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Last Mile Delivery: Research Trends Using Bibliometric Analysis

Heddry Purba ✉ **Francis Hutabarat** [2]

✉, [2] *Universitas Advent Indonesia, Bandung, Indonesia*

Abstract

This study aims to explore and analyze research trends in the field of Last Mile Delivery (LMD) by systematically mapping the direction of scientific studies over the past twelve years. This study also aims to identify future research agendas in the field of LMD based on topic trends and geographical distribution. A bibliometric approach was used to review academic literature sourced from Google Scholar and Scopus during the period 2013–2024. The analysis techniques employed included citation analysis, co-citation analysis, and keyword co-occurrence using VOSviewer software. This study analyzed publication data by time and geographical region, and examined the interrelationships among authors, institutions, and countries. The results show fluctuations in the number of publications each year, with a peak in 2019. A total of 186 documents were found, involving 494 authors from 9 countries, with the United Kingdom and the United States being the most prominent. In the last four years, publication trends have shown a significant decline. Theme cluster visualization reveals a diverse range of topics, including sustainability, technological innovation, consumer behavior, and urban distribution systems. This study provides theoretical contributions to understanding the scientific landscape of LMD and serves as a practical reference for policymakers and logistics practitioners in developing more adaptive and efficient final-mile delivery strategies. Further research is proposed to expand the scope of local and theoretical contexts.

Keywords: *Last Mile Delivery; Bibliometric Analysis.*

✉ Corresponding author :
Email Address: hpurba@unai.edu

INTRODUCTION

In the context of modern supply chain management, shipping goods is no longer viewed solely in terms of production and distribution efficiency, but also in terms of a company's ability to deliver a satisfying customer experience throughout the entire logistics process. One of the most critical stages in the supply chain is long-distance shipping, also known as last-mile delivery, which involves delivering goods from a distribution center to the end consumer (Ranieri et al., 2018). This stage plays an important role in shaping customer perceptions of service quality, as it is the last point of contact between the company and the consumer. The complexity of long-distance delivery is increasing due to urban growth, traffic congestion, and rising

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customer expectations for delivery speed (Vakulenko et al., 2019). With the proliferation of e-commerce services, pressure on logistics systems to ensure timely, efficient, and affordable delivery has become increasingly high. This phenomenon underscores the importance of managing long-distance delivery, which frequently contributes to operational inefficiencies and customer complaints. According to Agatz et al. (2018), final-mile delivery accounts for up to 53% of total logistics costs, making it the most expensive component in the supply chain. Additionally, issues such as customer absence during delivery, traffic congestion, and limited access to delivery locations also impact service effectiveness and customer satisfaction (Cortes & Suzuki, 2022; Wang et al., 2020). When companies fail to manage these challenges, not only is cost efficiency compromised, but they also risk losing customer loyalty in the long term.

Recent studies indicate that last-mile delivery has become a focal point in the development of modern logistics strategies, particularly in response to the surge in e-commerce demand and customer expectations for speed and reliability of delivery. Vakulenko et al. (2019) emphasize that the growing consumer expectations for fast and flexible delivery have driven companies to design efficient and adaptive delivery systems. One key aspect analyzed in previous research is logistics technology, including real-time tracking and route planning algorithms, which have proven effective in enhancing delivery efficiency and reducing operational costs (Boysen et al., 2018). Route optimization software, GPS tracking systems, and big data integration in fleet management have become strategic variables in improving logistics reliability (Cortes & Suzuki, 2022). Additionally, delivery innovation has become a key focus in the development of last-mile delivery systems. Agatz et al. (2018) note that exploring the use of autonomous vehicles, drones, and delivery robots not only reduces labor costs but also enables delivery to densely populated or hard-to-reach areas. This trend is confirmed by Figliozzi (2020), who highlights the adoption of sustainable technologies such as electric vehicles and drones as solutions to efficiency and sustainability challenges. Research also highlights the importance of customer experience as a strategic outcome of last-mile delivery efficiency. Ignat & Chankov (2020) demonstrate that the speed, reliability, and transparency of the delivery process significantly influence customer satisfaction. Additionally, Rechavi & Toch (2022) note that crowdsourced delivery models can enhance delivery flexibility while strengthening interactions between service providers and customers.

Previous studies have discussed strategic issues in last-mile delivery. However, most research still focuses on practical aspects such as technological efficiency, delivery innovation, and its impact on customer satisfaction. Research by Boysen et al. (2018) and Vakulenko et al. (2019) has extensively reviewed the effectiveness of tracking and route planning systems. However, it has tended to overlook longitudinal analysis of the direction and development of scientific studies in this field. A similar situation can be observed in the study by Agatz et al. (2018), which examined the impact of autonomous vehicles and drones on delivery efficiency, but did not systematically evaluate how these research trends have evolved over the past decade. Furthermore, few studies integrate theoretical approaches and bibliometric analysis to explore the dynamics of the literature on long-distance delivery. Empirically, limitations are evident in the lack of systematic mapping of dominant themes, influential authors, and key journals in this field. Such mapping is crucial for identifying comprehensive academic contributions and setting

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future research directions. From a theoretical perspective, the approaches used in previous literature also fail to emphasize the interconnection between the theoretical frameworks of logistics and digital technology, particularly in the context of evolving consumer behavior in the e-commerce era. Most studies focus solely on technical efficiency without delving into theoretical reflections on the structural transformations in modern supply chain management.

Based on the identification of previous empirical and theoretical gaps, this study offers novelty through a bibliometric approach that systematically analyzes trends, main themes, and the dynamics of research development in last-mile delivery over the past twelve years (2013–2024). Unlike previous studies that have focused more on technical aspects or specific case studies, this research utilizes bibliometric analysis to map broad scientific contributions, including the identification of dominant keywords, author collaboration networks, and the most influential journals in this topic. Another novelty lies in the integration of a quantitative data-driven approach from Google Scholar, which has not been widely used as a primary source in analyzing trends in last-mile delivery. By filtering only 48 verified scientific documents from an initial total of 100 publications, this study provides a more focused and up-to-date overview of the academic landscape of last-mile delivery. The primary objective of this study is to comprehensively explore and analyze research trends related to last-mile delivery, aiming to provide valuable scientific contributions not only for academics but also for industry practitioners and policymakers seeking to understand the direction and priorities of modern logistics research based on data.

