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Last-Mile Simulation Approaches for Sustainable Delivery in Urban Outskirts: A Review

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Abstract

The growth of e-commerce has intensified challenges in the last-mile delivery, which represents a critical and costly segment of the supply chain. The increasing demand for integrative and sustainable supply solutions highlights the need for approaches that balance the environmental, social, and economic dimensions of last-mile delivery. A promising solution involves consolidating deliveries with zero-emission vehicles to central, barrier-free pick-up stations in urban outskirts, reducing environmental impact while addressing accessibility issues. Simulation-based approaches are emphasized as a tool to address the last-mile delivery challenges of urban outskirts. This paper presents a systematic literature review on simulation-based approaches to sustainable and inclusive last-mile delivery in urban outskirts. It addresses the underexplored logistical challenges in these areas and examines how customer needs impact on the three pillars of sustainability: social inclusion, ecological responsibility, and economic viability. By synthesizing current peer-reviewed research from 2020 to 2025, this study identifies critical research gaps, particularly with regard to designing inclusive infrastructures and developing adaptive simulation tools for rural areas and urban outskirts. This work contributes to a comprehensive research agenda, offering insights into inclusive, efficient, and environmentally conscious last-mile delivery solutions for urban outskirts.

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Keywords: last-mile; simulation system; transport logistics; urban outskirts; inclusion; sustainability

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1. Introduction

People all over the world use the internet to order products that are not available in their neighborhood, particularly in rural areas. Consequently, global e-commerce revenue has reached a record high of EUR 3.39 trillion and is expected to grow to EUR 5.4 trillion by 2029 [1]. This growth intensifies the challenges of last-mile delivery. The importance of this last segment is due to its complexity and costs, which account for around 70% of the total supply chain costs [2], and its contribution to high emissions [3,4].

To navigate these challenges effectively, a holistic approach to last-mile logistics must consider the three interconnected pillars of sustainability: ecological responsibility, social inclusion and economic viability [5,6]. These dimensions cannot be isolated from each other but rather as interacting dynamically, particularly as delivery services adapt customer needs. Customer decisions regarding preferred delivery points (home, parcel lockers, or pick-up stations) significantly impact on the overall sustainable effect of last-mile delivery. These preferences influence how environmentally friendly, socially accessible and economically efficient delivery networks can be. Therefore, incorporating customer behavior into the sustainability framework is essential for designing last-mile solutions that are both effective and socially fair.

Social sustainability in last-mile involves equitable access to delivery services, particularly for aging populations and residents in urban outskirts or rural areas [7,8]. These areas face unique challenges, such as limited personal mobility, infrastructure gaps, and a dependency on private vehicles for daily needs. The design and location of delivery points, such as parcel lockers, must account for barrier-free access and proximity to community hubs to avoid social exclusion [7,9]. If consumers do not have access to central delivery points due to mobility or digital barriers, the last-mile system does not fulfill its social function [10]. Thus, the delivery infrastructure must be customized to local needs and inclusively integrated.

From an environmental standpoint, customer choices and delivery configurations are essential. Sustainable transport modes, such as bikes or electric vans, are most effective when deliveries are clustered and predictable [9,11,12]. Choosing parcel lockers reduces stops and emissions per parcel. However, narrow streets, limited parking, and dynamic traffic conditions influence route efficiency [13]. Simulation studies show that well-placed parcel lockers aligned with customer behavior can substantially reduce environmental impact [13,14].

Economically, fragmented deliveries and repeated delivery attempts increase logistical costs [15]. Although opt-in time slots and alternative locations improve efficiency but complicate planning. Thus, understanding customer behavior is crucial for designing cost-efficient networks [2,8]. However, much research focus on provider-driven solutions, such as collaborative service delivery or micro-hub-based systems [16], rather than on empowering consumers to make decisions to optimize economic performance. Simulation models help to evaluate diverse configurations under varying preferences and spatial constraints and enable a data-driven analysis of trade-offs [3,17,18].

Current research focuses primarily on dense urban areas, with limited attention to rural areas and urban outskirts challenges [19,20]. These regions need inclusive, efficient and sustainable last-mile delivery solutions. Addressing this gap requires shifting focus from provider logistics to end-user needs and behaviors. Simulation-based planning, combined with inclusive design and green transportation, offers a path to equitable and environmentally responsible delivery systems. This paper fills this gap by presenting a systematic review of scientific literature focused on simulation-based approaches for inclusive and sustainable last-mile delivery. To guide this investigation, the study is driven by the following central research question:

What is the current state of the literature on simulation approaches that address sustainability and inclusion in last-mile delivery?

