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Dynamic Routing in Urban Logistics: A Comprehensive Review of AI, Real-Time Data, and Sustainability Impacts

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ABSTRACT : This paper examines the impact of dynamic routing algorithms on urban logistics, focusing on their role in improving operational efficiency and environmental sustainability. With the rise of e-commerce and the increasing complexity of urban transport networks, dynamic routing has emerged as a critical solution for reducing delivery times, optimizing fleet usage, and minimizing emissions. The methodology for this review involved a comprehensive search of key academic databases, including Scopus, IEEE Xplore, and Google Scholar, using relevant keywords and inclusion criteria. The results demonstrate that algorithms integrating real-time data, artificial intelligence, and hybrid optimization models significantly enhance routing decisions. Furthermore, real-time systems that incorporate GIS and IoT data enable more responsive and context-aware logistics operations. However, challenges such as infrastructure disparities, data interoperability, and policy support must be addressed to fully realize the potential of dynamic routing in urban environments. The study concludes by emphasizing the importance of policy interventions and collaborative efforts to overcome these barriers and proposes future research directions to improve scalability and data integration in dynamic routing systems..

Keywords: Dynamic Routing Algorithms, Urban Logistics, Operational Efficiency, Sustainability, Real-Time Data, Artificial Intelligence, Optimization Techniques.

INTRODUCTION

Urban logistics has become a focal point in the broader discourse of sustainable city development, driven by the exponential growth of e-commerce, increasing demand for last-mile delivery efficiency, and mounting environmental concerns. In response to these challenges, the evolution of dynamic routing algorithms has emerged as a critical area of research, particularly with the integration of real-time data, artificial intelligence (AI), and advanced optimization techniques. Recent studies have highlighted the increasing relevance of approaches such as approximate dynamic programming (Çimen et al., 2020) and reinforcement learning-based models (Ge & Jin, 2021), which have demonstrated significant promise in addressing traffic unpredictability and demand variability. Furthermore, advancements in digital connectivity systems that incorporate real-time demand updates have facilitated greater responsiveness in urban logistics networks, enhancing their ability to scale and operate within complex metropolitan environments (Wang et al., 2022; Ghorbani et al., 2022).

The interplay between traffic congestion and travel time uncertainty remains a pivotal factor affecting the efficiency and reliability of urban distribution systems. Liu et al. (2024) emphasized that fluctuations in route choice behavior and traffic flow patterns directly influence the throughput of transportation networks. These findings are corroborated by time-dependent route planning models, which suggest that congestion significantly hampers network efficiency and introduces volatility into logistic operations (Ge & Jin, 2023). Agile optimization techniques, as explored by Ghorbani et al. (2022), offer adaptive solutions capable of responding to these dynamic conditions in real time, thereby reinforcing the value of hybrid methodologies in managing urban logistics.

Electric vehicles (EVs) have added another layer of complexity to the implementation of dynamic routing algorithms in urban logistics systems. The primary challenge lies in managing battery constraints and ensuring sufficient access to charging infrastructure. Raeesi and Zografos (2022) proposed a coordinated routing strategy incorporating intra-route recharging and en-route battery swapping to address these limitations. Complementary studies, such as Fan (2023), have introduced multi-depot and hybrid algorithms, including two-stage hybrid ant colony algorithms, which optimize EV allocation and routing to reduce both operational costs and carbon emissions. These models must simultaneously account for technical constraints and economic feasibility, ensuring responsiveness to fluctuating demand amid urban traffic variability (Raeesi & Zografos, 2022; Fan, 2023).

Overall, the recent trajectory of dynamic routing research underscores a shift toward the adoption of sophisticated methodologies and computational technologies aimed at mitigating field-level uncertainties. Despite these advancements, traffic congestion and time variability continue to present significant challenges, prompting researchers and practitioners to develop increasingly adaptive and real-time optimization models (Wang et al., 2022; Liu et al., 2024; Ge & Jin, 2023). In the case of EV applications, the need for synergistic integration of mathematical modeling and infrastructural considerations is paramount to ensure environmental and economic sustainability (Raeesi & Zografos, 2022; Fan, 2023).