Last Mile Delivery

Last Mile Delivery (LMD) is the final phase of the logistics distribution chain where goods are delivered from distribution centers, warehouses, or fulfillment facilities to the customer's final destination address. This stage is crucial as it determines the overall success of the customer experience in receiving products on time, accurately, and efficiently (Tilk et al., 2021). In today's digital business environment, LMD is no longer viewed merely as a technical component of logistics but as a strategic element that directly influences customer satisfaction and loyalty. As explained by Olsson et al. (2022), the final interaction in the delivery process often serves as the sole physical contact between the company and the customer, making the quality of service at this point significantly impact brand perception. Therefore, e-commerce companies and logistics providers are striving to develop LMD systems that are not only fast and reliable but also capable of meeting customers' personalized expectations. In this context, psychological factors also play a crucial role. Klein & Popp (2022) indicate that consumers' preferences for delivery methods are greatly influenced by their perceptions of convenience, sustainability, and trust in the delivery system used. Thus, LMD is not just a matter of transporting goods, but also a critical point in long-term and sustainable customer relationship management strategies in an increasingly complex digital market competition.

Technological developments have brought about significant transformations in last-mile delivery systems, particularly in addressing the challenges of efficiency, delivery delays, and cost pressures. Innovations such as electric vehicles, drones, and real-time tracking systems enable companies to create more responsive and sustainable delivery systems. Research conducted by Chandratreya et al. (2024)

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highlights that route optimization technology and environmentally friendly vehicles can substantially reduce operational costs and carbon emissions, particularly in short-distance deliveries within densely populated urban areas. Additionally, the use of drones as an alternative LMD solution is gaining attention. Jazairy et al. (2025) in their literature review state that drones offer efficiency solutions in areas with high traffic barriers or difficult-to-reach geographical conditions. However, challenges in regulation, air safety, and battery limitations remain obstacles to mass adoption. Meanwhile, parcel lockers as self-service pickup points are also an effective innovation in addressing customer absence issues. Grabenschweiger et al. (2021) demonstrate that the use of heterogeneous locker boxes can reduce delivery times and frequency of redeliveries, while enhancing flexibility for consumers. In this context, technology is not merely a tool but has become the cornerstone of redesigning logistics distribution systems. Through the integration of information systems, automation, and data management, LMD has evolved from traditional systems to digital systems focused on operational efficiency and sustainability.

Beyond efficiency and speed, sustainability has become a crucial element in the development of modern Last-Mile Delivery systems. In the context of urbanization and global climate change, LMD is required to transform into a system that is not only fast but also environmentally friendly. A study by Mogire et al. (2025) demonstrates that electric vehicles in LMD offer significant potential for reducing emissions, but they face challenges related to charging infrastructure and operational range. As a result, alternative approaches such as crowdsourced delivery are being adopted as adaptive community-based solutions. Rhouzali et al. (2024) note that collaboration between logistics providers and individual community members can create a more flexible and cost-effective delivery system, particularly in the context of smart cities and the sharing economy. This model also opens opportunities for local economic empowerment and decentralized distribution. Additionally, a bibliometric review by Chandratreya et al. (2024) indicates that LMD research is increasingly developing in an interdisciplinary manner, involving fields such as technology, consumer behavior, public policy, and urban planning.

Logistics Technology

Logistics technology refers to the application of information technology, automation, and digitalization systems in all logistics processes, from planning and processing to transportation and the delivery of goods to end consumers. This technology aims to enhance operational efficiency, improve delivery accuracy, increase supply chain visibility, and ultimately increase overall customer satisfaction. According to Shuaibu et al. (2025), logistics technology encompasses key elements such as the Internet of Things (IoT), route optimization algorithms, Artificial Intelligence (AI), and the use of drones and electric vehicles in distribution systems. The implementation of this technology is crucial in the context of e-commerce growth, which demands fast, flexible, and transparent delivery services. Jazairy et al. (2025) add that the use of drones in logistics distribution not only accelerates the delivery process but also serves as a solution for access limitations in densely populated or remote areas. On the other hand, Pourmohammadreza et al. (2025) emphasize that technologies such as parcel lockers and self-service pickup points have proven effective in reducing redelivery rates due to customers' absence, thereby improving cost efficiency.

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Thus, logistics technology is not only revolutionizing how companies distribute goods but also creating new distribution models that are more adaptable to the market's dynamics and the increasingly complex behavior of modern consumers. In operational logistics practices, technology is not merely a support but has evolved into the backbone of modern distribution systems. One of the main innovations is the adoption of electric vehicles in goods delivery, particularly in the context of last-mile delivery.

Cano et al. (2022) note that logistics companies are increasingly adopting electric vehicles because they reduce carbon emissions and operating costs associated with fossil fuels. In addition, pressure from environmental policies and increased consumer awareness of sustainable logistics are also driving this transformation. The use of route optimization algorithms also plays a role in designing efficient distribution routes. Chandratreya et al. (2024) emphasize that integrating traffic data, demand prediction, and AI-based systems can significantly reduce travel time and operational costs. One example of the application of such algorithms is in a locker box-based delivery system that allows consumers to pick up goods independently at specific locations. Grabenschweiger et al. (2021) demonstrate that this system can reduce the number of vehicle stops, improve workforce efficiency, and provide customers with flexible delivery times. The integration of these technologies indicates that modern logistics is no longer static but dynamic, highly influenced by data processing speed, system connectivity, and real-time responsiveness to customer needs. With increasingly mature technology, companies can achieve operational efficiency while supporting broader environmental sustainability goals.