The following sections of this paper present a literature review on recent scientific publications related to simulation-based approaches for sustainable last-mile delivery. Section 2 outlines the systematic methodology used to identify and analyze relevant literature. Section 3 summarizes key findings from the reviewed studies, categorized by sustainability dimension, simulation technique, and geographic context. Section 4 interprets these results, highlighting research gaps and emerging patterns. Section 5 proposes a research agenda, identifying directions for future work, particularly in relation to inclusive logistics solutions for urban outskirts. Finally, Section 6 concludes the paper by reflecting on contributions, limitations, and the need for more inclusive, adaptable, and data-driven last-mile delivery frameworks.

2. Methodology - Literature Review

Motivated by the increasing demand for sustainable delivery in urban outskirts, this study investigates simulation-based strategies within supply chain logistics. A systematic literature review based on the rigorous guidelines [21] and the framework for literature reviewing [22] was utilized. The review was conducted between December 2024 and February 2025 and contains three search and analysis iterations. This systematic review approach maps the current literature on the research topic of last-mile simulation systems for sustainable urban outskirts logistics to identify relevant key concepts, theories, models and potential gaps in research. For literature review a search using four scientific databases was performed to identify journal articles and scientific papers published in the last five years period from 2020 to 2025 in English language. The literature search was extended to several specialized databases, not only to ensure comprehensive coverage of area-specific scientific sources, but also to incorporate different methodological perspectives and interdisciplinary findings. To ensure academic rigor and thematic relevance, only peer-reviewed publications from reputable academic journals and conference proceedings were included in the selection of sources.

Table 1. Systematic literature review approach.

Database	Search String	Search Fields	Hits	Relevant
IEEExplore			13	3
ScienceDirect	<i>"sustainable" AND ("urban" OR "city" OR outskirts) AND ("last mile" OR "last-mile") AND "simulation" NOT (drone OR robot OR crowdsourcing OR "public transport")</i>	Title, Abstract and Keywords	432	12
Wiley Online Library			71	0
PLOS ONE			38	1
		Forward search	551	16
	Backward search		14	
	Publications included		30	

The process of identification, screening, eligibility and inclusion was carried out in accordance with the PRISMA statement [23]. The literature analysis revealed a total of 551 relevant scientific publications in the identification phase after seven duplicates have been removed. Publications focusing on drones, robots, crowdsourcing, or public transportation for delivery have been removed due to the lack of thematic relevance for urban outskirts ($n = 370$). After screening the papers by title, abstract, and keywords matching the topic, 181 publications have been left. A full-text screening was then carried out to identify a further 89 publications that were not in the focus. The full-text screening made it possible to find additional literature through a backward search. Well-reviewed articles from the literature retrieved, not identified through the forward search, were subsequently added. The full-text screening included 16 publications, and the backward search added 14 relevant articles. In total there are 30 publications included in the following qualitative synthesis.

3. Review Results

Different types of simulation systems or other mathematical approaches, such as heuristic, stochastic, genetic, or machine learning approaches, etc. play a crucial role in the modeling, analysis and optimization of complex last-mile processes and offer insights into various challenges. The most common simulation methods used are Agent-Based Simulation (ABS), Multi-Agent System (MAS), or Discrete-Event Simulation (DES) models. Additionally, map-based tools such as Geographic Information Systems (GIS) are used for processing spatial data and representing geographical features by combining them with simulation models [24]. Fundamentally, these simulation models are based on mathematical formulations. Table 2 summarizes the results of the literature review and provides a detailed overview of the case studies and the utilized simulation approaches. These are categorized based on the sustainability dimension: economic, environmental, or social as well as the contextual local setting examined in the literature, such as rural areas, outskirts or urban environments.

Table 2. Summary of reviewed literature on inclusive and sustainable last-mile logistics.