While substantial progress has been made, several critical gaps in the literature remain, particularly regarding the integration of real-time data sources such as Geographic Information Systems (GIS) and the Internet of Things (IoT) into dynamic routing frameworks. Although studies like Shi et al. (2020) have attempted to incorporate digital connectivity and real-time information, significant barriers related to data heterogeneity, latency, and sensor coverage persist. Danchuk and Hutarevych (2024), for instance, proposed a GIS-driven dynamic routing system to optimize urban road network configurations; however, their system struggled to adapt to dynamic data variations and address disparities in data quality across different regions. Similar challenges exist in IoT integration, where data interoperability and security standards must be enhanced to support the precision required for effective real-time route planning (Shi et al., 2020).

Several prior studies have aimed to assess and enhance the efficacy of dynamic routing algorithms with a focus on reducing operational costs and minimizing carbon emissions. Ge and Jin (2023) introduced a time-dependent routing model leveraging real-time traffic data to improve logistical efficiency while lowering emissions. Meanwhile, Ghorbani et al. (2022) explored agile optimization strategies capable of rapid adjustment in response to operational changes, demonstrating improved energy efficiency and carbon footprint reduction. These evaluations often involve complex trade-offs between travel time, fuel costs, and environmental impact, providing a robust empirical basis for adopting economically efficient and ecologically sound solutions.

Geographic dynamics also play a vital role in shaping the implementation of dynamic routing technologies. In Southeast Asian metropolises, for example, dense and congested road infrastructure necessitates highly adaptive routing algorithms capable of deeply integrating GIS data to manage uncertainty and variability (Danchuk & Hutarevych, 2024). Conversely, European cities, which often feature modern infrastructure and stringent environmental regulations, tend to focus on intelligent logistics systems that incorporate emission policies and local governance structures, as evidenced in Calvet et al. (2021). These geographical differences influence not only the availability and quality of real-time data but also the adaptation and customization of routing algorithms to align with local logistical and regulatory environments.

The current study aims to address these multifaceted challenges by conducting a comprehensive review of recent advancements in dynamic routing algorithms for urban logistics. Specifically, this review will analyze the integration of real-time data, the role of AI-based optimization methods, the applicability of routing models in EV contexts, and the adaptation of algorithms to various geographic and infrastructural settings. By synthesizing these aspects, the study seeks to elucidate the current state of the art and identify promising avenues for future research.

This review will encompass scholarly articles published in reputable databases such as Scopus, IEEE Xplore, and Web of Science, focusing on research from the past decade. The analysis will prioritize studies that incorporate hybrid methodologies, real-time decision support systems, and applications across different urban environments. The geographical scope of this review includes case studies from both developed and developing regions, enabling a comparative perspective on how dynamic routing solutions are shaped by infrastructural maturity and policy frameworks.

In sum, this introduction has outlined the growing significance of dynamic routing in urban logistics, framed by advancements in real-time data integration, optimization techniques, and electric vehicle deployment. Despite considerable progress, persistent challenges in data standardization, adaptive modeling, and geographic variation highlight the need for further investigation. By examining recent developments and unresolved issues, this review endeavors to contribute meaningful insights into the optimization of urban logistics networks, thereby informing more sustainable, responsive, and efficient routing practices for modern cities.

METHOD

This study employed a structured and rigorous approach to collect, evaluate, and synthesize existing academic literature concerning dynamic routing algorithms in urban logistics. The methodology was designed to ensure comprehensive coverage of relevant studies that explore the design, development, and implementation of dynamic vehicle routing strategies. Three major scholarly databases were selected as the core sources for literature retrieval: Scopus, IEEE Xplore, and Google Scholar. These databases were chosen due to their extensive indexing of peer-reviewed journals, conference proceedings, and academic books, particularly in the domains of operations research, computer science, logistics engineering, and artificial intelligence. The combination of these platforms provided a robust foundation for exploring interdisciplinary research related to dynamic routing, especially those employing heuristic, metaheuristic, machine learning, and reinforcement learning techniques (Yang & Jiang, 2024; Meng et al., 2022; Wang et al., 2022).