Digitalization in logistics has led to the emergence of new data- and customer service-based business models. Models such as crowdsourced delivery, real-time service application integration, and QR code-based self-pickup systems are part of innovations that leverage technology to improve delivery flexibility and effectiveness. Cano et al. (2022) explain that digital platforms connecting logistics service providers, customers, and delivery partners simultaneously can enhance transparency, accelerate decision-making, and reduce coordination costs. Digitalization also supports local economic empowerment through gig economy models where individuals can act as delivery agents within an open system. Furthermore, data-driven decision-making has become the primary approach for selecting the most suitable logistics strategy in operational contexts and addressing customer needs. Pourmohammadreza et al. (2025) emphasize the importance of applying multi-criteria decision-making (MCDM) to assess trade-offs among cost efficiency, delivery time, and environmental impact. This strategy is particularly relevant when companies must choose between direct-to-home delivery or a self-pickup system, depending on customer preferences and locations. Additionally, Shuaibu et al. (2025) emphasize that technology-driven supply chain management is no longer merely reactive but proactive, with the ability to predict demand, manage risks, and deliver personalized services.

Customer Experience

Customer experience can be defined as the accumulation of perceptions, emotions, and cognitive responses that customers have as a result of their interactions with a product, service, or process, either directly or indirectly, throughout the consumption journey (Olsson et al., 2023). In the context of logistics,

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particularly last-mile delivery (LMD), customer experience plays a strategic role because this final distribution point is the only physical interaction between customers and the broader digital service system. A study by Vrhovac et al. (2023) states that in e-commerce-based delivery, customer experience is not only determined by delivery speed but also by the clarity of tracking information, packaging aesthetics, and ease of access to services. These experience dimensions are divided into functional and emotional aspects that mutually influence each other in shaping customers' overall perception of service quality. In an empirical study by Sharma et al. (2025), it was found that variables such as delivery time flexibility, the ability to choose a delivery location, and real-time tracking systems have a significant influence on customer satisfaction levels and long-term loyalty. This underscores that companies aiming to excel in the digital logistics competition must prioritize the quality of customer experience as a key indicator of operational success.

Digital transformation in LMD has expanded the spectrum of elements that shape the customer experience from mere delivery of goods to an integrated service that encompasses communication, transparency, and convenience. In a study by Mogire et al. (2023), it was revealed that customers highly value responsive two-way communication systems, both in the form of delivery notifications and self-service rescheduling options. This research also indicates that trust in couriers as brand representatives influences customers' perceptions of professionalism and service security. Furthermore, Vrhovac et al. (2023) introduced a CMX-LMD user experience measurement scale encompassing six key dimensions: delivery efficiency, tracking, convenience, emotional anticipation, visual aesthetics, and ease of use. This scale is relevant for measuring customer experience in digital ecosystems, particularly in services without direct face-to-face interaction. Additionally, Agboyi (2025) in their study on supply chain collaboration and service integrity emphasize that customer experience is indirectly influenced by coordination among logistics providers, the availability of real-time information, and responsive complaint management systems. When distribution systems are supported by process and technology integration, customers tend to experience smoother service interactions, which ultimately enhances repeat purchase intent and organic brand advocacy.

In the era of hypercompetition and digitalization of services, customer experience has become a key differentiator in customer retention strategies. Research by Agboyi (2025) highlights that excellence in LMD is no longer sufficient based solely on the fastest delivery time, but rather on how customers feel engaged, valued, and facilitated throughout the process. In this context, the concept of “joyful anticipation” or pleasant anticipation, as raised by Vrhovac et al. (2023), becomes a new factor influencing satisfaction, where customers not only wait for the product to arrive but also enjoy the waiting process due to an immersive and informative digital experience. This emphasis on a pleasant experience indicates a shift from a transactional orientation to a relational orientation in logistics service management. On the other hand, the findings of Sharma et al. (2025) also show that dissatisfaction in just one aspect—such as delays or a lack of tracking information—can reduce overall customer trust, even if other aspects are well-managed. Therefore, a holistic and consistent customer experience design is essential across all touchpoints. Logistics companies that can create seamless, transparent, and responsive interactions not only enhance customer satisfaction but also build a competitive advantage that is difficult for competitors to replicate.

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METHODOLOGY

This study examines Last-Mile Delivery by conducting a data investigation using data sourced from Scopus from 2013 to 2024. Over the twelve-year period, this study discusses Last Mile Delivery. First, there is a potential trend of increasing research during the first three years. Last-mile delivery has been extensively researched in the first few years of this decade. During the final observation period from 2020 to 2024, the COVID-19 pandemic occurred, potentially leading to a decline in research trends on the topic of last-mile delivery. Therefore, this study examines whether the research trend on the topic of Last Mile Delivery during that period indeed decreased or increased. Subsequently, testing was conducted using mapping and clustering analysis with data from Google Scholar. The bibliographic coupling technique was applied using the VosViewer program. The collected data was imported, and its relationships were mapped through similarity visualization methods using VosViewer for bibliometric mapping. VosViewer focuses on the graphical representation of bibliometric maps and presents them in an easily interpretable manner. This study focuses on exploring information about how the research topic of Last Mile Delivery, from 2013 to 2024, with sample data from the Scopus database, was analyzed using Vosviewer, as shown in Figure 1.

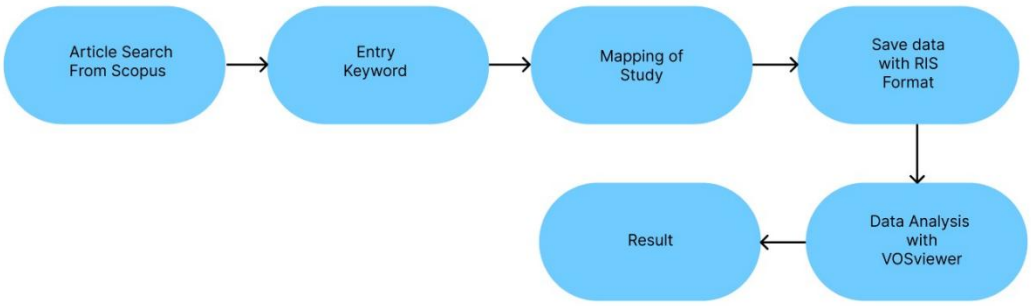

Figure 1. Example of a graph using lines to compare the number of publications by authors

RESULTS AND DISCUSSION

Development of Annual Publications

Based on data processing using the VosViewer program, as shown in Figure 2, the frequency of annual publications on Last-Mile Delivery can be observed. The average trend shows fluctuations in publications between 2013 and 2024.

