

The Applications of Operations Research in Last Mile Delivery

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Abstract

Last-mile delivery has emerged as a critical component of modern supply chain management due to the rapid growth of e-commerce, increasing customer expectations, and the need for faster and more reliable deliveries. Despite covering a relatively short distance, it is often one of the most complex and expensive stages of logistics, involving challenges related to route optimization, delivery costs, traffic congestion, environmental sustainability, and customer satisfaction. This study examines the evolution of last-mile delivery research from 2013 to 2026 using a bibliometric analysis of 2,771 journal publications retrieved from the Scopus database. The data was screened using the PRISMA approach and analysed using Biblioshiny to identify publication trends, influential journals, leading countries, research themes, keyword patterns, and citation impact across pre-COVID, pandemic, and post-COVID periods. The findings reveal a substantial increase in scientific publications, with research activity accelerating during and after the COVID-19 pandemic. China emerged as the leading contributor to publications by 2025, while India demonstrated significant growth in research output. Key themes have evolved from traditional city logistics and home delivery towards vehicle routing optimization, drone delivery, machine learning, parcel lockers, crowdshipping, and sustainable transportation. However, the study identifies important research gaps, including the limited use of real-world operational data, the need to balance cost efficiency with service quality and environmental sustainability, and the early-stage application of artificial intelligence and machine learning in delivery optimization. The study concludes that future research should focus on validating optimization models under actual operating conditions and developing integrated, data-driven solutions for more efficient and sustainable last-mile delivery systems.

Keywords: Last-mile delivery, Operations Research, Bibliometric Analysis, Route Optimization, E-commerce, Drone Delivery, Machine Learning, Sustainability, Scopus, COVID-19.

Introduction

Our approach to moving goods through cities has been transformed as a result of online shopping. As time was spent as consumers at shops, they now expect delivery of their orders and items to be received at their doorsteps within a day or even a few hours, a requirement which thrust logistics suppliers (Lim et al., 2018; Mangiaracina et al., 2019) to a great deal of pressure. This pressure is especially strong for

last-mile delivery – the final part of the supply chain from a local distribution centre to the end customer. Although the distance is small, it is generally accepted that the most costly and most complicated part of the logistics chain is this one (Boysen et al., 2021; Lim et al., 2018). It's also the stage where customers can see, meaning late, damaged or failed deliveries impact customer levels of satisfaction with the retailer.

Last-mile delivery is not just a cost issue. Several separate vehicles are used for a lot of small deliveries, which is a potential source of traffic congestion, emissions and noise in dense urban areas (Boysen et al., 2021; Ranieri et al., 2018). Last-mile logistics innovations have not ignored environmental and social aspects but instead have been included in the The students will learn about these concerns first because they take the study of the topic from the point of view of operations research, transport planning, environmental science and management, and because lately, everyone in the academic world is interested in studying this topic.