Title	Problem formulation	Simulation approach	Sustainability dimension	Spatial area of interest
Design of a two-echelon last-mile delivery model [2]	LRP model for uncertain demand.	Mixed-Integer Linear Programming	economic	urban
Fostering collaboration and coordination in urban delivery: a multi-agent microsimulation model [3]	A multi-agent microsimulation method for facilitating communication among process agents.	Multi-agent microsimulation model	social	urban
A heuristic-attention method for location-routing problems with shared pick-up stations in green last-mile delivery [4]	LRP-Model for eco-friendly delivery to shared pick-up stations.	Heuristic algorithm + attention-based learning model	environmental	urban
Sustainable Strategic Management and Business Intelligent Systems within the Sustainable Development Context – Key Research Areas [6]	Review of key research areas in Sustainable Strategic Management and Business Intelligent Systems for sustainable business outcomes.	Literature review	economic, environmental, social	urban
Age and the 20-min city: Accounting for variation in mobility [7]	Geodemographic model for classification of older people's needs.	Geodemographic model	social	urban
Flowers of proximity in Spain: understanding local context priorities [8]	The study evaluates the 'flower of proximity' as a participatory tool for exploring preferences.	Qualitative approach	economic	rural and urban
Towards A More Sustainable Future? Simulating the Environmental Impact of Online and Offline Grocery Supply Chains [9]	ABS and DES of environmental effects of e-grocery home deliveries.	AnyLogic	environmental	urban
Unravelling the last-mile conundrum: A comparative study of autonomous delivery robots, delivery bicycles, and light commercial vehicles in 14 varied European landscapes[10]	A framework for evaluating the efficiency of light commercial vehicles, cargo bikes, and autonomous delivery robots in Europe.	Google OR-Tools solver	economic	rural and urban
A simulation study of the impacts of micro-hub scenarios for city logistics in Rotterdam [11]	Scenario simulation for a multi-agent demand model for urban freight transportation.	Tactical Fright Simulator	economic	urban
Reconfiguration of last-mile supply chain for parcel delivery using machine learning and routing optimization [12]	Optimization delivery area distribution to reduce urban last-mile travel time and distance.	Non-supervised Machine Learning + two-echelon VRP algorithm	economic	urban
A Simulation-Optimization Model for Automated Parcel Lockers Network Design in Urban Scenarios in Pamplona (Spain), Zakopane, and Krakow (Poland) [13]	ABS model for the design of a parcel locker network to determine the optimal number and locations of parcel lockers.	AnyLogic + CPLEX	economic	urban
Micro-hub location selection for sustainable last-mile delivery [14]	A multi-criteria micro-hub location approach for sustainable delivery.	Hybrid BWM-CRITIC-WASPAS	environmental	urban
An agent-based simulation framework for the study of urban delivery [15]	Crowdsourced-based MAS of a fleeting vehicle for goods transportation.	SimFleet	economic	urban
Traffic impact on last mile parcel delivery with cargo bikes [16]	ABS of sustainable delivery methods regarding emissions.	SUMO	economic, environmental	urban
Urban e-Grocery Distribution Design in Pamplona (Spain) Applying an Agent-Based Simulation Model with Horizontal Cooperation Scenarios [17]	Cooperative scenario-based multi-depot VRP for economic and quality of service implications.	AnyLogic	economic	urban
From operational to strategic modelling: A continuous multi-scale approach for last-mile analysis [18]	A continuous multi-scale approach (LRP) of customer locations, customer demand, delivery routes.	Continuous approximation and districting problem	economic	rural