In the first four years (2013–2016), only 4 documents were published in 2013, 9 documents in 2014, 3 documents in 2015, and 15 documents in 2016. Then, from 2017 to 2019, the number of scientific publications increased to 37 documents in 2019. Over the last four years, the number of documents decreased, reaching 33 in 2020, then further decreasing to 28 in 2021, and finally to only 6 in 2022. The following outlines the annual development of publications on Last-Mile Delivery.

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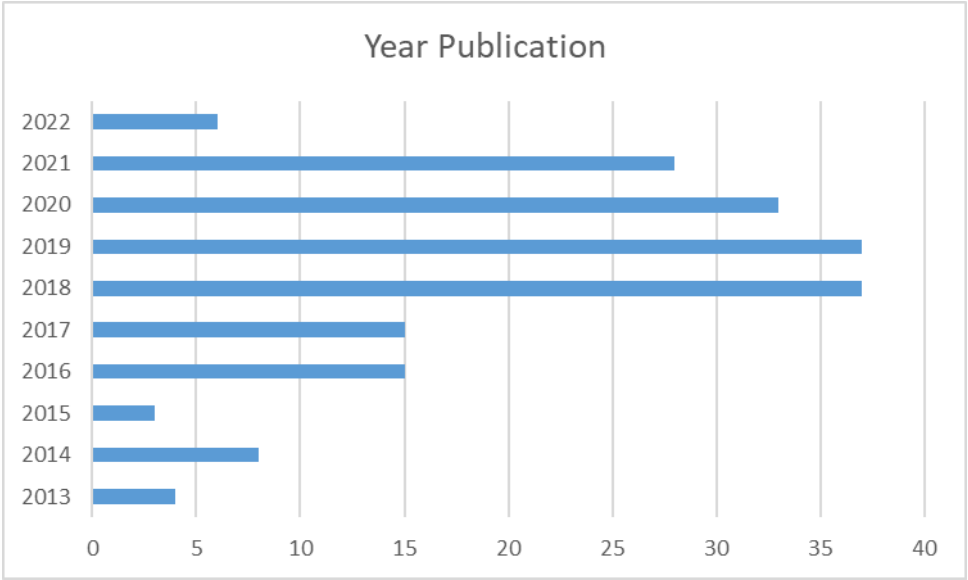

Figure 2. Example of a graph using lines to compare the number of publications by authors

Author Citations

Author citations describe metrics that explain the author's expertise in a particular area of research. Identification of author expertise reveals M. Moshref-Javadi, N. Boysen, C. Chen, G. Perboli, and Y. Vakulenko, with three documents, and C. Fikar, P. Kitjacharoenchai, D. Schermer, J.C. de Freitas, L. Zhou, V. Gatta, X. Wang, K.F. Yuen, and L. Di Puglia Pugliese, M.D. Simoni, S., Kapser, C.C., Murray, M.A., Figliozzi, J.H.R., Van Duin, with two documents. The results also found that 140 authors have published at least one article, contributing significantly to the development of knowledge about Last-Mile Delivery. The following is the distribution of authors on Last Mile Delivery and the number of papers published.

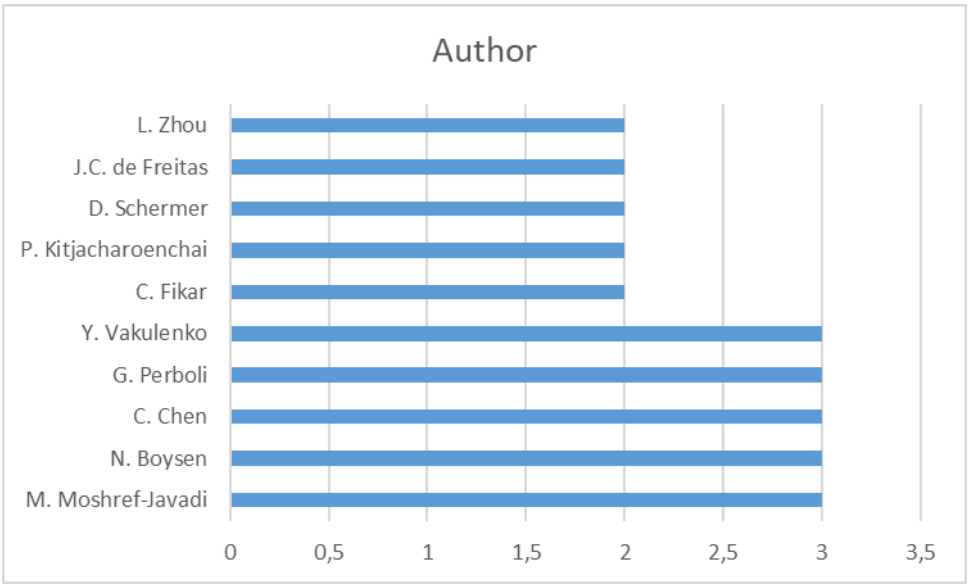

Figure 3. Example of a graph using lines to compare the number of publications by authors

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Geographical Distribution

Geographical Distribution Data processing revealed the geographical distribution shown in Figure 4, which illustrates the distribution of citations by country. Publications originated from nine different countries. Data analysis showed greater interest in the United Kingdom, which contributed 89 documents. This was followed by the United States, with 31 documents, and then the Netherlands, with 27 documents.

Switzerland has 19 documents and Germany has six documents. Singapore, Belgium, Italy, and Hungary each contributed 1 document. The following is the development of publications based on the geographical coverage of Last Mile Delivery.

