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Smart Last-mile Delivery Systems: Technological Advances, Operational Strategies, and Future Directions

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ABSTRACT

The rapid expansion of e-commerce and on-demand services has transformed last-mile delivery into one of the most critical, complex, and cost-intensive components of modern supply chains. Traditional delivery models are increasingly unable to cope with rising customer expectations, urban congestion, environmental pressures, and operational inefficiencies. In response, smart last-mile delivery systems based on digital technologies, automation, and data-driven optimization have emerged as a promising solution. This study provides a comprehensive and systematic review of the literature on smart last-mile delivery by integrating technological advances, operational strategies, and sustainability perspectives. Using a structured systematic literature review and bibliometric analysis of Scopus-indexed publications from 2000 to 2026, this research examines the evolution, intellectual structure, and thematic trends of the field. The analysis reveals a sharp growth in scholarly output after 2017, reflecting the increasing strategic importance of last-mile logistics in global e-commerce and urban freight systems. Keyword co-occurrence, thematic clustering, and network analysis show that the field is primarily anchored in e-commerce, logistics, and supply chain management, with last-mile delivery emerging as the dominant operational challenge. Strong linkages are also observed with sustainability, artificial intelligence, digital transformation, and urban logistics, indicating a shift toward technology-enabled and environmentally responsible delivery solutions. The findings further highlight the growing role of artificial intelligence, the internet of things, autonomous vehicles, drones, smart lockers, and micro-fulfilment centers in improving routing efficiency, reducing delivery failures, lowering costs, and mitigating environmental impacts. At the same time, the review identifies significant research gaps, particularly in relation to developing economies, long-term sustainability impacts, regulatory frameworks, and socio-economic consequences of automation. By offering an integrated synthesis of technological, operational, and sustainability dimensions, this study contributes to a deeper understanding of smart last-mile delivery systems and provides a roadmap for future research and policy. The results support the development of more resilient, efficient, and sustainable last-mile logistics models in the digital economy.

Keywords: Smart Last-mile Delivery, Logistics Innovation, Digital Technologies, Urban Logistics, Bibliometric Analysis, Sustainable Transportation, E-commerce Logistics
JEL Classifications: L91, O33, R41, Q55

1. INTRODUCTION

The last-mile delivery segment denoting the final leg of the logistics chain from a distribution hub to the end consumer has emerged as one of the most complex, cost-intensive, and customer centric facets of modern supply chains (Silva et al., 2023). Traditionally, this segment has been beset with inefficiencies related to high operational costs, traffic congestion, unpredictable delivery times, and customer dissatisfaction. Indeed, last-mile delivery can account for over 40% of total supply chain costs, driven by multiple stops, urban traffic complexity, and labor-intensive processes (Shuaibu et al., 2025). This challenge has gained urgency in the digital age, propelled by the exponential growth of e-commerce and the rising expectations of consumers

for faster, cheaper, and more transparent delivery services. As retailers increasingly promise same-day or even one-hour delivery windows, logistics providers must adopt innovative, intelligent solutions to keep pace (Jazairy et al., 2025). These operational challenges not only inflate delivery expenses but also undermine service quality and customer satisfaction. Furthermore, failure rates in last-mile delivery due to missed delivery windows or incorrect addresses remain high, contributing to inefficiencies and additional costs (Burugu, 2019).

Historically, traditional route planning tools and heuristic scheduling approaches lacked adaptability to real-time disruptions, leading to suboptimal delivery performance. However, the advent of digital technologies particularly artificial intelligence (AI), the internet of things (IoT), robotics, and autonomous vehicles has introduced a paradigm shift. These technologies enable dynamic decision-making, route optimization based on real-time constraints, predictive delivery planning, and enhanced visibility across the logistics network (Sorooshian et al., 2022; Attenni, et al., 2023; Eskandaripour and Boldsaikhan; 2023). AI and machine learning are now core components of smart delivery platforms. These technologies analyze vast amounts of historical and real-time data to optimize delivery routes, forecast delivery time windows with higher precision, and predict potential delays before they occur. For instance, advanced AI systems dynamically adjust routes based on traffic conditions, weather data, and package load, resulting in tangible cost and fuel savings (Vaka, 2024; Adeoye et al., 2025). Autonomous surface vehicles and ground robots are increasingly deployed to address the cost and labor challenges of traditional courier models (Wang, 2025). Recent studies highlight the potential of autonomous delivery robots (ADRs) to deliver parcels in urban environments with minimal human intervention, contributing to reductions in operational costs and carbon emissions (Reyana and Kautish, 2024). Additionally, hybrid collaborative systems where vehicles serve as mobile bases for drones and robots have been proposed to enhance delivery efficiency and flexibility, especially for complex urban networks.

Despite the growing body of literature on last-mile delivery, existing studies often focus on isolated technological solutions or specific optimization problems, such as vehicle routing or drone deployment. There is a lack of comprehensive reviews that systematically synthesize technological advances with operational strategies while critically examining their sustainability implications and future research directions. Moreover, limited attention has been paid to governance, regulatory barriers, and socio-economic impacts associated with large-scale deployment of smart last-mile delivery systems. Against this backdrop, the present study provides a comprehensive review of smart last-mile delivery systems by integrating three key dimensions: technological advances, operational strategies, and future directions. The novelty of this paper lies in its holistic perspective, which bridges engineering-oriented optimization and automation research with logistics management, sustainability, and policy considerations. By consolidating insights from recent academic studies and industry practices, this paper aims to (i) Synthesize state-of-the-art technologies enabling smart last-mile delivery, (ii) Examine innovative operational strategies adopted in practice, (iii) Identify key challenges and research gaps, and (iv) Propose future research directions to support the development of resilient, sustainable, and intelligent last-mile delivery systems. The remainder of this paper is organized as follows. Section 2 reviews key technological advances underpinning smart last-mile delivery systems. Section 3 discusses operational strategies and emerging delivery models. Section 4 examines sustainability and energy considerations. Section 5 highlights challenges, research gaps, and policy issues. Section 6 outlines future research directions, followed by concluding remarks in Section 7.

2. REVIEW OF LITERATURE

Last-mile delivery (LMD) has attracted growing academic and industrial attention due to its critical role in supply chain efficiency, customer satisfaction, and sustainability. With the rapid expansion of e-commerce and on-demand services, traditional delivery models have proven insufficient to meet modern expectations of speed, flexibility, and cost-effectiveness. Consequently, researchers have increasingly focused on smart last-mile delivery systems, integrating advanced technologies, optimization strategies, and innovative operational frameworks.

2.1. Technological Advances in Smart Last-Mile Delivery

Recent literature highlights the transformative role of digital and intelligent technologies in addressing LMD inefficiencies. Artificial intelligence (AI) and machine learning (ML) have been widely adopted to enhance route optimization, demand forecasting, and real-time decision-making. Studies show that AI-driven predictive analytics significantly improve delivery accuracy by dynamically adjusting routes based on traffic, weather conditions, and customer availability (Li et al., 2023; Lu et al., 2025; Shuaibu et al., 2025). The internet of things (IoT) further complements AI by enabling real-time monitoring and visibility across logistics networks. IoT-enabled sensors, GPS devices, and smart tracking systems provide continuous data on vehicle location, parcel condition, and delivery status, reducing uncertainty and operational delays (Wang and Liu, 2024). Several studies confirm that IoT-integrated delivery systems enhance transparency and coordination among logistics stakeholders, leading to improved service quality and reduced operational costs (Ivankova et al., 2023). Another major technological advancement is the deployment of autonomous delivery systems, including drones (Unmanned Aerial Vehicles—UAVs) and autonomous ground robots. Drones have gained prominence due to their ability to bypass road congestion and deliver small parcels quickly, particularly in urban and remote areas. Eskandaripour and Boldsaikhan (2023) argue that drone-based delivery systems can significantly reduce delivery time and carbon emissions, although limitations related to battery life, payload capacity, and regulatory constraints persist. Ground-based delivery robots, on the other hand, are found to be effective for short-distance urban deliveries, offering cost savings and lower environmental impact (Ostermeier et al., 2022).

2.2. Optimization and Operational Strategies

Optimization remains a central theme in the LMD literature, with researchers extensively exploring routing and scheduling

problems. The vehicle routing problem (VRP) and its variants—such as VRP with time windows (VRPTW) and capacitated VRP (CVRP)—form the backbone of many LMD optimization models. Classical mathematical programming approaches, including mixed integer linear programming (MILP), provide optimal solutions but are often computationally expensive for large-scale, real-time applications (Kuo et al., 2022).

To overcome scalability issues, heuristic and metaheuristic methods—such as genetic algorithms (GA), ant colony optimization (ACO), and simulated annealing (SA)—have been widely adopted. These approaches offer near-optimal solutions with significantly lower computational costs, making them suitable for dynamic LMD environments (Stodola and Kutej, 2021). Recent studies also emphasize hybrid approaches that combine mathematical models with heuristics to balance solution quality and computational efficiency (Madani et al., 2023).