Therefore, the volume of research about the last-mile delivery sector has grown steadily. According to a systematic review by Olsson et al. (2019), 75% of the articles examined relating to last mile logistics were published in the last five years, and three-quarters of these articles mentioned the increased focus on omni-channel retailing, urbanisation, consumer behaviour and sustainability. Since then, there has also been an increase in the number of review articles. We conducted a literature review of 122 review articles from 2014–2026 that showed a range of publication dates starting after 2022 with 30 reviews published in 2025 and 21 published in 2024. These reviews have been cited 4,799 times in total, indicating that there is a point where summarising existing knowledge becomes a research task, in itself. The research has taken a multi-dimensional form as follows. It is one of the oldest and influential one, routing and optimisation. The paper most cited on the list (1671 times) is the introduction of the flying sidekick traveling salesman problem by Murray and Chu (2015) where a delivery truck supports the drone in its service of customers. Murray and Raj (2020) later developed this concept to include a group of several drones flying from a single truck. Drone delivery has since evolved into its own research field and various reviews have been written on it such as Benarbia and Kyamakya (2022) related to feasibility of drone package delivery, and Eskandaripour and Boldsai Khan (2023) related to past, present and future of drone delivery. This implies that problems involving computers, including the routes to take and the coordination of vehicles were among the most important problems to be addressed first. An alternative delivery line focusses on other delivery methods and considers how the cost/impact can be minimised. Mangiaracina et al. (2019) studied new solutions to make LMD in B2C e-commerce more efficient, while Lim et al. (2018) analyzed how the LMD models have evolved from the context of city logistics, home delivery & business to consumer (B2C) distribution. Alnaggar et al. (2021) conducted a review of crowdsourced delivery platforms and distinguished them based on how each ought to match customers with deliverers, the customers targeted and remuneration offered. Deutsch and Golany (2018) used the parcel locker network as a design problem, and their questions as the "how many lockers should be opened, where should they be and what size should they be? In the environmental aspect, Patella et al. (2021) conducted a systematic review on the use of green vehicles in the last-mile logistic sector. These studies highlight that the world has progressed beyond vehicle routing and business models, infrastructure, sustainability, are now part of the field.

Lately there has also been some research with data-driven approaches. For instance, Bruni et al. (2023) have given a machine learning optimisation method that can aid last mile delivery decisions for third

party logistics. The work at this level indicates that new information and learning-oriented methods are being increasingly incorporated into the traditional optimisation models.

An added reason for studying this field would be through the study of COVID-19 pandemic. This forced the pandemic to speed up e-commerce adoption, in which case, Wang et al. (2023) have recommended that the use of newer last-mile delivery modality, specifically self-collection using parcel lockers, gained acceptance among consumers. Through analysis of behavioural change, maintenance and habit formation, they looked at whether there has been a behavioural shift in consumers after the pandemic has reached the last mile in delivery. As the pandemic altered how people buy and deliver packages, it's logical to wonder if it also impacted researchers' approach to writing about last-mile delivery – how much, what they about what and which countries and journals are the leaders. Given the data in this study, the question does need to be asked, as is evidenced by the roster of 146 papers with a reference to COVID-19 or COVID related in either the title or abstract.

Even with this expansion, it is hard for one to imagine the field as a whole. The majority of the reviews available in the literature focus on a specific aspect of it, for instance, drones (Benarbia & Kyamakya, 2022; Eskandaripour & Boldsaikhan, 2023), crowdsourcing (Alnaggar et al., 2021) and green vehicles (Patella et al., 2021). There are also several more general type reviews (Lim et al., 2018; Mangiaracina et al., 2019; Olsson et al., 2019) but these use a specific subset of the papers and they do not illustrate the way the literature is distributed between the years, journals and countries. Suggested as a starting point was a review of 122 review articles, however this only included review articles, and not the large number of research articles which lie below the review articles. As far as we can see, there is not much research on whole body which is conducted by utilizing the bibliometric method. Explores the evolution of the last mile delivery research, its themes and citation statistics before, during and after the COVID-19 pandemic. The aim of the present paper is to fill this gap.

This is very well suited for bibliometric analysis. When dealing with thousands of papers, it can examine a lot of scientific data and illustrate how a subject has progressed over time, it says, Donthu et al. (2021), “which is difficult to accomplish manually.” This allows for such an analysis and for the production of science maps, which can consist of thematic maps (Aria & Cuccurullo, 2017) and keyword networks (Wohmann, 2019), and is possible with the bibliometrix R-package and the web browser version Biblioshiny. The underlying approach for screening is through the use of a PRISMA flow diagram optimised for the experiences of the bibliometric screening because the PRISMA was implemented to create efficient presentation of how records are identified and selected for inclusion in the review (Page et al., 2021).

This study is intended to showcase the journey of last mile delivery research from 2013 to 2026 and on how the Covid-19 has impacted it. The research in the study is based on four research questions:

What is the evolution of scientific output by year and was there a turning point during Covid?