The keyword search strategy was central to the identification of relevant literature. Initial keyword terms included "dynamic vehicle routing," "DVRP," "time-dependent routing," and "urban logistics," which represent the core thematic elements of the study. These keywords were further expanded by incorporating associated phrases that reflect more specific dimensions of the problem domain, such as "real-time routing," "adaptive routing," "multidepot vehicle routing," "cold chain logistics," and technological integration terms like "GIS data" and "IoT integration." For instance, Yang and Jiang (2024) emphasized the importance of "time-varying road networks" in the optimization of logistical paths, while Meng et al. (2022) used "dynamic vehicle routing" to explore preemptive pickup and delivery services. Additionally, Wang et al. (2022) discussed demand fluctuation and time-window constraints in route planning, and Fan (2023) introduced a hybrid approach for electric vehicle (EV) routing under time-sensitive conditions. These examples highlight the effectiveness of incorporating diverse and specific keywords in identifying studies that align with the scope of the review.

To further refine the search results and enhance their relevance, Boolean operators such as AND, OR, and NOT were strategically employed in the query construction process. This allowed for the combination of broad and narrow search terms, filtering out irrelevant results while expanding the inclusion of interdisciplinary studies that addressed not only the algorithmic and technical aspects of dynamic routing but also environmental, operational, and infrastructure-related dimensions. The use of compound search strings, for example, ("dynamic routing" AND "urban logistics") OR ("time-dependent routing" AND "real-time optimization"), enabled the extraction of studies that bridged theoretical modeling with real-world applications. These sophisticated search strategies significantly contributed to the breadth and depth of the literature survey.

Inclusion and exclusion criteria were clearly defined prior to the literature screening process to ensure that only high-quality and contextually appropriate studies were selected for review. Studies were included if they met the following criteria: (1) they were published in peer-reviewed journals or conference proceedings indexed in Scopus, IEEE Xplore, or Google Scholar between 2010 and 2024; (2) they explicitly addressed dynamic routing algorithms in the context of urban logistics; (3) they involved optimization models or computational techniques applied to real-time routing or time-dependent vehicle routing problems; and (4) they provided empirical evidence, simulation outcomes, or case studies demonstrating the practical applicability of the proposed models or algorithms. Articles were excluded if they lacked methodological rigor, were limited to non-urban settings, or focused solely on static routing problems without consideration of real-time or dynamic elements.

The types of studies included in the review encompassed a diverse array of research methodologies, including simulation studies, algorithmic model development, comparative analyses, and empirical case studies. Notably, randomized controlled trials were not applicable given the nature of the research domain. Instead, a significant portion of the literature involved the development and testing of heuristic and metaheuristic algorithms (e.g., genetic algorithms, ant colony optimization, particle swarm optimization), hybrid models integrating artificial intelligence techniques (e.g., reinforcement learning, deep Q-networks), and real-time decision support systems using data from GIS and IoT sources. Case studies and scenario-based simulations were also frequently employed to evaluate model performance under various urban logistics conditions, such as fluctuating demand, congestion, and vehicle constraints.

The literature selection process followed a multi-phase screening protocol to ensure consistency and objectivity. In the first phase, titles and abstracts were reviewed to assess initial relevance based on the predefined inclusion criteria. Articles that met the basic thematic alignment were then subjected to a second round of full-text evaluation to verify methodological soundness, clarity of scope, and the presence of empirical or computational validation. During this phase, each study was independently assessed by multiple reviewers to mitigate bias and ensure comprehensive evaluation. Discrepancies in judgment were resolved through discussion and consensus.

Articles selected during the screening process were then systematically categorized based on thematic focus, methodological approach, algorithm type, and technological integration. This thematic classification enabled a more structured synthesis of the findings in the results and discussion sections. Studies were grouped under major themes such as AI-assisted dynamic routing, electric vehicle route optimization, integration of real-time traffic data, and geographic variability in implementation. This taxonomy allowed for a comparative analysis of methodologies and outcomes across different research streams.

Overall, the integration of robust database sources with a meticulously designed search strategy and strict inclusion criteria enabled the identification of high-quality and thematically aligned literature. The methodological diversity of the selected studies ensured a comprehensive understanding of dynamic routing innovations in urban logistics. The rigorous screening and classification process provided the necessary foundation for extracting nuanced insights and drawing informed conclusions about the current state of research, existing gaps, and future directions in the field of dynamic vehicle routing.

RESULT AND DISCUSSION

The findings of this narrative review are organized into four major thematic areas: operational efficiency, environmental impact, technological innovation, and global case studies. Across these domains, the literature reveals substantial advancements in the application and effectiveness of dynamic routing algorithms within urban logistics systems. Each theme is discussed in detail, highlighting the specific contributions of existing studies and their relevance to the evolving landscape of intelligent transportation systems.