Operational strategies such as crowdsourced delivery (crowdshipping) and multimodal delivery systems have also gained attention. Crowdshipping leverages independent drivers or couriers to increase delivery flexibility and reduce costs, especially during peak demand periods (Buldeo Rai et al., 2022). Multimodal delivery frameworks integrate trucks, drones, robots, and public transport systems to enhance delivery coverage and efficiency. Wang et al. (2023) demonstrate that multimodal solutions significantly reduce congestion and emissions in dense urban environments.

2.3. Smart Lockers and Micro-Fulfilment Centers

Smart parcel lockers represent another important operational innovation in last-mile logistics. By allowing customers to collect parcels at their convenience, smart lockers reduce failed delivery attempts, improve delivery success rates, and lower operational costs. Studies conducted in urban contexts show that IoT-enabled smart lockers enhance customer satisfaction while reducing traffic congestion and emissions (Tang et al., 2021; Yuen et al., 2022).

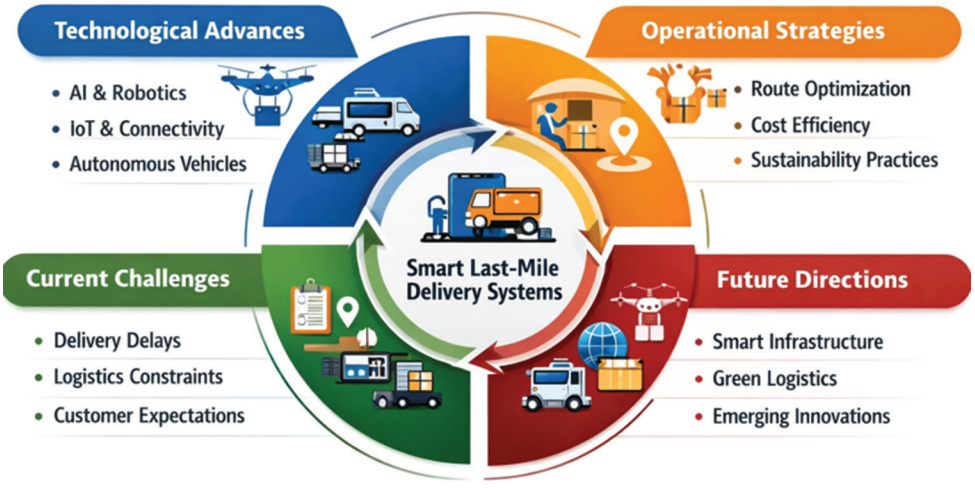
Similarly, micro-fulfilment centers (MFCs) located close to consumers are increasingly recognized as effective solutions for shortening delivery distances. Research indicates that MFCs enable faster delivery times and better inventory management, particularly for grocery and quick-commerce sectors (Leyerer et al., 2023; Shuaibu, & Onyinyechi, 2025). However, high setup costs and location optimization challenges remain key barriers to widespread adoption.

2.4. Sustainability Considerations in Last-Mile Delivery

Sustainability has emerged as a dominant theme in recent LMD research. The environmental impact of increasing urban deliveries has prompted scholars to explore low-carbon and energy-efficient delivery solutions. Electric vehicles (EVs), cargo bikes, drones, and robots are frequently cited as viable alternatives to conventional fuel-based vehicles (Andreas, 2024).

Life-cycle assessments reveal that hybrid delivery systems—combining electric trucks with drones or robots—offer significant reductions in greenhouse gas emissions compared to traditional delivery models (Lemardelé et al., 2022). Nevertheless, sustainability outcomes depend heavily on factors such as energy sources, infrastructure readiness, and regulatory support. Several studies argue that without supportive policy frameworks and investment in charging infrastructure, the environmental benefits of smart LMD systems may remain limited (He et al., 2024). Despite extensive research, notable gaps persist in the literature. First, most studies focus on individual technologies or optimization techniques, with limited integration of technological, operational, and governance perspectives. Second, empirical evidence from developing and emerging economies remains scarce, despite rapidly growing e-commerce markets in these regions. Third, the long-term socio-economic implications of automation—such as labor displacement and equity concerns are underexplored. Future research should adopt holistic and interdisciplinary frameworks that integrate AI, IoT, autonomous systems, and sustainable logistics strategies. Additionally, comparative studies across urban, peri-urban, and rural contexts can provide deeper insights into scalable and inclusive last-mile delivery solutions. Figure 1 revealed that the framework of the study.

Figure 1: Framework of the study



3. RESEARCH METHODOLOGY

This study adopts a systematic literature review (SLR) methodology to comprehensively analyze technological advances, operational strategies, and future directions in smart last-mile delivery (LMD) systems. A structured and transparent review protocol was followed to ensure rigor, reproducibility, and minimization of selection bias, in line with established review guidelines in logistics and transportation research.

3.1. Data Sources

Relevant academic literature was collected from leading scholarly databases, including Scopus, Web of Science, IEEE Xplore, ScienceDirect, and MDPI, which are widely recognized for high-quality publications in logistics, transportation, and intelligent systems. A keyword-based search strategy was employed using combinations of terms such as "*last-mile delivery*," "*smart logistics*," "*delivery optimization*," "*autonomous delivery*," "*drones*," "*AI-based routing*," and "*IoT in logistics.*" Boolean operators (AND/OR) were used to refine and expand the search scope.

3.2. Inclusion and Exclusion Criteria

The review focused on peer-reviewed journal articles and high-impact conference papers published primarily between 2015 and 2025, reflecting the rapid technological evolution in LMD systems. Studies were included if they addressed (i) Technological innovations (AI, IoT, drones, robotics), (ii) Operational and optimization strategies, or (iii) Sustainability and future challenges in last-mile delivery. Articles lacking methodological clarity, empirical relevance, or direct linkage to LMD optimization were excluded.

3.3. Screening and Classification

An initial screening was conducted based on titles and abstracts, followed by a full-text review of shortlisted articles. The selected studies were systematically categorized into thematic dimensions: optimization models, autonomous technologies, AI-driven decision-making, IoT-enabled systems, energy management, and smart locker solutions. This thematic synthesis enabled comparative analysis across methodologies and application contexts.

3.4. Analysis and Synthesis

Both qualitative synthesis and comparative assessment were employed to evaluate methodological approaches, performance outcomes, and practical limitations reported in the literature. The methodology facilitates identification of research gaps and supports the development of a future research agenda for scalable, intelligent, and sustainable last-mile delivery systems. Figure 2 revealed that the research methodology of the study.

4. RESULTS AND DISCUSSION

The analysis procedure will be developed from four major angles in this essay. To start, we will look at the primary features of publications in order to investigate the field of strategic entrepreneurship research. Secondly, we will conduct data analysis and visual illustrations to investigate the domain, countries, and affiliations involved in strategic entrepreneurship. Thirdly, we will identify the conceptual structure of keywords within the strategic entrepreneurship area. Finally, bibliometric analysis which includes keyword co-occurrence and coupling networks will be used to identify the field's development trends, future directions, and essential contents.

Figure 3 displays a range of bibliometric analysis for a collection of scholarly articles published between 2014 and 2024. The bibliometric analysis covers a 26-year period (2000-2026), reflecting the long-term evolution and maturity of the selected research domain. A total of 252 documents published across 135 sources (journals, conference proceedings, and publishers) were identified, indicating a broad and interdisciplinary knowledge base. The dispersion of publications across a large number of sources suggests that the field is not confined to a single discipline but spans multiple academic areas. The annual growth rate of 2.7% indicates a steady expansion of research output over time. This moderate

Figure 2: Research methodology of the study

Figure 3: Main information of scopus data

yet consistent increase reflects sustained scholarly interest and the growing relevance of the research theme in addressing contemporary academic and policy-oriented issues. A total of 667 authors contributed to this body of literature, highlighting a large and active research community. Among them, only 49 documents were written by single authors, implying that collaborative research dominates the field. This is further supported by the average of 2.88 co-authors per document, which indicates that most studies are conducted through teamwork rather than individual efforts. The international co-authorship rate of 21.03% reveals a significant level of cross-country collaboration, suggesting that the research topic is globally relevant and benefits from diverse institutional and geographical perspectives. The dataset includes 826 unique author keywords, reflecting a high degree of thematic diversity and indicating that the field encompasses multiple sub-topics, methodologies, and conceptual frameworks. Furthermore, the 2059 cited references demonstrate that the literature is grounded in a strong and extensive theoretical and empirical foundation. The average age of documents is 5.06 years, which implies that the knowledge base is relatively recent and dynamic, with a strong emphasis on contemporary developments. Finally, the average of 19.67 citations per document indicates a high academic impact, confirming that publications in this domain are widely recognized and frequently used by other scholars.

4.1. Size and Growth of Publication on the Field

Figure 4 illustrates the year-wise distribution of scientific publications in the selected research domain from 2000 to 2026, revealing the evolutionary trajectory of scholarly output over time.