Identify the most significant sources, authors and countries.

What are some vocabulary that has evolved over time?3. What are some research themes that have evolved over time?

What is the difference in impact on citations for these pre-COVID vs pandemic vs post-COVID publications?

3,100 hits were found with the keyword "last mile delivery" in Scopus database. The filters used to provide the 2,771 publications used for analysis were publication year (2013–2027), document type (articles and reviews), language (English) and source type (journals). Substantive analysis is available

for publications up to 2026, but the year of 2026 is considered provisional as only half the year had elapsed by the time the data was collected. The study has two contributions. First, it offers an evidence-based overview of the structure of this rapidly expanding discipline, through which new participants (such as researchers and students) can be oriented and acquaint themselves with the discipline's main journals, countries and themes. Secondly, splitting the data into pre-COVID, pandemic and post-COVID periods helps to distinguish the impact of time from the impact of the pandemic and allows more careful interpretation of the effect of the pandemic on publications and the effect of the pandemic on citations. The rest of this paper is organised as follows. The existing literature is reviewed in Section 2, the methodology for the study, and screening strategies, in Section 3, the data analysis, in Section 4, the findings of the study, with implications, limitations and directions for further research, in Section 5, and finally, the paper is concluded in Section 6.

Literature Review

General comments on the relevant literature

E-commerce is increasingly generating urban freight, and last-mile delivery — the final link of the supply chain from a local distribution centre to the final customer — has become a topic of increasing academic focus, creating a niche of its own. While this represents only a small space in the physical logistics chain, this stage is generally recognised as the most expensive and most intricate in the chain, requiring potentially the largest portion of the overall logistics distribution cost, and the most noticeable source of congestion, pollution, and delivery failures. These pressures have been worsened by the growth of online retail and increased expectations for very quick, flexible and reliable delivery, and have led to the emergence of last-mile delivery as a prominent research area of operations research and urban logistics. Existing review literature on last-mile delivery is reviewed to understand the evolution of the field, the main themes of this literature, and the gaps which have led to continued research. The analysis does not concern itself with individual primary studies, but instead concentrates on the available review articles, which can by themselves synthesise the state of knowledge within a set of sub-fields and so provide an efficient and authoritative vantage point from which to map the domain and to situate the present work within it.

Researchers in the past: methods used

A purely bibliometric approach was adopted to analyse the review literature systematically and to minimise any subjective interpretation that could be introduced when dealing with the literature in a purely narrative way. The dataset was compiled via Publish or Perish to gather review-type articles on the subject of last-mile delivery, and the publications were then screened and processed in Biblioshiny, the web interface of the bibliometrix R package. Document type was filtered to include only review articles, and after sorting out duplication and off-topic items, 122 review articles were advanced for analysis, covering the period 2014 to 2026. The bibliographic records were then analysed through a number of complementary aspects, such as the annual publication volume, the publication sources with the most publications, the most frequently cited records, and the co-occurrence between author keywords. For these descriptive indications, complementary visualisation of keyword co-occurrence was carried out in VOSviewer, while a thematic map was generated in Biblioshiny in order to define the main themes based on their centrality (how relevant a theme is to the rest of the field) and density (how well developed a theme is). By using descriptive indicators and network-based visualisation, both the

amount of literature and its conceptual framework can be evaluated, and the observations that follow are accessible and verifiable.