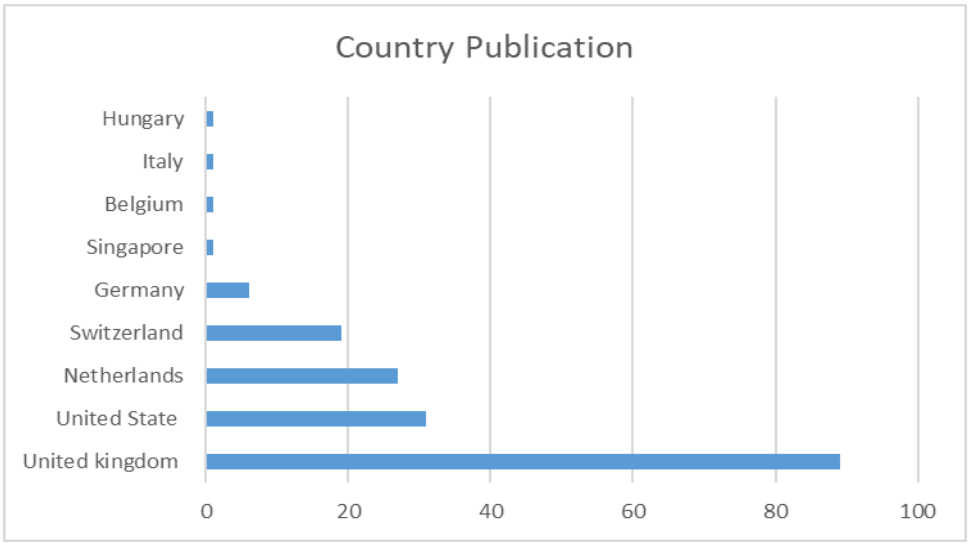

Figure 4. Example of a graph using lines that contrast with the geographical distribution

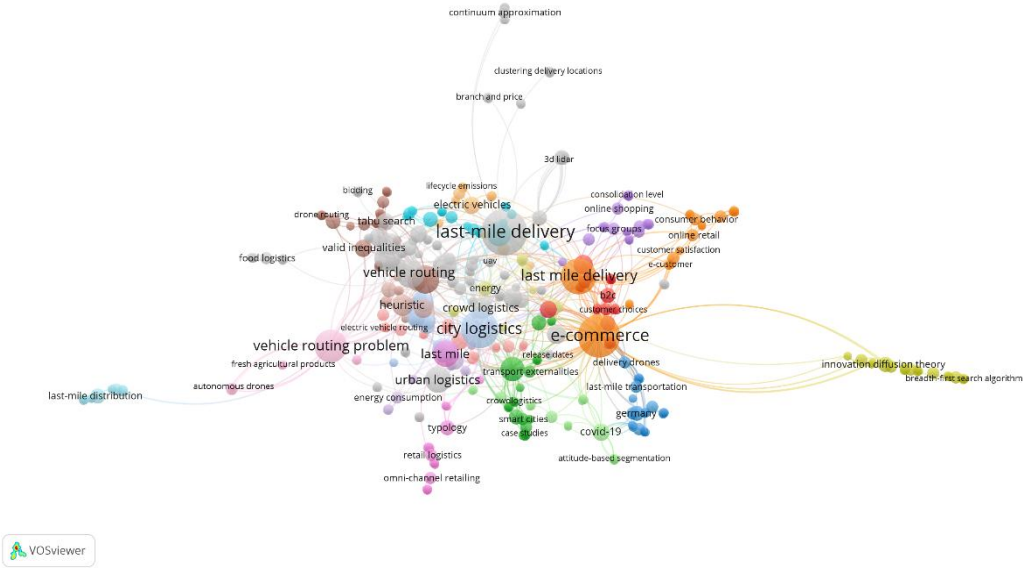

Figure 5. Network Visualization

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Network Visualization

The figure below illustrates Last Mile Delivery in several visualizations related to the research theme. Furthermore, their review with VOSviewer revealed nine concept clusters, as shown in Figure 5. These findings indicate concepts derived from the density view of the clusters. Furthermore, each color code is used to identify the prominent concepts within each cluster. The aim is to identify as many themes as possible that have been frequently discussed in previous research and can be utilized in future studies. The following figure shows that different colors distinguish the density of clusters within each cluster.

Grouping of Long-Distance Delivery Themes

Table 1 explains Last Mile Delivery in several visualizations related to the themes of this study. Then, a review of the VOSviewer display reveals eleven clusters, as shown in the following figure. This shows the concepts derived from the cluster density display. Furthermore, each color code is used to view the list of prominent concepts from each cluster. The aim is to identify as many themes as possible that have been frequently discussed in previous research and can be utilized in future studies. Figure 5 shows that different colors distinguish the density of clusters from each cluster. Some of these clusters can be explained in Table 1.