A simulative assessment of collaborative last mile delivery solutions [19]	Design of collaborative pick-up stations compared to home delivery in terms of cost and sustainability.	MATSim + Jspirt	economic, social	urban
A Dynamic Forecast Demand Scenario Analysis to Design an Automated Parcel Lockers Network in Pamplona (Spain) Using a Simulation-Optimization Model [20]	Dynamic simulation model for designing a parcel locker network to determine the optimal number and locations of parcel lockers.	AnyLogic + CPLEX	economic	urban
Reinforcement learning (RL) for logistics and supply chain management: Methodologies, state of the art, and future opportunities [25]	Application of RL to logistics and supply chain management.	Scoping review	economic	urban
Using greedy clustering method to solve capacitated location-routing problem with fuzzy demands [26]	Scenario-based capacitated LRP with fuzzy demands method.	Greedy clustering with stochastic simulation	economic	-
An open source decision support system for facility location analysis [24]	Support tool for the decision-making process for optimal facility locations.	FLP Spreadsheet Solver; integer programming	economic	urban
Robust optimization of microhub network and mixed service strategy for a multidepot location-routing problem [27]	Service model for the micro-hub LRP for urban areas with multi-depots and an alternative returned parcel service.	Sweep heuristic + iterative greedy algorithm + adaptive large neighborhood search	economic	urban
Out-of-home delivery in last-mile logistics: A review [28]	Review of out-of-home delivery approaches in terms of optimization.	Literature review	economic	urban
BinR-LRP: A divide and conquer heuristic for large scale LRP with integrated microscopic agent-based transport simulation [29]	A transferable multi-agent simulation framework for transportation.	MATSim + Jspirt	economic	urban
Optimising Urban Freight Logistics Using Discrete-Event Simulation and Cluster Analysis: A Stochastic Two-Tier Hub-and-Spoke Architecture Approach [30]	DES model for freight truck routes from cross-country transport to last-mile delivery.	ARENA + GIS	economic	urban
Many-objective sectorization for last-mile delivery optimization: A decision support system [31]	Dynamic demand decision support system for optimizing courier area assignment and capacity use.	GRASP and PICEA algorithms	economic	urban
Agent-based simulation of shared bikes and e-scooters: the case of Lyon [32]	Framework for simulating shared bike and e-scooter services with dynamic return stations.	MATSim	economic	urban
Spatial participatory planning for urban logistics: A GIS-enhanced Real-Time Spatial Delphi approach [33]	A framework that combines expert opinion and data to select technically sound sites.	Real-Time Spatial Delphi + GIS	economic, social	urban
Analytic hierarchy process for city hub location selection - The Viennese case [34]	Decision-support model for site selection.	Analytical Hierarchy Process	economic, environmental, social	urban
The location routing problem with facility sizing decisions [35]	LRP design approach considering the capacity of each depot.	Three mixed-integer programming models + CPLEX	economic	-

4. Findings on Last-Mile Delivery

This paper investigates the current state of the literature on simulation systems for sustainable and inclusive last-mile delivery in urban outskirts. The reviewed studies can be grouped into four categories: sustainability, optimization, decision-support models and simulation techniques. A meta-analysis of three reviews highlight sustainable out-of-home delivery options [28], sustainable strategic integration of business intelligence [6], and RL

for logistics optimization [25]. These reviews are unified by the goal of solving challenges through sustainable strategic and technological approaches.

Simulation tools like AnyLogic, MATSim, or GIS-based models are used to improve parcel locker networks, freight routes, facility locations, while addressing challenges like the Vehicle Routing Problem (VRP), Facility Location Problem (FLP), and Location Routing Problem (LRP). AI-driven decision-support frameworks and heuristic algorithms refine planning, balancing efficiency and cost [12,25]. Key sustainable strategies include cooperative models [15] and simulations, such as emission-free vehicles [4,9,14], urban micro-hubs [11], and parcel lockers [13,20], to address congestion and environmental aspects as a part of the ideal 15-minute city [7,8]. A collaborative delivery approach to non-branded parcel lockers in the city of Hamburg shows significant reductions for the delivery time, transport costs, and pollution reduction per simulation scenario [19]. The use of cargo bikes for last-mile delivery is recommended in densely populated urban areas with good bicycle infrastructure and well-located micro-hubs [16]. The literature lacks attention to inclusive or barrier-free pick-up station design.

The literature review shows that only a few publications deal with last-mile delivery in rural areas [8–10]. Many of the analyzed concepts apply to cities or metropolises with high population density, consistent demand, and heavy traffic [16]. However, it is important to understand the demand behavior of outskirts or rural area residents because the needs are different from those of urban residents [7,8]. From the perspective of outskirts residents, relevant locations can be designated as points of interest highlighting that area-specific characteristics strongly influence last-mile delivery across different European contexts [10].

To cover all aspects of simulation, a collaborative framework comprises three simulation layers: a multi-agent logistics network layer, a demand and urban context microsimulation layer, and a dynamic multi-agent microsimulation with defined inputs and outputs, all aimed at minimizing urban freight costs [3]. Participatory GIS approaches reveal gaps between data-driven and expert-identified optimal logistics facility sites in the Dublin case study [33]. While promising combined ABS-DES simulation models exist (e.g., for e-grocery shopping in Hanover, Germany [9]), specific simulation systems designed for last-mile delivery in outskirts or rural areas are lacking.