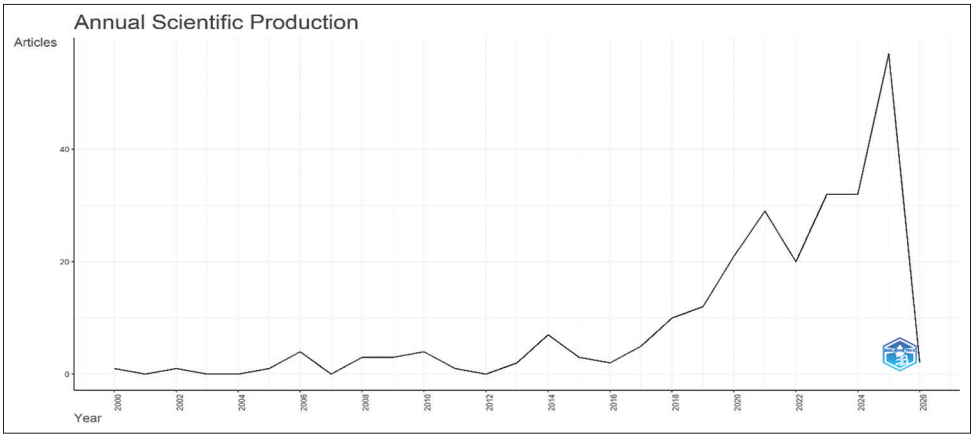
During the initial phase (2000-2007), the number of publications remains very low and irregular, indicating that the field was in a nascent stage. Only a few studies were published annually, suggesting limited academic attention and the absence of a well-established research community.

The period 2008-2014 shows a gradual but unstable increase in publications. Although some years (e.g., around 2010 and 2013-2014) record moderate growth, the overall trend remains inconsistent. This phase can be described as a formative period, where research interest started to develop, but the field had not yet reached mainstream academic recognition. A structural shift is clearly observed after 2016. From 2017 onwards, scientific production increases sharply, reflecting a rapid expansion of the research area. The number of articles rises steadily from 2018 to 2021, indicating that the topic gained substantial academic and policy relevance during this period. This growth coincides with increasing global concerns, technological advancements, and policy focus related to the domain. The period 2022-2025 represents the peak phase of research activity, with publication counts reaching their highest levels. The maximum output in 2025 suggests that the field has become highly mature, competitive, and globally visible. The sharp decline in 2026 should not be interpreted as a real decrease in research interest; rather, it is most likely due to partial-year data coverage, as 2026 is still ongoing and all publications for this year may not yet be indexed.

The Figure 5 illustrates the annual trend of average citations received by publications in the selected research domain. This indicator is widely used in bibliometric analysis to assess the scholarly influence, visibility, and intellectual impact of a research field over time. During the early period (2000-2005), citation levels remain low and highly volatile. A modest peak is observed in 2002, indicating that a few early studies attracted academic attention; however, the overall pattern suggests that the field was still in its emerging stage, with limited research output and weak knowledge diffusion.

In 2006, a noticeable rise in citations occurs, reaching nearly six citations on average. This increase implies the publication of one or more highly influential studies that temporarily raised the visibility of the field. However, this momentum was not sustained, as citation levels declined again between 2007 and 2010, reflecting either reduced research activity or lower-impact publications during this period. The most significant peak appears in 2011, when average citations rise sharply to approximately 12 citations/year. This indicates a major breakthrough or a highly influential publication that substantially shaped academic discourse in this research area. Such a spike reflects a period of intellectual consolidation and strong scholarly recognition. Following this peak, the years 2012-2015 show a sharp decline, with citations falling close to zero. This suggests a temporary research gap,

Figure 4: Year wise publication of last-mile delivery systems research in scopus database using R-studio



declining relevance, or lack of widely cited publications during this phase. From 2016 onward, citation activity begins to recover, reaching another major peak in 2019 with about 10 citations/year. This resurgence demonstrates renewed academic interest, likely driven by new theoretical developments, methodological advances, or policy relevance. Between 2020 and 2022, citation levels remain moderate, indicating sustained but stabilizing scholarly engagement. The decline observed after 2023 is largely due to citation lag, as recently published papers require time to accumulate citations.

4.2. Life-cycle and Cumulative Growth of Publications

The Figure 6 presents two complementary bibliometric perspectives of the research field: (i) The life-cycle of annual publications and (ii) The cumulative growth curve of publications over time. Together, these two plots explain how the field has evolved, expanded, and matured. The left panel illustrates the number of publications produced each year and fits a smooth life-cycle curve over the observed data points. The curve follows a bell-shaped pattern, which is typical of scientific fields that pass through stages of emergence, rapid growth, maturity, and stabilization. During the early years (2000-2008), publication activity remains very low, indicating that the research area was in its nascent or exploratory stage. Only a few studies were being produced, and the topic had not yet gained widespread academic attention. From around 2009 onward, publication output increases sharply, reflecting a rapid growth phase. This period represents rising interest, funding, and recognition of the field's relevance. The curve peaks around 2013-2014, which is marked by the dashed vertical line. This peak represents the maximum research productivity, meaning the field reached its most active phase in terms of scholarly output. After this peak, the curve gradually declines, indicating that the field has entered a mature or saturation stage, where fewer new studies are being produced because the core concepts, methods, and applications have already been well explored. The right panel shows the cumulative number of publications over time, following a classic S-shaped (logistic) growth curve. In the early phase (2000-2008), the cumulative curve grows slowly, reflecting limited research activity. Between 2009 and 2016, the curve becomes very steep, which indicates a period of rapid expansion when most of the publications were produced. This corresponds closely with the peak observed in the life-cycle plot. After around 2017, the curve begins to flatten, showing that the field is approaching maturity or saturation. Although new papers are still being published, the growth rate is much slower, meaning the field has become well-established.

4.3. Three-field Plot

The Figure 7 presents a three-field bibliometric plot (Sankey diagram) that integrates Cited References (CR), Authors (AU), and Keywords (KW_Merged) to visualize the intellectual structure of the research field related to last-mile delivery, e-commerce logistics, and sustainability. This analytical framework enables the identification of how foundational literature is linked to

Figure 5: Average citation per year in scopus database using R-studio

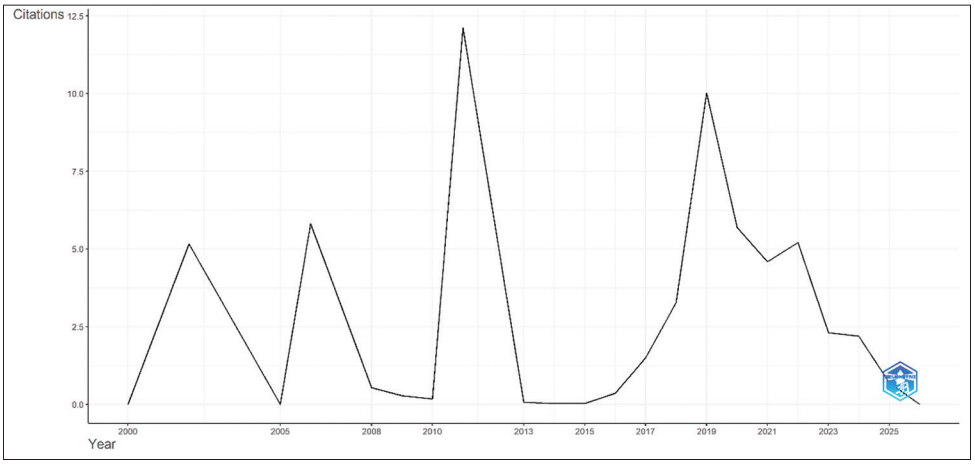
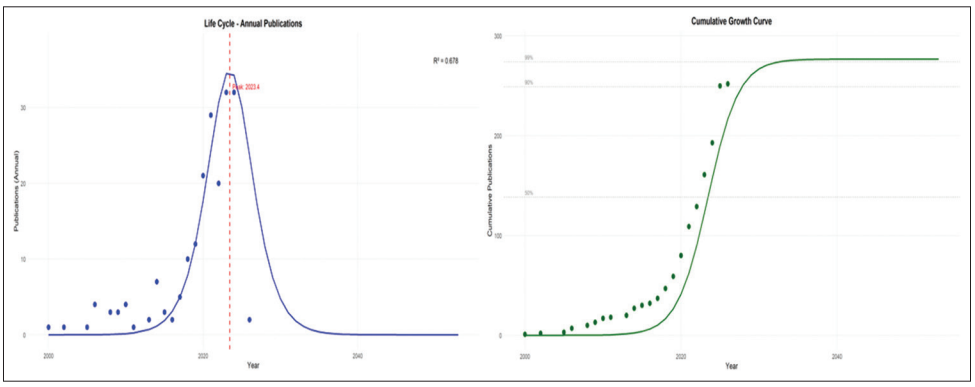


Figure 6: Life-cycle and cumulative growth of publications



influential scholars and how these, in turn, shape the dominant thematic directions of the field. The cited references (CR) on the left represent the most frequently referenced and influential publications that form the theoretical and conceptual foundation of the discipline. Key works include Ajzen's Theory of Planned Behavior, studies on crowd logistics by Carbone and Valentina, Boysen's contributions to last-mile delivery systems, and sustainability-oriented research by Bosona, Ranieri, and Brown. The prominence of these references indicates that the field is grounded in behavioral theory, logistics system design, and environmental performance, particularly in the context of urban and e-commerce logistics.