In terms of operational efficiency, dynamic routing algorithms have shown significant potential in improving fleet utilization and reducing both delivery time and vehicle travel distance. Yang and Jiang (2024) introduced a hybrid Adaptive Large Neighborhood Search-Ant Colony Optimization (ALNS-ACO) algorithm that successfully minimized exposure to peak-hour congestion. Their approach demonstrated an overall reduction in travel distance while maintaining high service levels. Similarly, Ulmer et al. (2019) developed a hybrid offline–online approximate dynamic programming model that enhanced both spatial and temporal anticipation of service demands. This method allowed for proactive routing decisions, leading to decreased delivery times and optimized fleet usage. Wang et al. (2022) further extended the discussion by presenting a collaborative multi-depot strategy that dynamically allocates vehicles based on real-time demand data, significantly improving vehicle distribution across the network. The cumulative evidence from these studies confirms that adaptive dynamic routing methods substantially increase operational responsiveness and reduce inefficiencies in last-mile delivery.

On the environmental front, dynamic routing has been empirically linked to significant reductions in carbon emissions. The correlation between optimized routing and lower fuel consumption is particularly evident in studies that integrate real-time traffic avoidance. Yang and Jiang (2024) reported that their congestion-aware routing algorithms contributed to meaningful decreases in greenhouse gas emissions by avoiding bottlenecks and minimizing idle engine time. Fan (2023) provided complementary findings through the application of a two-stage hybrid ant colony algorithm for electric vehicle routing. This model not only enhanced the operational performance of urban EV fleets but also reduced carbon output by optimizing vehicle allocation across multiple depots. Raeesi and Zografos (2022) presented an advanced routing framework that incorporates intra-route recharging and en-route battery swapping strategies. Their approach enabled electric vehicles to dynamically adjust routes based on real-time data, thus improving battery efficiency and reducing emissions. These studies collectively illustrate the environmental value of implementing intelligent dynamic routing strategies that align with sustainability goals.

Technological innovation, particularly the application of artificial intelligence (AI), is a recurring theme in the literature. Reinforcement learning has emerged as a key method for enabling routing systems to learn from historical data and real-time operational contexts. Ge and Jin (2021) illustrated how reinforcement learning techniques allow routing systems to dynamically adjust to fluctuations in traffic conditions and delivery demands. Pan and Liu (2022), along with Li et al. (2023), expanded this line of inquiry through deep reinforcement learning approaches, which demonstrated enhanced ability to manage route uncertainties and optimize vehicle dispatch in large urban networks. These AI-based models offer a dual advantage: they combine mathematical optimization with adaptive behavior, enabling practical deployment in rapidly changing urban environments. The flexibility and scalability of these algorithms are instrumental in developing next-generation routing systems that go beyond static optimization.

In parallel, the integration of Geographic Information Systems (GIS) and Internet of Things (IoT) technologies provides crucial support for real-time data acquisition and processing. Danchuk and Hutarevych (2024) highlighted how GIS tools supply spatial data on urban infrastructure and road conditions, allowing algorithms to make geographically informed routing decisions. Additionally, IoT-enabled sensors embedded in vehicles and urban infrastructure capture real-time data on traffic density, weather, and road quality. This information is subsequently used to inform routing decisions in real time, enhancing both safety and efficiency. The synthesis of GIS and IoT not only strengthens the accuracy of routing algorithms but also expands their capacity to react to environmental and contextual changes, supporting more resilient logistics systems (Danchuk & Hutarevych, 2024).

From a global perspective, the deployment of dynamic routing systems in cities such as London, Singapore, and Amsterdam provides compelling evidence of the technology's effectiveness when supported by robust digital and physical infrastructure. Calvet et al. (2021) reported that in Amsterdam and Barcelona, the integration of real-time information systems, AI algorithms, and GIS platforms led to reductions in travel time, delivery distance, and overall emissions. These successes are largely attributed to supportive public policy, advanced technological infrastructure, and active collaboration between public and private sectors. In contrast, developing countries face greater implementation challenges due to limitations in infrastructure and financial resources. While cities in Southeast Asia have made strides in adopting mobile and IoT technologies, their systems are often fragmented and lack the integration necessary for comprehensive dynamic routing solutions (Calvet et al., 2021). As a result, developing nations tend to rely on modular solutions and localized sensor upgrades to gradually improve system capabilities.