Table 3. Taxonomy of simulation approaches and research gaps for inclusive and sustainable outskirts delivery.

Topic	Simulation-based solutions	Research gaps identified
Simulation methods	<ul style="list-style-type: none"> - ABS, DES, MAS models used to simulate delivery networks [3,9,15,16] - AnyLogic, MATSim, SUMO, GIS-based models applied in urban logistics [9,13,16] 	<ul style="list-style-type: none"> - Lack of adaptive models for low-density areas / outskirts - Models must reflect dynamic demand and regional variability
Spatial context	<ul style="list-style-type: none"> - Focus on high dense urban centers [13,20,30] - Use of VRP, LRP models in dense city logistics scenarios [12,18,27] 	<ul style="list-style-type: none"> - Limited application in urban outskirts or rural areas - Outskirt-specific mobility patterns underexplored
Sustainability dimensions	<ul style="list-style-type: none"> - Environmental: Cargo bikes, electric vans reduce emissions [9,14,16] - Economic: optimization through micro-hubs and collaborative delivery [11,19] - Social: integration of demographic models [7,8] 	<ul style="list-style-type: none"> - Rare inclusion of accessibility (e.g. barrier-free design, aging populations) - Lack of studies that simultaneously address all three pillars
Infrastructure design	<ul style="list-style-type: none"> - Parcel-lockers, micro-hubs, shared pick-up stations in urban logistics [13,14,19] 	<ul style="list-style-type: none"> - Limited inclusive, barrier-free access studies for pick-up infrastructure - Site planning often lacks co-creation input
Customer behavior	<ul style="list-style-type: none"> - Simulated customer preferences for delivery locations [2,3,8] - Models incorporating demand elasticity and choice behaviors [8,9] 	<ul style="list-style-type: none"> - Poor behavioral data for outskirts population - Lack of citizen surveys or participatory methods
Decision support & optimization	<ul style="list-style-type: none"> - Use AI, ML, heuristic algorithms in routing and facility location [4,12,24,25] 	<ul style="list-style-type: none"> - Limited integration of behavioral and demographic data in optimization tools - Underuse of reinforcement learning and real-time adaptive systems in outskirts logistics

Implementing last-mile solutions faces challenges such as infrastructure constraints, different regional needs and different public-private priorities. Public planners focus on equity and accessibility, while private actors prioritize cost and efficiency. Simulation tools help to achieve these goals by testing facility locations [13,14], routing strategies [12] and various delivery modes under realistic conditions [9,10]. They enable stakeholders to assess the impact, reduce implementation risks and make data-driven decisions tailored to each site-specific context [3].

To synthesize the insights from the reviewed literature and identify key areas for future exploration, a taxonomy of existing simulation-based solutions and corresponding research gaps was developed (Table 3). This taxonomy categorizes the findings across six thematic dimensions: simulation methods, spatial context, sustainability focus, infrastructure design, customer behavior, and optimization strategies. It highlights the predominance of urban-centered models, and the relative lack of simulation tools tailored to the specific needs of urban outskirts and rural areas. Moreover, it underscores the limited integration of social inclusion criteria and real-world behavioral data into existing models.

5. Research Agenda

Despite the insights gained, some research needs remain, particularly about sustainable and inclusive solutions for urban outskirts or rural areas. This chapter outlines key future research directions (Table 4) to overcome existing challenges and unlock new potential.

Table 4. Future research agenda for sustainable last-mile delivery and inclusive pick-up solutions.