Prior studies: background and history of the studies conducted before

The analysis shows a significant increase in the amount of review literature between the beginning and end of the study period. Few reviews were released prior to 2019, but that number slowly climbed until it became noticeably high in 2024 (21) and 2025 (30), with a steady rise in each year. Most of the 122 reviewed pieces were published since 2022, suggesting a recent and growing activity of synthesising last-mile delivery research, and indicating that the field has now reached a level of development where the aggregation of knowledge gained from it is in itself a significant research focus. As a proportion of the publications, the reviews are concentrated in only a few outlets: Sustainability (Switzerland) holds the top spot with 16 articles, then Drones with 7, followed by Logistics with 4. This distribution is important in two regards: the presence of an environment-minded outlet provides a clue to the sharp focus on environmental aspects in the field, and the fact that a specialist drone journal is among the top sources underlines the current robust traction of the aerial and autonomous delivery niche. The total number of citations to the 122 reviews is 4,799, averaging some thirty-nine citations per review, with as many as 371 citations to a single review, reflecting a significant scholarly impact for a still relatively young literature.

Issued a reference to a previous investigation (researcher prominent)

Among the many reviews, some are noteworthy for their prominence in the collection as a whole, and their central themes indicate some of the issues around which the field developed. The ones mentioned most often are from Mangiaracina et al. (2019), who surveyed innovative solutions and have garnered 371 citations, followed closely by Lim et al. (2018) on consumer-driven e-commerce with 352 citations. Both were published in one of the top journals on physical-distribution and logistics management and paved the way for the rest of the research. In addition to these, two themes form the seeds of frequently cited reviews that stand out. The first is drone-based delivery, which is well represented by reviews such as Benarbia and Kyamakya (2022), cited 232 times, and Eskandaripour and Boldsai Khan (2023), which outlined the history, current landscape, and future prospects for drone deliveries. The second is alternative and shared delivery models, which comes from the study conducted by Alnaggar and colleagues (2021); their review of crowdsourced delivery platforms has received 218 citations. In the field of last-mile logistics, Patella and colleagues (2021) also highlight the importance of sustainability, as their research indicates that more companies are turning to green vehicles. Overall, this trend in citation suggests a focus on delivery innovation, technology adoption, and environmental performance as areas of scholarly interest, in addition to the classic routing problem.

This research reviews the work done in the past, what has been found and suggested

The thematic map and the keyword co-occurrence analysis complement each other and offer a coherent overview of the intellectual organisation of the field. Based on the co-occurrence network, four clusters of concepts emerged, related to methods (vehicle routing, optimization, drones); e-commerce, sustainability, and literature reviews; crowdsourcing, home delivery, and parcel lockers; and the methodology of systematic reviews. Last mile and logistics are central terms of this network, which underscores their centrality as expressions shared by the whole sector. Each cluster has been identified on the thematic map, which serves to confirm and expand on this reading by assigning each a position

according to its centrality and density. Both well developed and central, optimization, drones and vehicle routing come out as motor themes. Last-mile delivery and logistics appear as basic themes, highly central but relatively underdeveloped as a grouped sub-topic, functioning as the ground on which the literature builds rather than as a meaningful stand-alone sub-topic. Review- and human-factors keywords lie in a more compact zone between the emerging and declining themes, forming a cohesive if somewhat isolated strand. The recent appearance of the technology-oriented reviews, and the fact that they are increasingly cited, indicates that data-based approaches are an expanding rather than shrinking front, and are moving towards becoming dominant.