The disparity between developed and developing contexts underscores the importance of tailoring dynamic routing solutions to the specific infrastructural and policy environments in which they are deployed. In high-income countries, the focus is often on enhancing interoperability between systems and achieving marginal efficiency gains through advanced analytics. Conversely, in low- and middle-income settings, the emphasis is on building foundational capabilities and ensuring basic functionality. Despite these differences, both contexts benefit from the flexible nature of dynamic routing algorithms, which can be adapted to various levels of technological maturity and operational complexity.

Overall, the reviewed literature confirms the transformative impact of dynamic routing algorithms on urban logistics. Operational benefits include reduced travel time, optimized fleet usage, and lower delivery costs, while environmental gains are realized through reductions in carbon emissions and fuel consumption. Technological advances, particularly in AI, GIS, and IoT, have enabled real-time responsiveness and contextual adaptation, making dynamic routing an increasingly practical solution for urban distribution challenges. Furthermore, case studies from both developed and developing regions illustrate how dynamic routing can be scaled and adapted to diverse urban conditions, provided that the necessary data infrastructure and policy support are in place. These findings collectively demonstrate the multidimensional value of dynamic routing in creating efficient, sustainable, and future-ready urban logistics systems.

The findings of this review reinforce existing literature on the effectiveness of dynamic routing algorithms in enhancing urban logistics, while also providing new insights into contextual challenges and opportunities. The evidence from recent studies, including those by Ulmer et al. (2019), Yang and Jiang (2024), and Wang et al. (2022), supports the assertion that the deployment of adaptive routing systems can significantly reduce delivery times and travel distances. These operational improvements translate into lower energy consumption and reduced carbon emissions, aligning with broader sustainability goals. Ulmer et al. (2019) demonstrated how a hybrid offline-online approximate dynamic programming model could improve anticipatory capabilities, leading to more efficient real-time route adjustments. Similarly, Ghorbani et al. (2022) underscored the value of agile optimization methods in managing complex traffic dynamics and reducing logistical volatility. These findings collectively validate the growing consensus that intelligent routing strategies are essential for achieving both operational efficiency and environmental sustainability in urban freight systems.

However, these outcomes are not universally guaranteed and depend heavily on a variety of systemic factors. Among these, regulatory frameworks, digital infrastructure, and public policy stand out as primary enablers or constraints in the adoption of dynamic routing technologies. As highlighted by Cao (2020), supportive logistics policies and green technology incentives can significantly accelerate the transition toward more sustainable distribution systems. Cities that invest in digital infrastructure, particularly in real-time data acquisition and processing, are better positioned to benefit from the advanced capabilities of dynamic routing algorithms. Wang et al. (2022) emphasized that effective integration of GIS and IoT sensors is essential for enabling adaptive, context-aware routing decisions. Nevertheless, this level of integration necessitates a reliable data infrastructure and interoperable standards that are often lacking, particularly in developing regions. The resulting disparity between urban centers in high-income and low-income countries is a recurring challenge, as unequal access to technology and infrastructure limits the scalability of advanced routing systems.

A comparative analysis of the implementation of dynamic routing across global contexts reveals that infrastructural and policy readiness are key determinants of success. In technologically advanced cities such as Amsterdam and Singapore, dynamic routing systems have achieved significant operational and environmental gains due to their robust digital ecosystems and progressive public policies (Calvet et al., 2021). These cities benefit from well-developed data-sharing frameworks, high IoT sensor density, and a culture of public-private collaboration, which collectively create a fertile ground for innovation. Conversely, in many developing urban centers, while there is a growing interest in leveraging mobile technology and low-cost sensor networks, the absence of centralized data systems and standardized protocols often hinders full integration. This underscores the importance of context-sensitive policy-making that tailors smart logistics initiatives to local infrastructural and institutional capacities.

