht	Autoluw zones, cycling infrastructure, walkable city centre	Bike couriers, micro-hub integration	Very High - embedded logistics in a walkable system

Overall, these findings support the idea that the GULC model is both modular and adaptable in practice. Even cities with limited financial or institutional resources can achieve significant sustainability and accessibility gains by making targeted improvements in walkability and micro-logistics infrastructure, especially when those improvements are paired with shared or low-emission delivery modes. The experience of the developed cities demonstrates the scalability and integrative potential of all GULC elements, whereas the achievements in rapidly urbanising cities confirm that a phased, context-sensitive implementation is feasible.

5. DISCUSSION

The empirical evidence confirms that introducing walkability enhancements and low-emission last-mile logistics systems is both feasible and impactful, even across cities that differ greatly in their economic development and governance capacity. The comparative analysis reveals that developed cities, such as Paris, Hamburg, and Utrecht, tend to implement all five components of the GULC model comprehensively. By contrast, rapidly urbanising cities have adopted a more modular approach, often implementing select GULC elements, especially improvements in pedestrian infrastructure and informal logistics solutions, with considerable success.

One key insight from these cases is that walkability is highly adaptable as a foundational principle for urban logistics. Even in places with only rudimentary formal logistics systems, investing in sidewalks, pedestrian corridors, and mixed-use planning has created conditions conducive to sustainable last-mile solutions. This dynamic is evident in cities like Addis Ababa, Jakarta, and Pune, where such investments have paved the way for cargo-bike delivery services, pushcart-based logistics, and neighbourhood-level microhubs set up near transit nodes or within local communities. This finding echoes earlier research, which argues that the urban form itself (rather than technology alone) plays a central role in determining the efficiency and sustainability of freight systems [21],[30], [33]. Moreover, walkability can be understood as a key enabler of "smart" urban logistics, since it influences transportation behaviour, spatial equity, accessibility, and the efficient use of public space [34], [35].

The cases also highlight the growing importance of shared-mobility approaches to logistics, such as crowdshipping platforms and cooperative delivery networks. In cities like Bogotá and Lagos, where conventional logistics services are hampered by chronic congestion, regulatory hurdles, or cost issues, digitally enabled, informally coordinated delivery systems have emerged as viable alternatives. At the same time, the success of these bottom-up logistics solutions clearly hinges on having the right governance mechanisms in place. They require supportive regulations, robust data infrastructure, and quality assurance measures to ensure reliability and earn public trust [23], [25]. Overall, the evidence suggests a critical role for urban freight governance that is both flexible and integrative; one that utilises digital platforms to coordinate logistics while also remaining sensitive to each city's infrastructural and socio-economic realities.

Governance and financing are decisive in rapidly urbanising contexts, where informality, fragmented mandates, and limited municipal budgets constrain implementation. The cases suggest that early-stage progress can be enabled through low-cost instruments such as curb access reform, time-window management, pilot zoning for microhubs, and public-private coordination frameworks. Financing pathways may combine municipal experimentation funds, donor-supported pilots, climate-oriented funding streams, and partnerships with logistics operators - particularly where micro-consolidation and low-emission fleets generate measurable co-benefits such as reduced congestion and improved public space functionality.

Additionally, not all freight is the same, and certain sectors pose unique challenges that the GULC model will need to accommodate. Take the distribution of perishable foods in cities as an example: it demands specialised handling and often requires consolidation centres to maintain the cold chain. Establishing localised food logistics hubs could be one way to improve efficiency for these types of deliveries [36]. Another practical consideration is curbside management. Studies in high-density cities show that providing dedicated freight loading zones and implementing demand management strategies can significantly improve delivery reliability and minimise conflicts over limited street space [37]. Attending to these kinds of operational details helps ensure that sustainability interventions remain compatible with everyday logistical needs on the ground.

Furthermore, the empirical findings support the idea that the GULC model can serve as a modular framework. Cities that are earlier in their development trajectory do not have to implement all five components at once. Instead, they can follow a phased approach: start with spatial and behavioural interventions (for example, improving sidewalks or creating shared streets), then gradually introduce micro-consolidation pilots, green delivery fleets, and digital logistics platforms over time. This kind of step-by-step implementation supports adaptive governance and encourages iterative learning. It enables progress to be made without requiring an immediate wholesale institutional transformation [18], [19].