The middle column, Authors (AU), identifies the most productive and influential contributors, including Wang X., Gunasekaran A., Beckers J., Yuen K.F., Li M., Zhang Y., Cai, and Wong. The connections between CR and AU reveal that these authors have extensively built upon the foundational works in logistics, sustainability, and e-commerce, thereby advancing and modernizing the knowledge base of the field. This reflects a strong continuity between classical theories and contemporary empirical and technological research. The right column, Keywords (KW_Merged), highlights the major research themes, such as e-commerce, last-mile delivery, sustainable development, carbon emissions, supply chain management, urban logistics, artificial intelligence, and electric vehicles. The flows from AU to KW demonstrate how leading scholars are contributing to these core topics, indicating that the field is increasingly oriented toward sustainable, technology-enabled, and urban-focused logistics solutions.

4.4. Country Wise Publication and Citation

The Figure 8 illustrates the geographical distribution of scientific production in the selected research domain using a world map. The intensity of color represents the volume of scholarly publications contributed by each country, where darker shades indicate higher research output and lighter shades represent lower levels of scientific activity. The map clearly shows that China is the most dominant contributor, indicated by the darkest shading. This reflects China's leading role in producing research on the topic, likely driven by its rapid expansion of e-commerce, logistics infrastructure, urbanization, and digital technologies, which makes

Figure 7: Represents three field plot analyses of cited references (CR), author (AU), descriptors (DE) in strategic entrepreneurship field

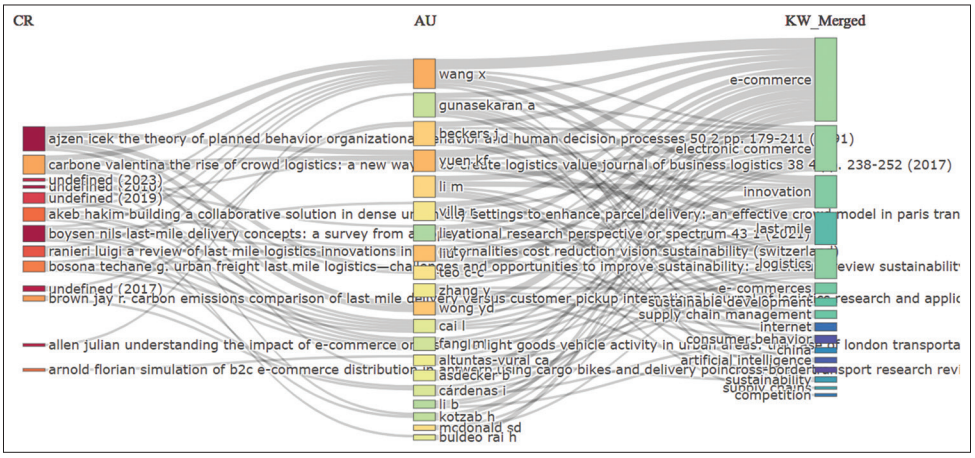
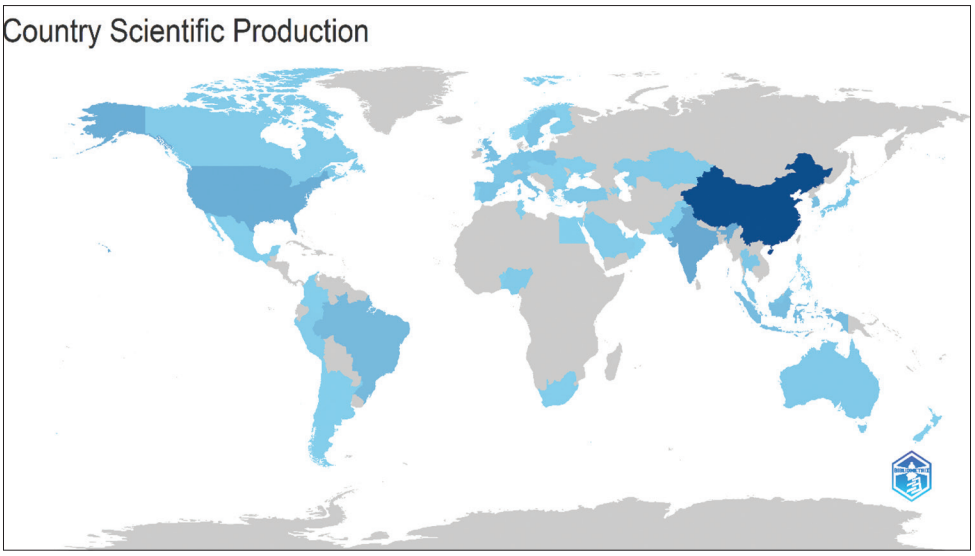


Figure 8: Countries wise collaboration studies last-mile delivery



the country a central hub for empirical and applied studies in this field. Other major contributors include the United States, India, the United Kingdom, Germany, and several European and East Asian countries, which are shown in moderately dark shades. These countries possess strong academic institutions, advanced logistics systems, and active research communities focused on supply chain management, last-mile delivery, sustainability, and digital commerce. Their significant publication output indicates that the research field has a global and multidisciplinary character. In contrast, large parts of Africa, Central Asia, and some regions of South America exhibit lighter shades or are not highlighted, suggesting relatively low scientific output. This does not necessarily imply a lack of relevance but may reflect limited research infrastructure, funding constraints, or lower publication visibility in international journals.

The Figure 9 displays the countries with the highest number of citations in the selected research domain, providing an indicator of their scientific influence and global visibility. Unlike publication counts, citation-based rankings reflect not only productivity but also the impact, relevance, and quality of a country's research output. The United States emerges as the most influential country, with approximately 830 citations, far exceeding all others. This highlights the central role of U.S.-based scholars and institutions in shaping theoretical, methodological, and applied research in this field. The dominance of the United States reflects its strong research infrastructure, high-quality journals, and leadership in areas such as e-commerce, logistics, and technological innovation. China ranks second with about 570 citations, confirming its rapidly growing influence in the global research landscape. This is consistent with China's strong performance in scientific production and its leading role in digital commerce, smart logistics, and urban delivery systems. Among European countries, Italy (410 citations), Spain (342), the United Kingdom (336), and Sweden (314) show strong citation performance. This indicates that European research in this domain is both active and highly visible, particularly in areas related to sustainable logistics, urban freight transport, and environmental performance. Singapore, South Korea, Belgium, and the Netherlands form a second tier with lower but still meaningful citation counts. Despite their smaller size, these countries contribute high-quality and specialized research, especially in supply chain optimization, smart cities, and green logistics.

4.5. Most Relevant Sources in the Domain

The Figure 10 presents the leading academic journals and publication outlets contributing to the selected research domain, ranked by the number of documents published. This indicator

Figure 9: Most cited countries in strategic last-mile delivery

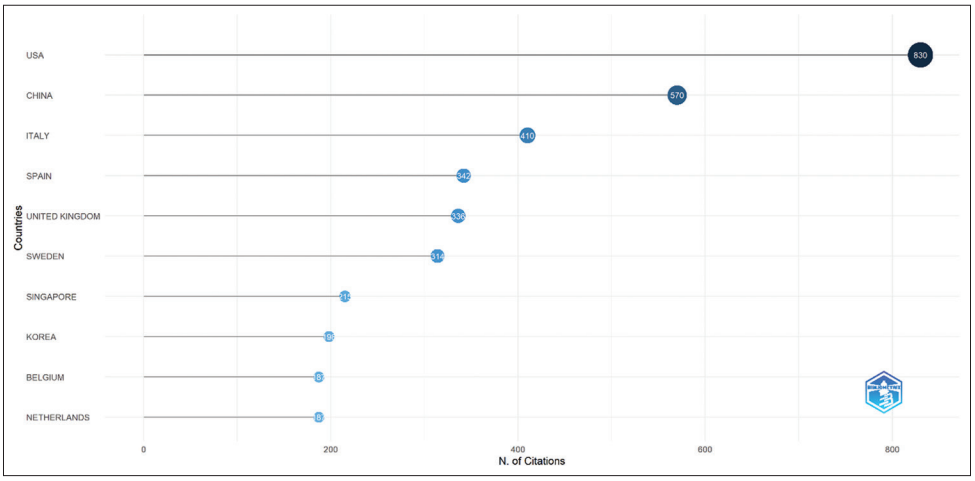
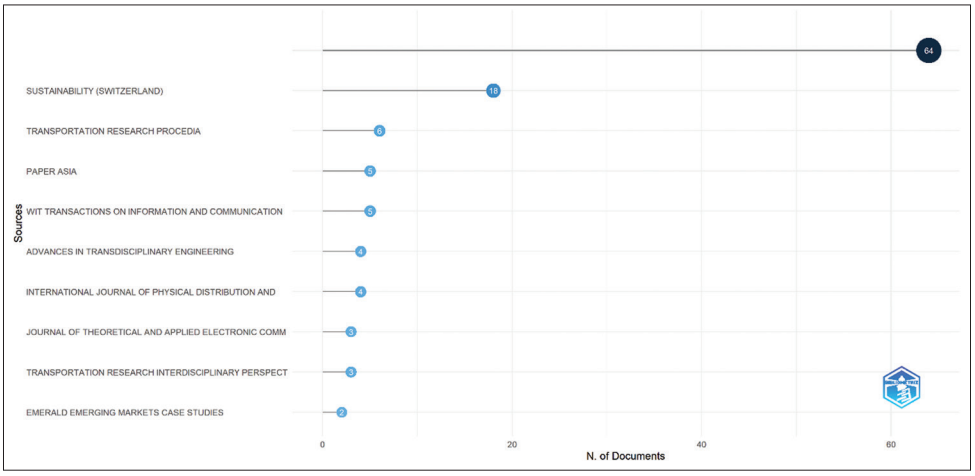