Research gap	Research direction	Suggested methodology	Dimension	Spatial context	Relevance
Lack of dynamic optimization in last-mile routing	Improve efficiency through dynamic routing algorithms and real-time optimization	Algorithm development, simulation modeling	Efficiency, Sustainability	Urban, outskirts, rural areas	Improves operational performance and responsiveness
Limited long-term evaluation of alternative delivery modes	Assess the long-term impact of low-emission delivery vehicles and urban micro-hubs	Long-term studies, pilot testing	Sustainability	Outskirts	Insights into sustainable infrastructure and mobility decisions
Lack of AI-integrated decision-support tools	Development of tools using AI-based simulation models	Simulation modeling, AI integration	Strategic planning	All areas	Improve facility location and routing decisions
Absence of adaptive logistics frameworks	Explore AI and heuristic-based algorithms for resilience	Computational modeling, algorithm testing	Resilience, Adaptability	Urban	Support flexible and robust logistics systems
No simulation tools for outskirts or rural areas	Design adaptable simulation models for diverse regional characteristics	Model development, validation independent of region	Strategic planning	Outskirts, rural areas	Application of simulations to underrepresented areas
Limited behavioral data from outskirt residents	Collect data on individual mobility and shopping behavior through citizen surveys	Citizen survey, data analysis	Inclusion, user-centered	Outskirts, rural areas	Provide empirical basis for inclusive logistics design
Lack of studies on barrier-free pick-up stations	Explore inclusive design principles for last-mile delivery points	Mixed-methods / user-centered design	Inclusion / accessibility	Outskirts	Improve equal opportunities in access to e-commerce services

Future last-mile logistics research should focus on improving efficiency with dynamic routing algorithms and real-time optimization. Sustainability can be enhanced by evaluating the long-term impact of cargo bikes and micro-hubs on outskirt mobility. The development of advanced decision-support tools, integrating AI-based simulation models, will enable more precise facility location and routing strategies. Additionally, exploring reinforcement learning and heuristic-based algorithms will drive innovation in adaptive logistics networks, ensuring resilience in rapidly evolving urban environments. Current simulation solutions do not address the unique challenges of outskirts or rural areas. Future models should be adoptable to various regions regardless of local characteristics. Another

essential aspect to explore is the data availability. There is a lack of information on residents' individual mobility patterns and shopping preferences in the context of living conditions. This can be addressed through citizen surveys about individual behaviors.

In summary, future research should focus on developing easy to customize simulation models for last-mile logistics on the outskirts and incorporating behavioral insights. Furthermore, collaborative frameworks that balance cost efficiency with sustainability goals should be explored to ensure inclusive and environmentally friendly delivery solutions. Addressing these aspects will be crucial for advancing sustainable last-mile logistics and meeting the evolving demands of modern urban and suburban populations.

6. Conclusion

This study provides valuable insights into the challenges and opportunities of sustainable last-mile logistics, particularly in the context of outskirts and rural areas. By analyzing various logistics models and assessing their applicability, it becomes evident that the characteristics of different regions significantly influence the efficiency and feasibility of proposed solutions. While many studies focus on optimizing logistics from the perspective of service providers, this research highlights the importance of considering customer needs and behavior, especially in less densely populated areas. One key finding is that the implementation of alternative delivery methods, such as parcel lockers or urban micro-hubs, requires a thorough understanding of local demand. Simulation models, although widely applied in urban settings, remain underdeveloped for outskirts. Further research in this field is needed. Moreover, participatory approaches that integrate expert assessments with GIS-based evaluations have proven useful in identifying real-world-related logistics facility locations. The future of logistics lies in integrating data-driven strategies to balance efficiency, cost, and sustainability.

Despite these contributions, this study has certain limitations. While the literature review identified valuable scientific papers, many of them do not directly address the specific outskirt problem under investigation. Instead, only aspects of the general topic were covered. The reliance on a limited number of four bibliometric databases may have limited the scope of the literature corpus, meaning that relevant contributions from other academic sources may not have been included. The chosen publication window of 2020-2025 narrows the time frame and thus excludes earlier foundational research that could provide valuable historical insights or longitudinal comparisons. Future research can expand the scope of bibliometric sources and incorporate alternative delivery technologies to improve the reproducibility, inclusiveness, and sustainability of results.

To build on these findings, future research should pursue several specific directions. First, simulation models need to be adapted to better reflect the specific geographical, demographic and behavioral characteristics of non-urban and rural areas. Second, the specific needs of stakeholders, especially elderly, digitally excluded or mobility-impaired users, should be included in the simulation parameters to design inclusive delivery infrastructures. Third, interdisciplinary methods that combine agent-based modeling, real-time spatial data and user surveys can support co-creative planning processes between municipalities, logistics providers and communities. Finally, simulations that assess the long-term impact of green technologies and infrastructure investments can serve as a basis for evidence-based policy and business decisions. As peri-urban areas become increasingly important, addressing these research needs is critical to ensuring that last-mile delivery systems remain efficient, equitable, and sustainable.

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