From a policy perspective, it is essential to integrate urban logistics considerations into the broader agendas of sustainable mobility and urban development. Cities that weave logistics reforms into their official planning processes (Paris with its 15-minute city zoning or Pune with its Smart Streets initiative, for instance) tend to achieve more coherent delivery strategies and better returns on investments in logistics infrastructure. These examples reinforce the argument that innovations in urban logistics should not be treated as isolated technical fixes. Instead, freight and delivery strategies must be seen as integral parts of spatial, social, and environmental planning [17], [27]. Beyond environmental and spatial benefits, the GULC model also supports economic supply chain performance by enabling cost-effective consolidation, infrastructure optimisation, and reduced last-mile delivery inefficiencies - key concerns in the economics of supply chains.

Ultimately, findings present several avenues for future research and practical experimentation. For one, longitudinal studies would be valuable for monitoring the evolution of GULC implementations and assessing their long-term effects on congestion and emissions. There is also a clear need for pilot programs in rapidly urbanising cities to test various combinations of GULC components, such as implementing pedestrianisation projects alongside micro-consolidation services, to see how these elements work in concert. Additionally, improved data collection on urban freight flows in rapidly growing city contexts will help refine the GULC model and inform more targeted interventions. In general, embracing more interdisciplinary approaches that connect transport planning, digital governance, and urban design will be crucial for unlocking the full transformative potential of the GULC model.

6. CONCLUSIONS

In summary, this paper has introduced the Green Urban Logistics Corridor (GULC) model - a comprehensive framework that integrates walkability, shared logistics, and green last-mile delivery into a unified approach for sustainable urban freight. By drawing on the principles of the 15-minute city, collaborative mobility, and urban consolidation, the GULC model integrates these concepts into a practical and scalable solution for cities aiming to decarbonise their logistics systems while enhancing urban livability.

The comparative analysis of developed versus rapidly urbanising cities reveals that European urban areas typically feature advanced integration of GULC components, whereas many cities in the Global South are adopting more innovative, modular strategies tailored to their local realities. In particular, findings highlight that investments in pedestrian infrastructure can serve as a catalyst for broader logistics transformations; that shared logistics platforms help extend delivery reach in resource-constrained settings; and that micro-consolidation hubs can significantly reduce emissions and congestion when backed by supportive policies and digital coordination.

For urban policymakers and planners, the GULC model offers a phased and adaptable roadmap toward sustainable urban logistics. The process begins with the upgrade of pedestrian infrastructure to enhance safety and accessibility, laying the spatial foundation for integrated logistics solutions. Subsequently, cities are encouraged to establish neighbourhood-scale micro-consolidation hubs strategically located near transit intersections and mixed-use zones. Complementing these spatial interventions, the promotion of green last-mile fleets (such as electric vans and cargo bikes) serves to reduce emissions and traffic impacts. Equally important is the deployment of digital logistics platforms that facilitate coordinated, crowd-based delivery models, enabling real-time efficiency gains. To ensure successful implementation and long-term impact, coherent governance structures must be developed, supported by robust public-private coordination mechanisms and data-driven regulatory frameworks.

Reimagining last-mile logistics through the GULC lens can advance both climate and transportation objectives, while also contributing to spatial equity and urban resilience. This human-centred model aligns freight flows with everyday mobility patterns, making logistics a visible and integrated part of a sustainable urban system.

6.1 Limitations and Future Research

This study has several limitations, chiefly stemming from its reliance on publicly available secondary data that vary in detail and quality across the case cities. Additionally, reliance on online and institutional sources may introduce reporting bias, especially in rapidly urbanising cities where informal logistics practices and small-scale initiatives are less consistently documented. Therefore, some GULC elements may be underreported, despite their practical relevance.

Although the comparative framework enables theory-informed analysis and helps validate the conceptual model, future research should build on this work by incorporating primary data collection (e.g. on-the-ground field studies, stakeholder interviews, and longitudinal observations) to enhance validity. Upcoming studies could also explore contexts beyond the scope of this paper, such as North American cities or major port cities, to test how well the GULC model scales in different urban environments. In addition, employing mixed-methods approaches that combine spatial analysis, user behaviour studies, and performance metrics would further strengthen the evidence base and enhance the practical relevance of GULC strategies.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES:

During the preparation of this work, the author(s) used a Grammarly EDU licence to assist with language editing and clarity, and ChatGPT solely for the visual rendering of Figure 1. After using these tools, the author(s) carefully reviewed and edited the content as necessary and take(s) full responsibility for the content of the publication.