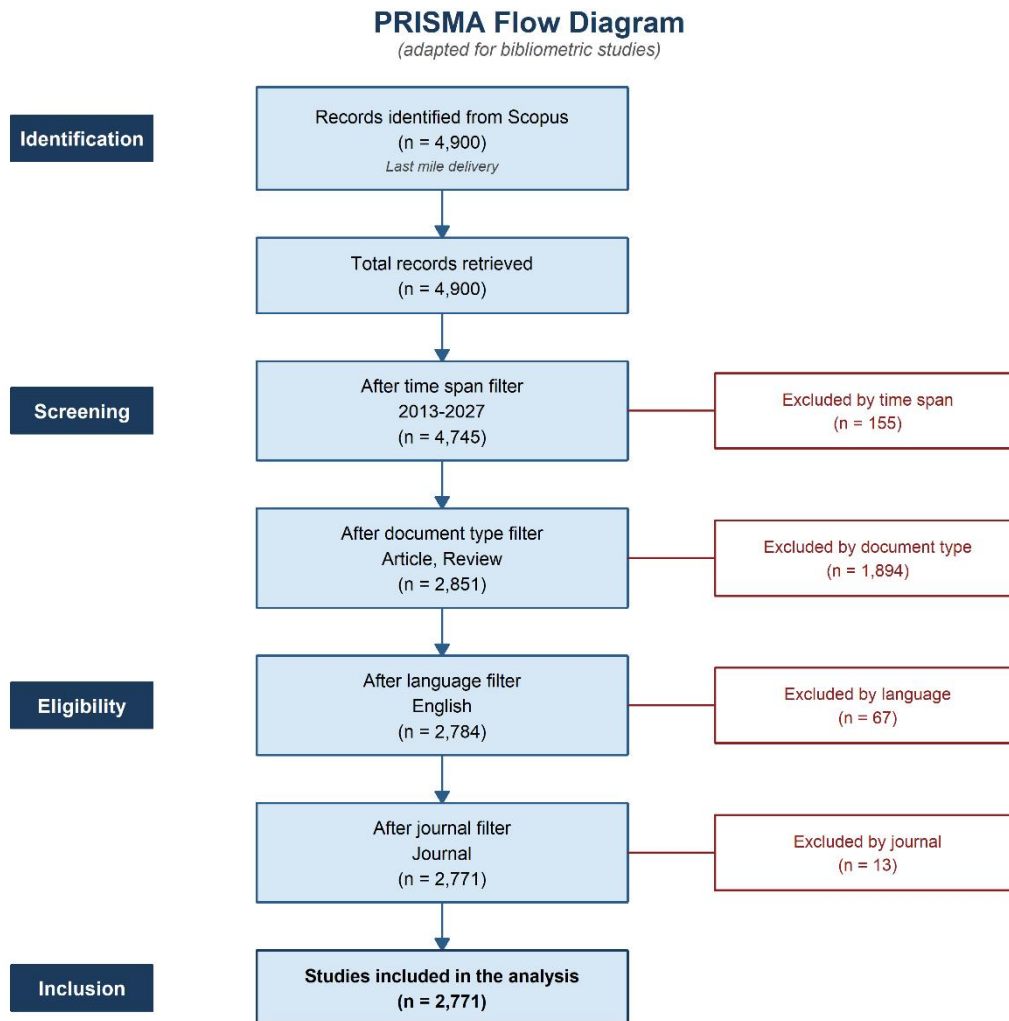
Summarising elements or parts of the review

To conclude, the literature surveyed over the last ten years has grown significantly, moving towards a blend of operations-research methods and new technologies with sustainability goals, without losing its focus on cost-efficiency and customer service. The bibliometric results suggest that this field is not only maturing, with a growing number of synthesis reviews beginning to appear, but is also gaining in diversity, with classical routing being joined by themes on drones, crowd-based delivery and data-related optimisation. Despite this, several areas warrant further investigation. The early stage of the AI and machine-learning theme means that the application of data-based approaches to existing optimization models is not yet well advanced, while the divergent nature of the technology-oriented and sustainability-oriented reviews suggests that a truly integrated approach — one that optimises cost, service and environmental targets at the same time — has yet to be developed. Another drawback seen throughout the literature is the continued use of simulated or benchmark data instead of operational data, which raises the question of whether the efficiency improvements reported in the literature translate to real-world conditions. Addressing these shortcomings, and testing the proposed models under the operating conditions of interest, serves as a basis for the present investigation.

Research Methodology

The authors of this study have used a bibliometric research approach to examine the existing literature related to last mile delivery. Through bibliometrics analysis, it is possible for the researcher to conduct systematic analysis of a collection of published researches by studying patterns in terms of growth of publications, topics of researches, sources of research, authors, and various other features of the literature. The data used in this paper was extracted from Scopus.