Table 1. Theme Classification

Cluster	Items	Total
Cluster 1 (27 items)	adaptive large neighbourhood search, autonomous delivery robot, b2c, Barcelona (Spain), Benders decomposition, business logistics, city logistics management, continuous approximation, customer choices, externalities, food/agriculture supply chain, grasp meta-heuristic, inventory-routing, last mile logistics, last-mile logistics, logistics services outsourcing, omnichannel, operation costs, optimal localization, packstations, parcel lockers, Paris (France), perishable products, retail, reverse logistics, systematic review, two-echelon system	5%
Cluster 2 (26 items)	bin packing, case studies, cooperative freight transport systems, copert, crowdlogistics, crowdshipping, discrete choice, discrete choice model, discrete choice models, electric tricycles, innovative solution, last mile distribution, light goods vehicles, on demand, on demand economy, on-demand economy, parcels, smart cities, stated choice experiment, stated preference, systematic literature review (slr), transport externalities, urban consolidation centres smart cities, urban delivery, urban freight, urban freight transport	5%
Cluster 3 (24 items)	Acceptance, China, delivery drones, fast-food meal delivery, final deliveries, France, gender, Germany, last-mile, last-mile, last-mile transportation, literature review, moderator analysis, omnichannel, package delivery, parcels deliveries, perceived risk, perceived satisfaction, self-service parcel delivery service, U-space, U-space, user acceptance, UTAUT, UTAUT2	5%
Cluster 4 (24 Items)	adoption behavior, adoption behavior, consumer behavior, consumer coproduction theory, consumers' intention, customers' intention, innovation diffusion theory, last-mile deliveries, last-mile logistics delivery, last-mile split delivery, logistics innovation, online retailing, perceived value, piecewise-integer structure, resource matching attributes, resource matching theory, self-collection, self-service parcel delivery, shipment consolidation, smart lockers, structural equation modelling, technology readiness, theory of planned behavior, transaction costs	5%
Cluster 5 (24 items)	automated collection point (ACP), collection and delivery point (CDP), collection and delivery points, consolidation level, customer valuedelivery tours, distribution, environmental impacts, focus groups, freight transport, last mile deliveries, last-mile travel, New Zealand, local food, location, multi-criteria decision aid, online shopping, parcel locker, qualitative analysis, safety, self-service technology, shopping behaviors, substitution and complementarity, system dynamics, taxi trajectory data mining	5%
Cluster 6 (23 Items)	bound analysis, cargo tricycles, cities, drone logistics, hybrid particle swarm optimization, logistics planning, mobile depot, mobile depots, multi-actor multi-criteria analysis, multi-compartment vehicle routing problem, open vehicle routing problem, pollutant emissions, routing optimization, shared mobility, simulated annealing, stakeholders, sustainability, theory of planned behaviour, transitions, traveling repairman problem, urban distribution, urban freight distribution, vehicle routing problem with time windows	5%
Cluster 7 (22 Items)	Business process re-engineering, conjoint analysis, consumer behavior, customer experience, customer journey, customer satisfaction, e-commerce, e-commerce logistics, e-customer, expert systems, first mile delivery, freight transport logistics, internet of things, last mile delivery, mental accounting theory, o2o retailing, online retail, order fulfilment, service innovation, service quality, smart parcel locker, warehouse postponement applications	4%

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Cluster 8 (22 Items)	branch-and-cut, branch-and-price,car-trunk delivery, column generation, compact formulation, drone routing, drones, dynamic programming, exact methods, flying sidekick tsp, large-scale instances, locker location, logical cut, matheuristics, mixed-integer linear programming, multinomial logit model, multitrip vehicle routing, nonlinear energy function, quadratic transform, set partitioning, subgradient cut, valid inequalities	4%
Cluster 9 (19 Items)	crowdsource delivery, distribution strategies,e-retail, exploratory study, framework, grocery logistics, grocery retailing, last mile, last mile operations, logistics networks, omni-channel retailing, order fulfillment, retail logistics, social gratification, social media, social presence, typology, unstructured big data, urban goods distribution	4%
Cluster 10 (18 Items)	crowdsourced delivery, dynamic traffic simulation, electric vehicle routing, energy storage, external costs, item-sharing, Lagrangian relaxation, last miles, metaheuristics, mixed integer programming, neighborhood delivery, pickup, same-day delivery, sharing economy, sustainable city logistics, sustainable last-mile delivery, tabu search heuristics, two echelon routing problem	4%
Cluster 11 (17 Items)	attitude-based segmentation, consumer acceptance, COVID-19, design for service, drone parallel scheduling, dynamic capabilities, environmental economics, facility location, latent class analysis, low-carbon delivery, mixed integer linear programming, ruin and recreate metaheuristic, supply chain design, supply chain resilience, sustainable development, sustainable transport, willingness to pay	3%
Cluster 12 (17 Items)	Autonomous robots, city logistics, delivery robots, drone delivery, ground-vehicle and unmanned-aerial-vehicle systems, hybrid genetic algorithm, metaheuristic algorithm, mobile satellite, optimization, routing, routing problems, scheduling, surveys, transportation, two-echelon systems, uncrewed aerial vehicles, vehicles.	3%
Cluster 13 (16 Items)	air drone, carbon emissions, delivery industry, emissions, energy, entrepreneurship, grocery shopping, ground robot, omnichannel distribution, parking, robot, strategic management, supply chain management, sustainable logistics, travel, travel distance.	3%
Cluster 14 (16 Items)	continuous approximation (ca), cost model, electric trucks, energy consumption, generalized bin packing problem, GHG emissions, green transportation, guest, logistics cost, moves, parcel delivery, picking, PM2.5, population density, urban consolidation center (UCC), van delivery	3%
Cluster 15 (16 Items)	Asia, autonomous transport, cold chain, delivery robots, disaster relief operations, drone routing problem, genetic algorithm, humanitarian supply chain, industry 4.0,last-mile distribution, location-routing problem, mixed method, quality deterioration, regulatory framework, shelf life, simultaneous home delivery, and customer's pickup	3%
Cluster 16 (16 Items)	battery swapping, EV, electric vehicles, emissions mitigation, energy efficiency, green logistics, green vehicles, heuristic optimization, hybrid metaheuristic, incentives, last mile services, lifecycle emissions, logistics last mile, total cost of ownership, tricycles, UAV drone	3%
Cluster 17 (16 Items)	delivery, drone, exact method, grasp, heuristic, integer programming, minimize operational cost, mixed integer program (mip), simulated annealing (sa), tandem truck-drone, traveling salesman, traveling salesperson problem with drone, two-echelon vehicle routing problem, uncrewed aerial vehicle(uav), vehicle routing problem (vrp)	3%
Cluster 18 (14 Items)	autonomous drones, contactless delivery, drone assignment, drone charging station repositioning, drone delivery modeling, drone routing optimization, drone-based package delivery system, e-commerce delivery, fresh agricultural products, matheuristic algorithm, nsga-ii algorithm, self-driving delivery robot, split delivery, vehicle routing problem	3%
Cluster 19 (19 Items)	automated parcel lockers, batch demand, bidding, crowdsource-enabled delivery, large neighborhood search, mixed-integer programming, myopic strategy, relay, routing and scheduling, simultaneous pickup and delivery problem, tabu search, truck routes and schedule, UAV logistics	4%
Cluster 20 (12 Items)	3d lidar, autonomous vehicles, loam, localization, mapping, navigation, PCL, ROS, self-driving cars, sensor fusion, SLAM, urban navigation	2%
Cluster 21 (12 Items)	case study, collaboration, electric vehicle, first-last mile, freight-passenger integration, key performance indicators, modular vehicles, public transport, scenario analysis, service level, urban logistics, VNS	2%
Cluster 22 (12 Items)	carbon reduction, drone speed, heuristics, small package shipping, subcontracting, supply chain sustainability, traveling salesperson problem, truck-drone, UAV speed, uncrewed aerial vehicle, variable neighborhood search, vehicle routing,	2%
Cluster 23 (12 Items)	b2c e-commerce, business model, crowd logistics, crowdsourcing, design science, efficiency, innovation, minimum cost flow, occasional couriers, same day delivery, social networks, social transportation	2%
Cluster 24 (11 Items)	attended home delivery, column and row generation, dynamic vehicle routing, greenhouse gas, heuristic algorithms, non-split deliveries, on-demand meal delivery, pickups and deliveries, road transport, split deliveries, time windows	2%
Cluster 25 (11 Items)	batch demands, cyclic assignment, e-groceries, home delivery, last mile problem, pick-up points, policy, queueing, stated preference survey, travel behaviour, waiting time approximation	2%