Figure 10: Most relevant sources related to last-mile delivery



reflects the core sources that shape scholarly communication and knowledge dissemination within the field. The journal *Sustainability* (*Switzerland*) is by far the most dominant outlet, with approximately 64 publications, indicating its central role in disseminating research related to sustainable logistics, e-commerce, last-mile delivery, and environmental impacts. Its strong performance reflects the increasing importance of sustainability-oriented perspectives in logistics and supply chain research. The second most relevant source shows a considerably lower output (around 18 documents), revealing a steep concentration of publications in the leading journal. This suggests that the field relies heavily on a few specialized outlets for scholarly communication. Other notable sources include *Transportation Research Procedia*, *Paper Asia*, *WIT Transactions on Information and Communication*, *Advances in Transdisciplinary Engineering*, and the *International Journal of Physical Distribution and Logistics Management*. Although these journals contribute fewer papers, they play an important role in supporting methodological, technological, and operational research in transportation, logistics, and supply chain management. In addition, journals such as *Transportation Research Interdisciplinary Perspectives*, *Journal of Theoretical and Applied Electronic Commerce*, and *Emerald Emerging Markets Case Studies* indicate the interdisciplinary and applied nature of the field, combining perspectives from transport economics, digital commerce, sustainability, and emerging markets.

4.6. Most Relevant Affiliations and Authors in Last-Mile Delivery

The Figure 11 presents the leading academic institutions contributing to the selected research domain, measured by the number of published articles. This indicator highlights the institutional hubs of knowledge production in the field of e-commerce logistics, last-mile delivery, and sustainability. The Hong Kong Polytechnic University emerges as the most productive institution, with nine publications, indicating its strong leadership in research related to logistics, supply chain management, urban transport, and digital commerce. The university is internationally recognized for its specialization in transportation and logistics studies, which explains its dominant position. The University of Antwerp ranks second with five publications, reflecting Europe's significant contribution, particularly in transport economics, freight transport, and sustainability research. Similarly, Chung-Ang University and the School of Civil and Environmental Engineering (likely part of a major technical university) each contribute four publications, showing the strong role of engineering-based and systems-oriented research in this field. A group of institutions—including Hebei Normal University, Obafemi Awolowo University, RMIT University Vietnam, Universidad Camilo José Cela, Universidad Politécnica de Madrid, and Universidade Federal de Pernambuco—each contributed three publications. These universities represent Asia, Africa, Europe, and Latin America, demonstrating the global and geographically diverse nature of research activity in this domain.

The Figure 12 identifies the most productive and influential authors in the selected research domain, based on the number of documents published. This metric reflects each author's scholarly engagement and leadership in advancing research on e-commerce, last-mile delivery, logistics, and sustainability. Wang X. emerges as the most prolific author with eight publications, indicating a dominant role in shaping the intellectual development of the field. Wang's consistent output suggests sustained research activity and strong expertise in key themes such as urban logistics, digital commerce, and last-mile delivery systems. The second most productive author is Yuen K.F., with five publications, highlighting a significant contribution to areas such as logistics performance, consumer behavior, and sustainability in e-commerce logistics. This positions Yuen as a major contributor to both the theoretical and applied dimensions of the field. Liu Y. and Wong Y.D., each with four publications, also represent important scholarly voices. Their contributions further strengthen the field's focus on transport systems, logistics optimization, and environmental considerations. A group of authors—Beckers J., Li M., McDonald S.D., Teo C.-C., Villa R., and Zhang Y.—each with three publications, form a strong second tier of contributors. Although their output is slightly lower, their work adds important depth, particularly in sustainable transport, supply chain management, and urban freight systems.

4.7. Factorial Analysis of Last-Mile Delivery Research

The Figure 13 presents a hierarchical clustering dendrogram, which is a bibliometric technique used to identify the intellectual

Figure 11: The most relevant affiliation with number of articles in last-mile delivery

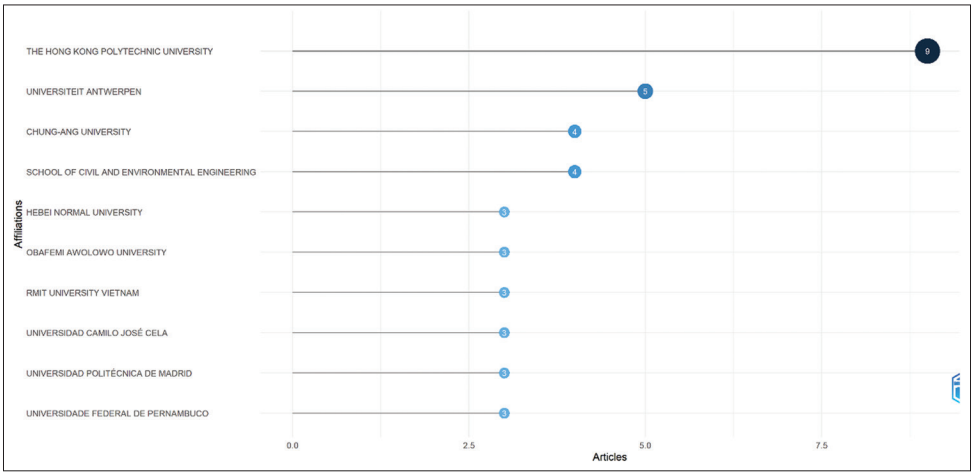


Figure 12: The most relevant author with number of articles in last-mile delivery

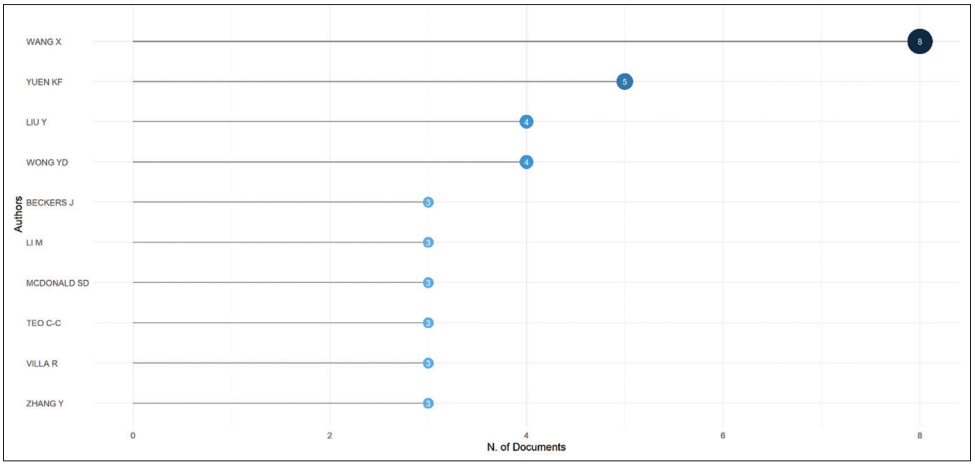
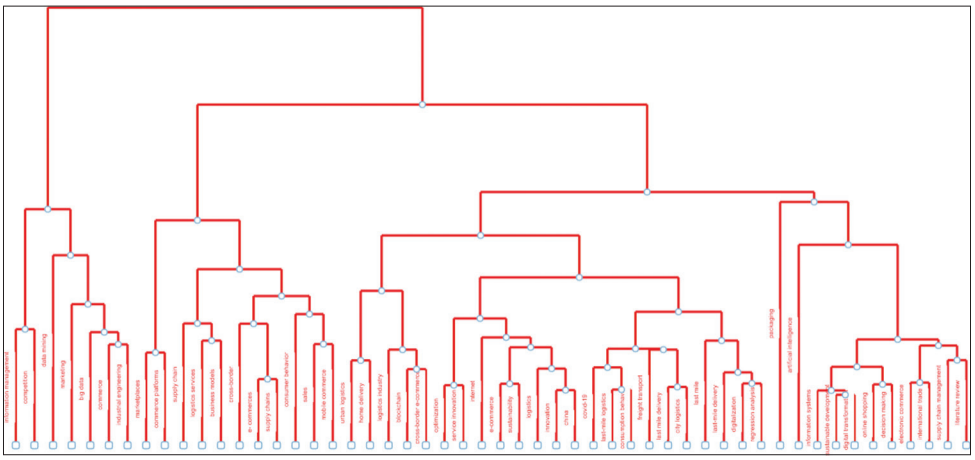