A PRISMA screening process was used to document the filtering of papers. PRISMA was used to clearly show how applying different filters to the original dataset affected it to reach the final set of studies used for analysis.



Data Collection

Scopus was used for the initial search and “last mile delivery” was used as the primary keyword. The key word was selected because it directly connects to the central idea of the topic and allowed scopus to give researches specifically associated to the topic.

4900 records were produced in the initial search. As the paper focuses on the recent developments in the area of research, a time period criterion was applied. A 15-year period from 2013-2027 was selected for the study. The publication year filter in scopus showed that research on last mile delivery has increased over time, particularly in recent years. 4745 records were left after applying the year filter, which means 155 papers were excluded from the study as it was not part of the time period selected. This provided a broad time span for studying the development of research on last mile delivery.

Subject Area Selection

Scopus has many subject areas which it covers like engineering, computer science, social science, medicine and many more. However, this filter was not applied as it excludes the subject area selected and the topic last mile delivery is a very broad topic. It involves operational and logistical issues but also includes areas such as technology, mathematics, decision science, Business, Management and

Accounting and many more. Thus, removing any subject area could have resulted in removal of relevant studies to last mile delivery which look at it in a different academic perspective. Hence, subject area was observed during the screening process but not applied, allowing the study to retain a wider pool of research papers.

Document Type Filtering

In the next step document type filter was applied. Only Articles and Review papers were retained for this study which came up to 2851 papers, 1894 papers were excluded from the overall study as they belonged to other document types.

Articles and Review papers were selected due to the information required for the study. Research articles are usually structured and contain everything like methodology, analysis and findings, making it easy to understand the contribution of established research. Review articles help in giving direction within a field and also provide information stating the developments in said research area as they provide broader examination of existing research.

There were many other document types as well like Conference papers, book chapter, book, note, etc. Biggest chunk of papers which were excluded were Conference paper, which were 1409. Conference papers were removed from the overall study because the goal was to create a consistent dataset for the bibliometric analysis and conference papers represent work at different stages of development which can vary and is not consistent. Hence, the document filter helped to narrow down the dataset and keep publications most useful for the study.

Language Filtering

After document type, language filter was used. Publications written in English were retained which were 2784, showing that 67 records were written in different languages. Chinese and Spanish papers had some contribution in total research papers of 45 and 10 respectively. This shows that this topic is not language specific and other countries researchers are also researching in this area.

English is a language that most of the researchers can consistently read and understand. Having papers in only one language helped maintaining a consistent dataset and made it easier during the process of analysis of titles, abstracts, keywords and research themes. But the contribution done by Chinese and Spanish papers in this area were excluded which could have relevant information related to the topic, so language filter is helpful but at the same time is limiting the scope of the study.

Source Type Filtering

For the last filter documents are removed based on their source type. The dataset was restricted to only Journals which were 2771. Other sources like trade journals, book series and conference proceeding were removed which added up to 13 records.

Only Journals were selected to have a consistent dataset and also journal publications are structured and established source of academic research and help in identifying research trends, publication pattern and development in the research area.

The final dataset after applying all these filters was 2771 journal publications, these were used for the bibliometric analysis through Biblioshiny.

PRISMA Based Screening Process

The complete selection process is shown in the PRISMA flow diagram. Initially 4900 records were identified in Scopus. After applying publication year range of 2013-2027, 4745 records were left. After that the documents were restricted to articles and reviews, resulting in 2851 records. Language filter further reduced the dataset to 2784 English publications. Finally, restricting the source type to journals resulted in 2771 studies for the final analysis.