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Cluster 26 (10 Items)	cargo-bikes, decision support, decision support system, dynamic routing, e-grocery, food logistics, fresh fruit supply chain, simulation optimisation, simulation optimization, urban consolidation	2%
Cluster 27 (9 Items)	actor-critic methods, logistics, Markov decision process, neural network, packaging, product waste, Q-learning, reinforcement learning, supply chain	2%
Cluster 28 (9 Items)	branch and price,last-mile delivery,multi-criteria decision-making, picture fuzzy set, prediction, robust optimization, routing behavior, uncertainty,waspas	2%
Cluster 29 (6 Items)	collection-and-delivery points, continuum approximation, e-commerce distribution, fulfillment options, pickup and delivery problems, route efficiency	1%
Cluster 30 (5 Items)	clustering delivery locations, integrated optimization approach, minimize delivery completion time, minimize total cost,truck-drone routing,	1%
Cluster 31 (4 Items)	freight consolidation policy,multi-actor multi-criteria analysis (mamca), multi-criteria decision analysis (mcda), urban consolidation centre,	1%
Cluster 32 (3 Items)	integrated truck-robot delivery, local search with adaptive perturbation, traveling salesman with robot,	1%
Cluster 33 (3 Items)	access to service,drone-beehives, UAV	1%
Cluster 34 (3 Items)	inventory routing, release dates, routing problems	1%

Overlay visualization of Last Mile Delivery

Overlay visualization is performed by analyzing metadata and then processing it with VOSviewer. The visualization process involves loading existing themes by examining node colors based on the appearance of the theme and its publication year. Each color represents the growth trend of research on Last-Mile Delivery. Figure 6 illustrates topics related to Last Mile Delivery, such as empirical studies and corporate environmental management, among others, which have not been extensively discussed from 2013 to 2024. The following topics are included in the scope of Last Mile Delivery: last-mile delivery, e-commerce, city logistics, and the vehicle routing problem, which were extensively studied between 2013 and 2016. From 2017 to 2019, Last Mile Delivery was extensively studied in the fields of higher education, mapping, universities, collaborative learning environments, total quality management, transformation, and implementation. From 2020 to 2024, the same topics were discussed with the addition of accreditation, education, learning, learning object repositories, literature review, and service quality. This visualization facilitates research on last-mile delivery by providing an overview of studies conducted each year, as illustrated in Figure 6.

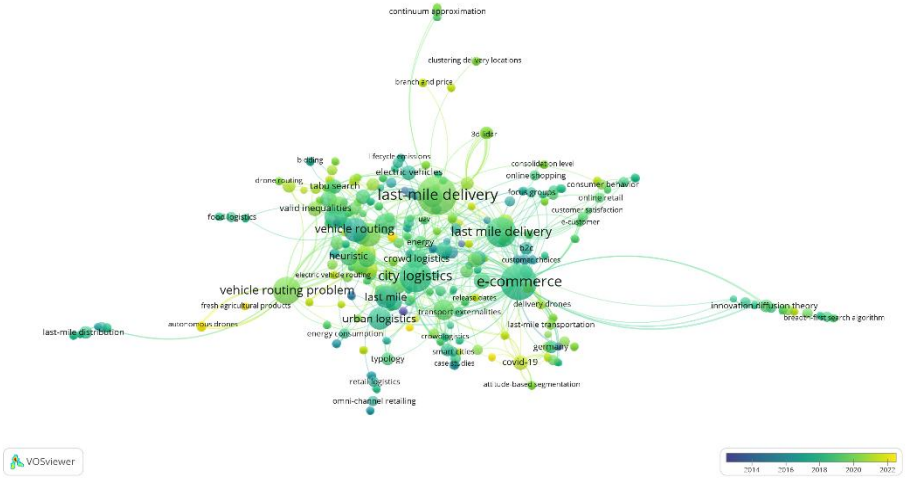

Figure 6. Overlay Visualization

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Discussion

Dynamics of Publication Development and Time Trends

The visualization of annual publication trends reveals significant fluctuations in the intensity of research related to Last Mile Delivery (LMD) from 2013 to 2024. In the initial phase (2013–2016), the number of publications was still relatively low, ranging from 3 to 15 documents per year, indicating that LMD was not yet a primary focus in academic logistics studies. However, there was a significant surge from 2017 to 2019, reaching a peak of 37 publications in 2019. This phenomenon reflects a growing academic interest in the increasingly complex challenges of long-distance delivery, driven by the rapid growth of e-commerce and the pressure on service speed. However, the period from 2020 to 2022 saw a sharp decline in the number of publications, with only 6 documents published in 2022. This decline can be attributed to the global disruption caused by the COVID-19 pandemic, which led to a shift in research and operational logistics priorities. Nevertheless, the pandemic has underscored the importance of LMD research, given the surge in demand for long-distance delivery services during social distancing measures. This change in trend confirms that LMD is adaptive to external conditions. In the context of the pandemic, despite the decline in publications, the urgency and challenges of LMD have increased, particularly in terms of safety, contact efficiency, and high-demand management. Thus, the dynamics of publications illustrate that LMD is not just a temporary topic, but an important part of the strategic and sustainable logistics discourse.