Figure 13: The factorial analysis of last-mile delivery research in a dendrogram diagram



structure and thematic groupings within a research field. Each label at the bottom represents a keyword, document, or term (depending on the analysis), while the vertical axis indicates the degree of dissimilarity between them. Items that merge at lower heights are more closely related, whereas those joining at higher levels are more conceptually distant. The dendrogram shows that the research field is organized into several distinct clusters, indicating the presence of multiple sub-themes within the broader domain of e-commerce, last-mile delivery, and sustainable logistics. The long vertical branches near the top suggest that these clusters are relatively well separated, implying a high level of thematic diversity. Within each main branch, closely spaced items merge at very low heights, which means that these terms or studies are highly similar and frequently co-occur in the literature. These tight groupings reflect specialized research streams, such as urban logistics, sustainable transportation, digital platforms, delivery optimization, and environmental performance. At higher levels of the dendrogram, these specialized clusters merge into broader groups, illustrating how different research topics are interconnected. For example, clusters related to e-commerce logistics may merge with those focused on sustainability and carbon emissions, highlighting the increasing integration of environmental concerns into digital supply chain research.

4.8. Trending Topics Related to the Keywords

The Figure 14 presents a trend-topic analysis of the research field, showing how key terms have evolved over time in terms of their frequency and thematic relevance. Each horizontal line represents a keyword, while the position of the circle along the time axis indicates the period when that topic became prominent. The size of the circle reflects the term frequency, meaning larger circles correspond to greater scholarly attention. In the early phase (2006-2012), the dominant topics are "industrial engineering," "regression analysis," and "commerce." This indicates that the field initially developed from a methodological and engineering-oriented perspective, focusing on quantitative modeling and basic commercial systems. Between 2013 and 2017, themes such as "international trade," "big data," "mobile commerce," "internet," and "competition" gained prominence. This period reflects a transition toward digitalization and data-driven approaches, as well as the growing role of online platforms in commercial activities. From 2018 onward, the field experiences a major thematic shift. Core topics such as "e-commerce," "logistics," "supply chain management," "innovation," and "electronic commerce" become highly prominent, indicating a strong consolidation around digital supply chains and last-mile delivery systems. In the most recent period (2020-2024), emerging and high-impact themes include "COVID-19," "China," "cross-border," "sustainable development," "artificial intelligence," "consumer behavior," and "marketplaces." This demonstrates that

Figure 14: The trending topics of last-mile delivery studied

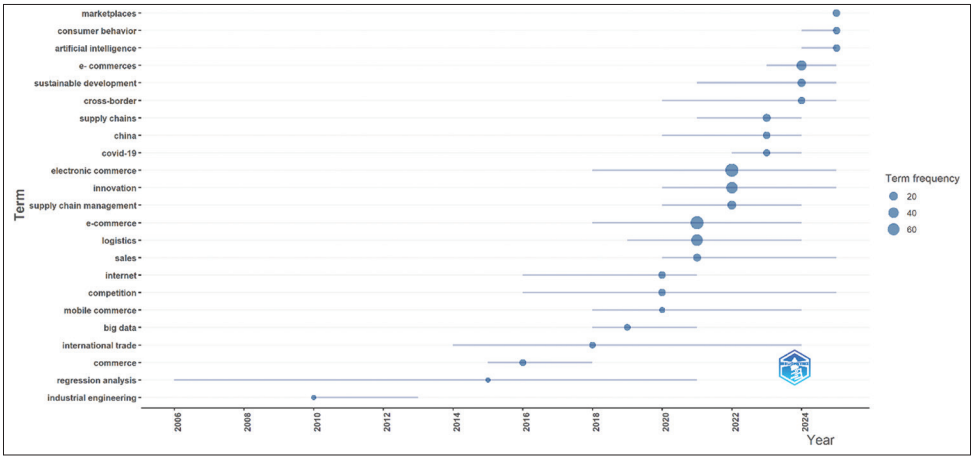


Figure 15: Tree map plot of last-mile delivery research

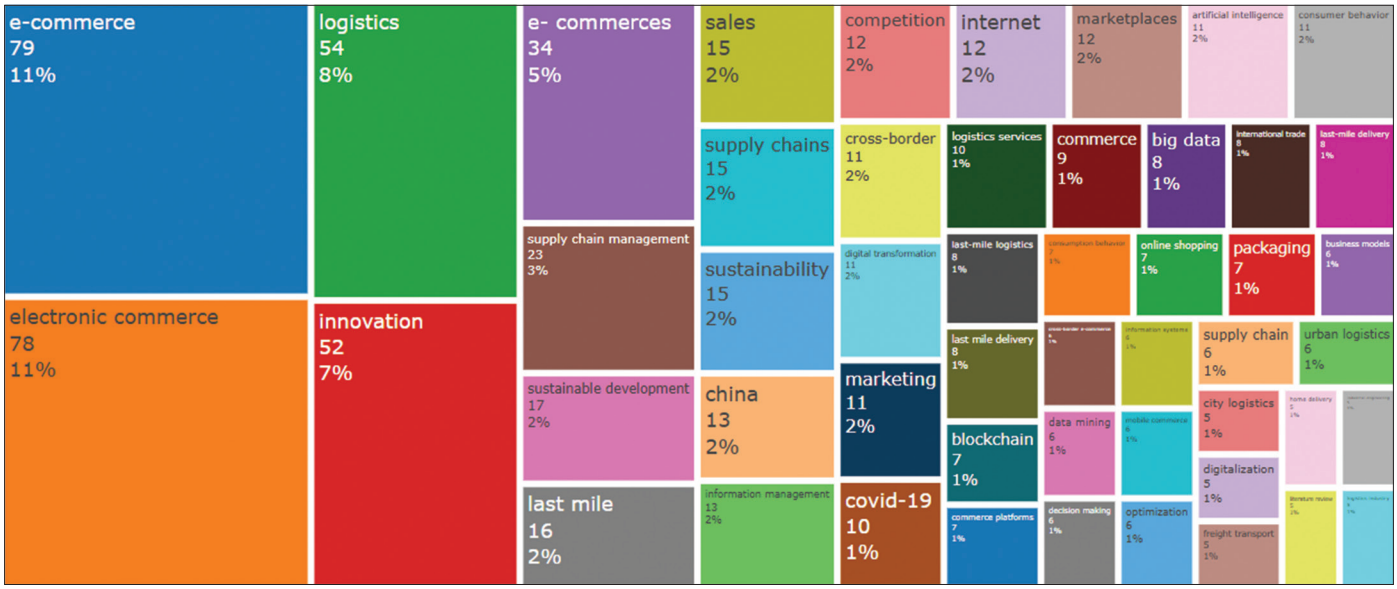
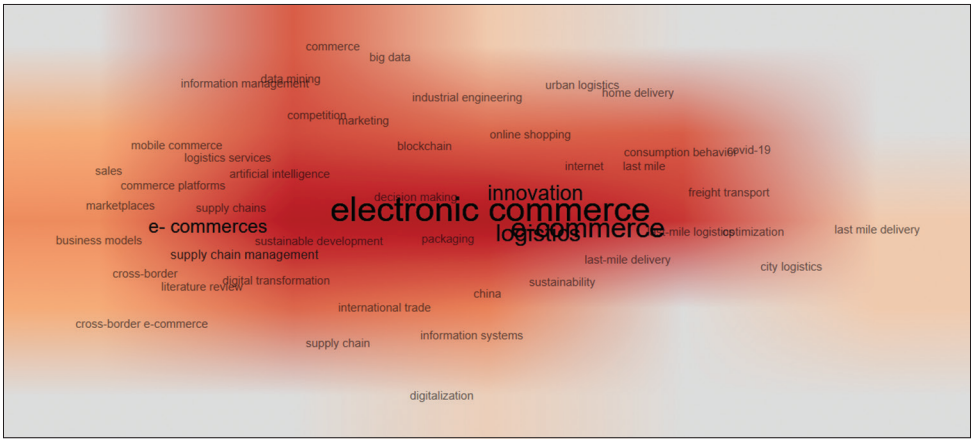


Figure 16: The word cloud of last-mile delivery research

the field has become more policy-relevant, global, and sustainability-oriented, with strong emphasis on technological innovation and behavioral aspects of e-commerce logistics.