7. REFERENCES

[1] Ambrosini, C., & Routhier, J.-L. (2004). Objectives, methods and results of surveys carried out in the field of urban freight transport: An international comparison. Transport Reviews, 24(1), 57-77. https://doi.org/10.1080/0144164032000122343

[2] Anderson, S., Allen, J., & Browne, M. (2005). Urban logistics - How can it meet policy makers' sustainability objectives? Journal of Transport Geography, 13(1), 71-81. https://doi.org/10.1016/j.jtrangeo.2004.11.002

[3] Benjelloun, A., & Crainic, T. G. (2008). Trends, challenges, and perspectives in city logistics. In Proceedings of the Transportation and Land Use Interaction 2008 (TRANSLU'08) (pp. 269-284). Bucharest, Romania.

[4] Browne, M., Allen, J., Nemoto, T., Patier, D., & Visser, J. (2012). Reducing social and environmental impacts of urban freight transport: A review of some major cities. Procedia - Social and Behavioral Sciences, 39, 19-33. https://doi.org/10.1016/j.sbspro.2012.03.088

[5] Moreno, C., Allam, Z., Chabaud, D., Gall, C., & Pratlong, F. (2021). Introducing the "15-minute city": Sustainability, resilience and place identity in future post-pandemic cities. Smart Cities, 4(1), 93-111. https://doi.org/10.3390/smartcities4010006

[6] Gehl, J. (2022). "The Human Dimension": from Cities for People (2010). In The Sustainable Urban Development Reader (pp. 137-139). Routledge.
[7] Moura, F., Cambra, P., & Gonçalves, A. B. (2017). Measuring walkability for distinct pedestrian groups with a participatory assessment method: A case study in Lisbon. Landscape and Urban Planning, 157, 282-296. https://doi.org/10.1016/j.landurbplan.2016.07.002
[8] Mehaffy, M. W. (2022, September). The New Urban Agenda in Urban Redevelopment: The Central Role of Public Space Networks. In International Seminar on Urban Form (pp. 205-220). Cham: Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-77752-3_11
[9] Shaheen, S. A., & Cohen, A. P. (2013). Carsharing and personal vehicle services: worldwide market developments and emerging trends. International Journal of Sustainable Transportation, 7(1), 5-34. https://doi.org/10.1080/15568318.2012.660103
[10] UITP - International Association of Public Transport. Sustainable and Smart Mobility: UITP input to the European strategy. EU Position Paper, September 2020, The International Association of Public Transport. Available online at: https://www.uitp.org/wp-content/uploads/sites/7/2025/04/20200924_UITP_contribution_EUSSMS_final.pdf
[11] Botsman, R., & Rogers, R. (2010). Beyond zipcar: Collaborative consumption. Harvard Business Review, 88(10), 30.
[12] Allen, J., Browne, M., & Thorne, G. (2007). BESTUFS Good Practice Guide on Urban Freight Transport. Rijswijk, Netherlands: BEST Urban Freight Solutions (BESTUFS).
[13] 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. https://doi.org/10.1080/01441647.2012.688074
[14] Taniguchi, E., & Qureshi, A. G. (2014). Urban consolidation centers: The good, the bad and the ugly. Center of Excellence for Sustainable Urban Freight Systems (COE-SUFS), Rensselaer Polytechnic Institute. (White paper).
[15] Janjevic, M., & Ndiaye, A. B. (2014). Development and application of a transferability framework for micro-consolidation schemes in urban freight transport. Procedia - Social and Behavioral Sciences, 125, 284-296. https://doi.org/10.1016/j.sbspro.2014.01.1474
[16] Van Rooijen, T., & Quak, H. (2010). Local impacts of a new urban consolidation centre - the case of Binnenstadservice.nl. Procedia - Social and Behavioral Sciences, 2(3), 5967-5979. https://doi.org/10.1016/j.sbspro.2010.04.011
[17] Holguín-Veras, J., Jaller, M., & Sánchez-Díaz, I. (2023). Urban freight policy, planning, and modeling for sustainable cities. Sustainable Cities and Society, 92, 104425.
[18] Gonzalez-Feliu, J., Ambrosini, C., & Pluvinet, P. (2018). Urban freight and logistics in the city: Current trends and perspectives. Transport Policy, 61, 97-101.
[19] Taniguchi, E., Thompson, R. G., & Yamada, T. (2020). City logistics: Network modelling and intelligent transport systems. Elsevier.
[20] Savelsbergh, M., & Van Woensel, T. (2016). 50th anniversary invited article - City logistics: Challenges and opportunities. Transportation Science, 50(2), 579-590. https://doi.org/10.1287/trsc.2016.0675
[21] Arvidsson, N., Givoni, M., & Woxenius, J. (2021). Exploring the performance of last mile logistics solutions for urban freight delivery. Journal of Transport Geography, 94, 103031. https://doi.org/10.2148/benv.42.4.523
[22] Hjalmarsson, A., & Woxenius, J. (2022). Replacing vans with cargo bikes in urban freight - Scenarios and policy implications. Research in Transportation Business & Management, 43, 100716.
[23] Yousef, S., Wubben, E., & Omta, S. (2022). A framework for urban logistics policy design: The case of sustainable last-mile delivery. Sustainability, 14(9), 5421.