Technological adaptation also emerges as a critical dimension in overcoming barriers to dynamic routing implementation. The integration of AI-driven methods such as reinforcement learning and deep learning within heuristic frameworks has proven effective in enhancing system responsiveness to real-time changes in traffic and demand. For instance, Meng et al. (2022) explored hybrid optimization approaches that merge classical heuristics with machine learning to adapt to uncertain delivery environments. These approaches facilitate faster computation and more nuanced decision-making, especially in dense urban areas where route volatility is high. The use of deep reinforcement learning, as explored by Pan and Liu (2022) and Li et al. (2023), has enabled routing systems to evolve through continual learning, thereby improving performance over time. Such innovations suggest that technological solutions must not only be intelligent but also flexible and scalable, adapting to the heterogeneity of urban logistics landscapes.

In addition to technological development, systemic collaboration plays a pivotal role in shaping the future of dynamic routing in urban logistics. Studies by Wang et al. (2022) and Ghorbani et al. (2022) point to the importance of integrated governance and cross-sector partnerships in overcoming both technical and institutional barriers. Public-private partnerships can facilitate the harmonization of data standards, improve infrastructure investment, and foster innovation by leveraging the complementary strengths of each stakeholder group. Municipal governments, for instance, can provide regulatory support and funding for smart city projects, while private firms can contribute technological expertise and logistical infrastructure. Such collaborative ecosystems are essential for nurturing sustainable and efficient logistics networks, especially in cities that face budgetary and administrative constraints.

Despite these advancements, several limitations remain in the current body of research. One notable gap concerns the scalability of dynamic routing algorithms in highly variable urban environments. Most studies focus on controlled simulations or case studies with limited geographical and temporal scope. As a result, the performance of these algorithms in real-world settings with unpredictable disruptions, such as extreme weather events or large-scale public gatherings, remains underexplored. Additionally, while many studies emphasize the integration of GIS and IoT, few provide detailed accounts of data governance, privacy concerns, and the ethical implications of continuous data collection. Addressing these issues is critical to ensuring that dynamic routing systems are not only efficient but also socially responsible and publicly acceptable.

Another limitation lies in the heterogeneity of algorithmic models and evaluation metrics used across studies. The lack of standardized benchmarks complicates cross-comparison and hinders the establishment of best practices. For instance, while some studies prioritize route minimization or delivery time reduction, others emphasize energy efficiency or emission control, making it difficult to generalize findings. Future research should aim to develop unified performance indicators that capture the multidimensional impacts of dynamic routing, including economic, environmental, and social outcomes. Additionally, there is a need for longitudinal studies that assess the long-term effects of dynamic routing adoption, including its influence on urban mobility patterns, delivery workforce dynamics, and consumer behavior.

To address these limitations, future studies should adopt more holistic research designs that combine quantitative modeling with qualitative assessments of policy, infrastructure, and organizational readiness. Comparative case studies involving cities from diverse socioeconomic backgrounds can provide valuable insights into the contextual adaptability of dynamic routing systems. Furthermore, transdisciplinary collaboration among urban planners, data scientists, policy-makers, and industry practitioners is essential for developing integrated solutions that balance efficiency, equity, and sustainability. Ultimately, the successful implementation of dynamic routing in urban logistics depends not only on technological sophistication but also on the alignment of institutional capacities, stakeholder interests, and public values.

CONCLUSION

This study has provided valuable insights into the role of dynamic routing algorithms in enhancing operational efficiency and sustainability in urban logistics. The key findings confirm that adaptive routing methods significantly reduce delivery times, optimize fleet utilization, and lower carbon emissions, aligning with global sustainability goals. The integration of real-time data, artificial intelligence, and advanced optimization techniques has proven effective in addressing the complex challenges of urban logistics. However, the successful implementation of these technologies is heavily influenced by systemic factors such as supportive policies, reliable data infrastructure, and cross-sector collaboration. The disparity between high- and low-income cities in terms of infrastructure and regulatory frameworks highlights the need for context-specific approaches. To overcome these challenges, future research should focus on developing standardized performance metrics, enhancing data governance, and exploring scalable solutions for cities with limited resources. Policymakers should prioritize investments in real-time data infrastructure, standardize digital governance frameworks, and incentivize public-private partnerships to accelerate the adoption of dynamic routing technologies. For developing regions, gradual integration through modular IoT systems and capacity-building programs can bridge infrastructure gaps. Furthermore, a holistic approach that combines technological innovation with policy alignment and infrastructure development will be essential for the widespread adoption of dynamic routing solutions. This study underscores the urgency of addressing these issues to create more efficient, sustainable, and resilient urban logistics systems.

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