Figure 15, the visualization reveals two primary macro-clusters that together account for approximately 22% of the thematic emphasis: E-commerce/Electronic Commerce cluster (predominantly blue and orange rectangles, 11% each). This constitutes the foundational domain, appearing in two near-equivalent large blocks ("e-commerce" at 79 occurrences/11% and "electronic commerce" at 78/11%). These terms function as umbrella concepts encompassing the entire field. Subordinate

Figure 17: Keyword co-occurrence network



themes branch hierarchically from this core. Logistics cluster (predominantly green rectangles) Positioned as the most salient applied subdomain (~8% for "logistics" at 54 occurrences), this cluster captures operational and infrastructural dimensions of e-commerce fulfillment. Smaller, subsidiary clusters radiate outward, reflecting more specialized or emerging concerns (each typically 1-3%). Core domain: E-commerce/Electronic commerce (~22% combined) Serves as the parent node from which most other topics descend. Logistics and Supply Chain Management (~8-10% at the mid-level) "logistics" (54) → branches into "supply chains" (15), "supply chain management" (23), "last mile"/"last-mile logistics"/"last mile delivery" (~8-16 combined across variants). This hierarchy underscores that logistics—particularly its final segment—represents one of the most intensively researched operational challenges in e-commerce scholarship. Last-Mile Delivery and Urban Logistics (cumulatively ~5-8%) Variants such as "last mile" (16), "last mile delivery" (13-16 estimated), "last-mile logistics," "last mile," and related terms ("urban logistics," "city logistics") form a clearly visible sub-cluster. The repeated emphasis on last-mile phenomena signals that this stage—characterized by high cost density, fragmentation, low asset utilization, and negative externalities (congestion, emissions)—is widely regarded as the critical bottleneck in contemporary e-retail supply chains. Sustainability and Environmental Dimensions (~2-4% visible) "sustainability" (15), "sustainable development" (17). Frequently co-located with last-mile and logistics concepts, reflecting the growing normative and regulatory pressure to mitigate the environmental footprint of rising parcel volumes (urban freight emissions, energy consumption, packaging waste). Innovation and Technological Transformation (~7%) "innovation" (52) as a large secondary node. Sub-themes include "digital transformation," "blockchain," "big data," "artificial intelligence," "data mining," "optimization". These indicate scholarly interest in technology-enabled solutions (route optimization, predictive analytics, autonomous vehicles, drones, parcel lockers, crowdsourcing) aimed at addressing efficiency and sustainability deficits. Market and Competitive Dynamics (smaller slices, 1-2% each) "competition," "marketplaces," "sales," "marketing," "consumer behavior," "online shopping," "business models." These reflect demand-side and strategic-management perspectives. Geopolitical and Contextual Factors Notable presence of "China" (13) and "cross-border," "international trade." This mirrors the outsized role of Chinese platforms, manufacturers, and research output in global e-commerce logistics scholarship. Pandemic and Disruption Effects "COVID-19" (10). Highlights how the 2020-2022 period accelerated structural shifts toward e-commerce penetration and exposed last-mile vulnerabilities.

Figure 16 reported that the word cloud employs typographic scaling (font size ∝ term frequency) and randomized spatial arrangement to highlight lexical prominence. Central, largest terms—"electronic commerce," "e-commerce," "logistics," "supply chain management," "last mile," "last-mile delivery"—replicate the treemap's macro-structure while accentuating mid-tier salience of sustainability ("sustainability," "sustainable development"), innovation ("innovation," "digital transformation"), and contextual markers ("China," "cross-border," "COVID-19").

Color coding in the cloud appears ornamental rather than analytical, though semantic proximity is discernible (e.g., logistics-related terms in blue tones, sustainability in green). The retention of morphological variants ("e-commerces," "last mile," "last-mile logistics") is typical of minimally preprocessed bibliometric outputs and signals the field's terminological heterogeneity.

Figure 17, revealed that this particular network maps the intellectual structure of scholarly literature on e-commerce (electronic commerce), with a pronounced focus on its logistics and supply-chain ramifications. The dominant central terms form a tightly interconnected core that defines the field's primary research identity: "electronic commerce"/"e-commerce"/"e-commerces" (largest nodes) function as the overarching domain labels, anchoring the entire map. "logistics," "supply chain management," "supply chains," "supply chain" constitute the strongest secondary cluster, indicating that operational and physical-distribution aspects dominate over purely digital or marketing-oriented inquiries. Variants "last mile," "last-mile delivery," "last mile delivery," "last-mile," "lastmile logistics" appear prominently and centrally linked, confirming last-mile delivery as the field's most salient operational challenge and research frontier. Surrounding this core, several thematic lobes or sub-clusters emerge: "sustainability," "sustainable development," "packaging" cluster together, frequently co-occurring with urban/city logistics and last-mile terms. This reflects the normative

shift toward addressing negative externalities (urban congestion, emissions, energy intensity, packaging waste) generated by surging parcel volumes. "innovation," "digital transformation," "digitalization," "artificial intelligence," "blockchain," "big data," "data mining," "optimization," "industrial engineering" form a visible lobe. These concepts represent proposed techno-solutionist pathways (algorithmic routing, predictive analytics, autonomous systems, IoT-enabled tracking) to mitigate last-mile inefficiencies and sustainability deficits. "urban logistics," "city logistics," "freight transport," "home delivery" highlight the urban context, where density, congestion, and regulatory constraints amplify last-mile complexity. "cross-border," "cross-border e-commerce," "international trade," "china," "marketplaces," "competition," "marketing," "consumer behavior," "online shopping" indicate geopolitical, competitive, and demand-side perspectives, with notable emphasis on China's outsized role in global e-retail volumes and scholarship. "COVID-19" (appearing as "COVID-19") captures pandemic-induced acceleration of e-commerce penetration and resultant last-mile pressures. "literature review" sits at the edge, signaling that a portion of the corpus comprises review articles synthesizing the field.

5. FINDINGS AND DISCUSSION

The bibliometric analysis reveals a clear evolutionary pattern in research on last-mile delivery (LMD), e-commerce logistics, and sustainability. The life-cycle and cumulative growth curves demonstrate that the field initially emerged slowly during the early 2000s, followed by rapid expansion after 2009, and reached a phase of maturity after 2017. This pattern reflects the transformation of LMD from a peripheral logistics issue into a central component of digital commerce and urban supply chains. The strong growth after 2015 coincides with the explosive rise of e-commerce platforms, same-day delivery models, and urban logistics challenges, which significantly increased academic and policy interest in this domain. Citation trends further support this developmental trajectory. The major citation peaks around 2011 and 2019 indicate two waves of intellectual consolidation. The first wave corresponds to foundational work on logistics systems and e-commerce integration, while the second reflects the growing influence of sustainability, digitalization, and technology-enabled delivery systems. The recent decline in citations is largely due to citation lag, suggesting that the field remains highly active and influential. The three-field plot provides important insights into the intellectual structure of the field. Foundational works such as Ajzen's Theory of Planned Behavior, along with classical logistics and sustainability studies, form the theoretical backbone of LMD research. Their strong linkage with contemporary authors such as Wang, Yuen, and Gunasekaran shows that modern research builds on established behavioral, operational, and environmental frameworks while extending them through digital and technological perspectives. This indicates that last-mile delivery is no longer treated as a purely technical routing problem but as a socio-technical system influenced by consumer behavior, sustainability imperatives, and platform-based commerce.

Thematic mapping further confirms that e-commerce and logistics constitute the core of the research domain. The dominance of keywords such as "e-commerce," "electronic commerce," "logistics," and "supply chain management" demonstrates that LMD is fundamentally studied as the operational backbone of digital retail. Within this core, "last-mile delivery" and "urban logistics" emerge as the most critical bottlenecks, reflecting the high cost, congestion, emissions, and service failures associated with final-stage distribution. This aligns with the growing recognition that last-mile operations are the least efficient and most environmentally damaging segment of modern supply chains. Sustainability has become a deeply embedded research priority. The strong co-occurrence of terms such as "sustainability," "sustainable development," and "carbon emissions" with last-mile and logistics keywords indicates a normative shift toward environmentally responsible delivery systems. This reflects increasing regulatory pressure, climate commitments, and public concern over urban freight pollution and energy consumption. At the same time, the prominence of "innovation," "artificial intelligence," "big data," "optimization," and "digital transformation" highlights the reliance on technological solutions to address efficiency and sustainability challenges. These tools are increasingly viewed as essential for real-time routing, predictive delivery, autonomous vehicles, and low-carbon logistics. Geographically, China dominates publication output, reflecting its massive e-commerce ecosystem and advanced logistics infrastructure, while the United States leads in citations, indicating greater theoretical influence and global visibility. European countries, particularly Italy, Spain, the UK, and Sweden, also show strong citation performance, especially in sustainability-oriented research. In contrast, many developing regions remain under-represented, highlighting a significant empirical gap despite rapid growth in e-commerce demand.