[24] Le, T., Ta, Q., & Lemoine, D. (2023). Assessing the performance of collaborative logistics systems in urban areas. Transport Reviews, 43(1), 58-80.
[25] Prause, G. (2014). Sustainable business models and structures for Industry 4.0. Journal of Security and Sustainability Issues, 5(2), 159-169. https://doi.org/10.9770/jssi.2015.5.2(3)
[26] Moradi, F. (2025). Decentralised logistics governance in urban environments: Challenges and perspectives. Journal of Urban Transport and Logistics, 15(2), 210-227.
[27] Gkoumas, K., van Balen, M., Tsakalidis, A, Grosso, M., Ortega Hortelano, A., & Pekár, F. (2022). Advancing urban logistics through digitalisation and smart governance. Sustainability, 14(4), 2297.
[28] Bosona, T., Gebresenbet, G., & Nordmark, I. (2020). Urban logistics system design and planning: A review. Sustainability, 12(17), 7147. https://doi.org/10.3390/su12218769
[29] Cárdenas, I., Beckers, J., & Dewulf, W. (2017). Defining and characterising last-mile logistics from an innovation perspective. The International Journal of Logistics Management, 28(4), 1234-1252.
[30] ITDP. (2022). Pedestrians First: Tools for a Walkable City. Institute for Transportation and Development Policy. https://www.itdp.org/publication/pedestrians-first/
[31] Diziain, D., Ripert, C., & Dablanc, L. (2012). How can we bring logistics back into cities? The case of Paris metropolitan area. Procedia - Social and Behavioral Sciences, 39, 267-281. https://doi.org/10.1016/j.sbspro.2012.03.107
[32] Trentini, A., Gonzalez-Feliu, J., & Malhéné, N. (2015). Developing urban logistics spaces: UCC and PLS in South-Western Europe. HAL Working Paper (hal-01167757).
[33] Dablanc, L., & Montenon, A. (2015). Impacts of environmental access restrictions on freight delivery activities: The example of low emission zones in Europe. Transportation Research Procedia, 12, 118-126. https://doi.org/10.3141/2478-02
[34] Dovey, K., & Pafka, E. (2020). What is walkability? The urban DMA. Urban Studies, 57(1), 93-108. https://doi.org/10.1177/0042098018819727
[35] Talen, E., & Koschinsky, J. (2013). The walkable neighborhood: A literature review. International Journal of Sustainable Land Use and Urban Planning, 1(1), 42-63. https://doi.org/10.24102/ijslup.v1i1.211
[36] Morganti, E., & Gonzalez-Feliu, J. (2015). City logistics for perishable products: The case of the Parma's Food Hub. Case Studies on Transport Policy, 3(2), 120-128. https://doi.org/10.1016/j.cstp.2014.08.003
[37] Campbell, S., Holguín-Veras, J., Ramírez-Ríos, D. G., González-Calderón, C., Kalahasthi, L., & Wojtowicz, J. (2018). Freight and service parking needs and the role of demand management. European Transport Research Review, 10(2), 1-13. https://doi.org/10.1186/s12544-018-0309-5