Identification of Major Contributors and Geographic Distribution

An analysis of author citations reveals that several researchers have made significant contributions to advancing the LMD literature. Key figures, including M. Moshref-Javadi, N. Boysen, C. Chen, G. Perboli, and Y. Vakulenko, have each contributed three publications on this topic. Meanwhile, authors such as C. Fikar, L. Zhou, and M.A. Figliozzi have contributed two documents each. In total, 140 unique authors are involved in the development of LMD literature, indicating the presence of a fairly active academic community, despite its relatively dispersed nature. The contributions of these authors are crucial in presenting a multidisciplinary approach, ranging from optimization techniques and technology adoption to consumer behavior analysis in delivery systems. Geographically, the United Kingdom ranks first with 89 documents, followed by the United States (31 documents), the Netherlands (27 documents), and Switzerland (19 documents). Other countries such as Germany, Singapore, Belgium, Italy, and Hungary contributed a smaller number of publications. This distribution suggests that developed countries with robust logistics infrastructure, advanced technology, and substantial academic support currently dominate LMD research. However, this dominance also reflects a geographical bias in LMD studies, where LMD challenges in developing countries or regions with limited infrastructure remain under-explored. In fact, local contexts such as traffic congestion, limited road access, and the absence of modern logistics systems are highly relevant issues for developing countries.

Thematic Analysis and Clustering of Research Concepts

Bibliometric mapping using VOSviewer produced 34 diverse and interconnected theme clusters, confirming that LMD is a complex and

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multidimensional field of study. Each cluster reflects specific subtopics that have been the focus of researchers. For example, Cluster 1 addresses topics such as adaptive large neighborhood search, autonomous delivery robots, and last-mile logistics, indicating a focus on technical efficiency and algorithm development in automated delivery. This cluster highlights quantitative approaches and optimization systems as the backbone of operational strategies. Meanwhile, Clusters 2 to 6 describe research developments in collaborative and sustainability approaches, such as crowdshipping, urban freight, electric vehicles, and green logistics. These topics focus on developing environmentally friendly and efficient solutions to mitigate carbon emissions and traffic impacts associated with long-distance delivery (Caggiani et al., 2021). Clusters 3 and 4 are also noteworthy for emphasizing consumer behavior aspects, such as user acceptance and perceived satisfaction, as well as the Theory of Planned Behavior, highlighting the importance of understanding user psychology in adopting technology-based LMD services. Additionally, other clusters highlight emerging technologies such as drone routing optimization, autonomous robots, and UAV-based logistics, indicating a trend toward automation in final-mile delivery. This clustering not only reflects the diversity of themes but also indicates the integration of theory and practice across various disciplines, including operations management, information technology, marketing, and urban planning.

Overlay Visualization and Research Development Directions

The overlay visualization from VOSviewer provides an evolutionary overview of the direction of LMD research based on node colors indicating publication time and theme density. The visualization results show that from 2013 to 2016, dominant topics included e-commerce, city logistics, and vehicle routing problems, reflecting an initial focus on solving technical issues and integrating urban logistics. However, from 2017 to 2019, the research focus shifted toward managerial themes, including collaborative learning environments, total quality management, and digital transformation. This shift reflects increased attention to cross-sectoral and integrative approaches. The 2020–2024 period shows the inclusion of more varied and multidisciplinary themes, such as accreditation, education, literature review, and service quality, indicating the expansion of LMD into the academic and higher education domains. This trend suggests that LMD is now viewed not only as a technical logistics issue but also as a framework for knowledge management, educational innovation, and the enhancement of technology-based service quality (Issaoui et al., 2021; Kiba-Janiak et al., 2021). With this overlay, researchers and practitioners can observe the temporal evolution of the literature and use this information as a foundation for designing future research aligned with emerging trends.

CONCLUSION

This study aims to explore and analyze research trends in the field of Last Mile Delivery (LMD) using a bibliometric approach, focusing on publications from 2013 to 2024. This study examines the temporal and geographical evolution of the LMD topic through citation analysis, co-citation analysis, and keyword co-occurrence analysis. By utilizing data from Google Scholar and visual mapping using VOSviewer, this study successfully identified annual fluctuations in publication, the most productive

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academic actors, and the distribution of countries that have significantly contributed to the development of LMD research. Specifically, the findings indicate that LMD is a dynamic topic, sensitive to global contexts such as pandemics, and undergoing a shift in focus from technical efficiency toward technology integration and logistics sustainability.

The original value of this research lies in its comprehensive and quantitative data-driven presentation, achieved through a bibliometric approach, which remains relatively rare in LMD studies. This study not only provides an overview of academic developments but also offers a conceptual map that can serve as a foundation for strategic decision-making in the logistics industry and policy-making levels. The practical implications of this study are to provide information that can help logistics companies, e-commerce businesses, and policymakers understand the evolution of needs and strategies for final-mile delivery. From a managerial perspective, these findings can serve as a reference for developing innovative services and more adaptive, sustainable, and data-driven urban logistics policies.

This study has limitations in the scope of its data sources, which only utilize Google Scholar. Although extensive, Google Scholar is not as precise or rigorous as academic databases such as Scopus or Web of Science. Additionally, this research has not specifically linked bibliometric trends to the implementation context of LMD in developing countries, so the generalizability of the findings may be more relevant for developed countries. For future research, it is recommended that this bibliometric analysis be expanded to include additional academic databases, as well as qualitative studies or case studies to elaborate on local contexts and best practices. Furthermore, integrating consumer behavior theory and logistics digitization frameworks could be a focus for future studies to achieve a more holistic understanding of LMD transformation within the global supply chain ecosystem.

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