6. CONCLUSION, LIMITATIONS AND FUTURE DIRECTIONS

This study provides a comprehensive and systematic synthesis of the evolving field of smart last-mile delivery (LMD) by integrating technological innovation, operational strategies, and sustainability considerations within a bibliometric and literature-based framework. The findings reveal that last-mile delivery has become one of the most intensively researched components of modern e-commerce and supply chain systems, driven by rapid digitalization, urbanization, and growing consumer expectations for fast, reliable, and environmentally responsible delivery services. The bibliometric evidence demonstrates a sharp rise in research activity after 2017, with peak productivity observed in recent years, reflecting the strategic importance of LMD in global logistics and urban mobility systems. The thematic structure of the literature shows that the field is strongly anchored in e-commerce and logistics, with last-mile delivery emerging as the most critical operational bottleneck. High research concentration on topics such as urban logistics, sustainability, artificial intelligence, and supply chain management indicates that scholars increasingly view LMD as a complex socio-technical system rather than a purely operational problem. The growing integration of sustainability-related keywords confirms a shift toward low-carbon, energy-efficient, and environmentally responsible delivery solutions, particularly in the context of rising parcel volumes and climate

policy pressures. Moreover, the strong presence of innovation-oriented themes—such as AI, digital transformation, optimization, and automation—suggests that technological solutions are being actively pursued to address inefficiencies, congestion, and service failures in last-mile logistics.

Despite these contributions, this study has several limitations. First, the bibliometric analysis is based primarily on Scopus-indexed publications, which may exclude relevant studies published in regional journals, practitioner outlets, or non-English sources. This could lead to an underrepresentation of research from developing economies, where last-mile challenges are often more severe. Second, bibliometric methods capture patterns of publication, citation, and keyword co-occurrence, but they do not directly assess the real-world effectiveness or economic feasibility of smart LMD technologies. Third, the reliance on keyword-based classification may oversimplify complex interdisciplinary relationships, particularly in areas where logistics, sustainability, and digital platforms overlap. Finally, although the study identifies thematic trends and intellectual structures, it does not provide micro-level empirical evidence on firm-level performance, consumer acceptance, or regulatory outcomes.

Future research should therefore move beyond conceptual and bibliometric mapping toward more empirical, comparative, and policy-oriented investigations. First, greater attention should be given to developing and emerging economies, where rapid growth in e-commerce coexists with weak infrastructure, informal labor markets, and regulatory gaps. Comparative studies across urban, peri-urban, and rural settings would help to identify scalable and inclusive delivery models. Second, future work should evaluate the long-term economic and environmental performance of autonomous vehicles, drones, parcel lockers, and micro-fulfilment centers using real operational data and life-cycle assessments. Third, socio-economic dimensions—such as labor displacement, platform governance, data privacy, and equity in access to delivery services—require deeper interdisciplinary investigation. Finally, policy-focused research is needed to examine how regulations, urban planning, and public investment can support the transition toward sustainable and intelligent last-mile delivery ecosystems.

REFERENCES

Adeoye, M.A. (2025), Trends and patterns in primary education research: A bibliometric review of instructional and teacher education studies. Profesi Pendidikan Dasar, 12, 288-303.

Andreas, K. (2024), Sustainability and new technologies: Last-mile delivery in the context of smart cities. Sustainability, 16(18), 8037.

Attenni, G., Moawad, Y., Bartolini, N., Thamsen, L. (2025), Spatio-Temporal Shifting to Reduce Carbon, Water, and Land-Use Footprints of Cloud Workloads; [arXiv Preprint].

Buldeo Rai, H. (2024), A place for logistics-perspectives from the placemaking literature. Journal of Urbanism International Research on Placemaking and Urban Sustainability, 17(3), 1-12.

Burugu, R.W. (2020), Hotel managers' perceptions and responses as counter measures for seasonality in Kenya's tourism industry. African Journal of Education Science and Technology (AJEST), 6(1), 244.

Eskandaripour, H., Boldsaikhan, E. (2023), Last-mile drone delivery: Past, present, and future. Drones, 7(2), 77.

He, C., Singh, P., P'yavka, S., Wolfe, L., Caldwell, K., Islam, T.M., Mustafa, A. (2024), Balancing trade-offs: The energy efficiency of unmanned aircraft systems integration in last-mile delivery and operational policy restrictions. In: AIAA Aviation Forum and Ascend. United States: Aerospace Research Central. p3646.

Ivankova, N.V., Rogers, L. Q., Martin, M. Y., Pisu, M., Pekmezi, D., Thompson, L., Fontaine, K., Schoenberger-Godwin, Y., Hall, A., Herbey, I.I., Anderson, J., Oster, R., Kenzik, K., Demark-Wahnefried, W. (2024), Using mixed methods research to optimize healthy lifestyle intervention adaptation for web-based delivery: A pragmatic approach. Journal of Mixed Methods Research, 18(3), 247-257.

Jazairy, A., Pohjosenperä, T., Prataviera, L.B., Juntunen, J. (2025), Innovators and transformers: Revisiting the gap between academia and practice: Insights from the green logistics phenomenon. International Journal of Physical Distribution and Logistics Management, 55(4), 341-360.

Kuo, C.L., Duan, Y., Grady, J. (2018), Unconditional or conditional logistic regression model for age-matched case-control data? Frontiers in Public Health, 6, 57.

Lemardelé, C., Estrada, M., Pagès, L. (2025), Uncertainty analysis of autonomous delivery robot operations for last-mile logistics in European cities. Journal of Intelligent Transportation Systems, 29(4), 469-490.

Leyerer, M., Sonneberg, M.O., Heumann, M., Breitner, M.H. (2020), Shortening the last mile in Urban areas: Optimizing a smart logistics concept for e-grocery operations. Smart Cities, 3(3), 585-603.

Li, L., Gong, Y., Wang, Z., Liu, S. (2023), Big data and big disaster: A mechanism of supply chain risk management in global logistics industry. International Journal of Operations Production Management, 43(2), 274-307.

Lu, J., Chuah, S.C., Xia, D.M., Gary, J. (2025), The development of the modern logistics industry and its role in promoting regional economic growth in China's underdeveloped northwest, driven by the digital economy. Economies, 13(9), 261.

Madani, Z., Goodarzian, F., Navaei, A., Ali, I. (2024), Optimization modelling for a sustainable closed-loop supply chain network using IoT: Multiobjective metaheuristic algorithms. Central European Journal of Operations Research, 34, 63-93.

Ostermeier, M., Heimfarth, A., Hübner, A. (2022), Cost-optimal truck-and-robot routing for last-mile delivery. Networks, 79(3), 364-389.

Reyana, A., Kautish, S. (2024), Machine learning techniques for route optimizations and logistics management description. In: Computational Intelligence Techniques for Sustainable Supply Chain Management. United States: Academic Press. p197-224.

Shuaibu, A.S., Mahmoud, A.S., Sheltami, T.R. (2025), A review of last-mile delivery optimization: Strategies, technologies, drone integration, and future trends. Drones, 9(3), 158.

Shuaibu, H., Onyinyechi, O.R. (2025), Evaluating the role of environmental sustainability in enhancing agricultural productivity in Nigeria. Review of Sustainability Energy Systems and Economic Development, 1(1), 30-46.

Silva, M.E., Pereira, M.M., Hendry, L.C. (2023), Embracing change in tandem: Resilience and sustainability together transforming supply chains. International Journal of Operations and Production Management, 43(1), 166-196.

Sorooshian, S. (2025), Exploration of socio-environmental solutions in the mining industry in comparison to other industries: A data-driven unveiling perceptions. Resources Policy, 104, 105594.

Stodola, P., Vojtek, J., Kutěj, L., Neubauer, J. (2021), Modelling militarized interstate disputes using data mining techniques: Prevention and prediction of conflicts. The Journal of Defense Modeling and Simulation, 18(4), 469-483.

Tang, S. (2024), Optimizing the Last-mile Parcel Delivery Problem with Crowd-shipping Under Demand and Supply Uncertainties: A Two-stage Stochastic Approach. [Doctoral Dissertation, Hong Kong University of Science and Technology].

Vaka, U., Ramkumar, M.C. (2024), Application of non-thermal plasma technology for enhancing food processing and storage: A review. Food Chemistry Advances, 5, 100788.

Wang, L., Liu, G. (2024), Research on multi-robot collaborative operation in logistics and warehousing using A3C optimized YOLOv5-PPO model. Frontiers in Neurorobotics, 17, 1329589.

Wang, S., Liu, X., Liu, Y. (2025), Spatiotemporal evolution characteristics of green logistics level: Evidence from 51 countries. Sustainability, 17(14), 6418.

Wang, Y., Derakhshan, A., Ghiasvand, F. (2025), EFL teachers' generative artificial intelligence (GenAI) literacy: A scale development and validation study. System, 133, 103791.

Yuen, K.F., Cai, L., Lim, Y.G., Wang, X. (2022), Consumer acceptance of autonomous delivery robots for last-mile delivery: Technological and health perspectives. Frontiers in Psychology, 13, 953370.