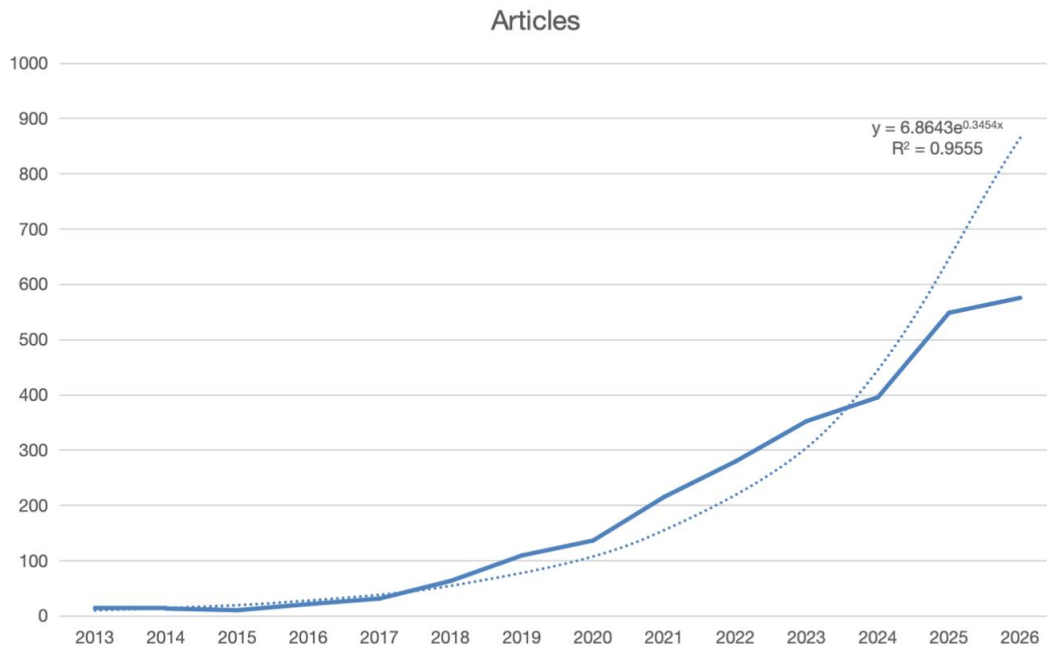
The PRISMA approach therefore shows a clear reproducible pathway from initial to final data set. Only relevant filters were used in Scopus rather than applying all of them. The final dataset of 2771 journal publications were then exported from Scopus in Ris and Bibtex file and processed using Biblioshiny for the bibliometric analysis. The resulting dataset formed the basis of examining publication trends and other things in the field of Last Mile Delivery.

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Data Analysis of Last Mile Delivery : A Pre- and Post-COVID Perspective

1. Annual scientific production

Annual scientific production in the field of Last Mile Delivery increased from just 14 papers in 2013 to 548 papers by 2025. It should also be noted that a total of 575 publications have been recorded for 2026. A very close fit to the figures of production can be given by a formula of an exponential trend line, as shown in $y = 6.8643e^{0.3454x}$, with R^2 being equal to 0.9555. The exponent indicates an average annual growth of 41 percentage points. As it turns out, the doubling of production happens every two years which is consistent with a compound annual growth rate of 41 percent for the period of 2013-2019 years. The graph shows three phases of the trend under review. In the period of 2013-2017, the number of publications remained stable. The growth started in 2018, when an output doubled from 31 papers in 2017 to 63 papers in 2018, leading to an increase to 109 papers in 2019. During the period of 2018 and 2023, the number of publications has not dropped below the line of trend. The increase of production in 2020 was recorded at the level of 25 percent from 109 to 136 papers, and in 2021 it reached the highest level of 58 percent, from 136 to 215 papers. The pandemic acted as a reinforcing factor for the growth trend already in place.



From 2024, there is a divergence between the observed and the fitted lines. In 2024, approximately 395 actual articles were published which is much lower than the fitted value of 433. The same happens in 2025 and 2026, where the model predicts that approximately 612 and 864 articles will publish respectively, while the actual outputs are around 548 and 575 articles respectively. First of all, the prediction for the year 2026 is not definite yet. Secondly, the exponential growth curves cannot last for a long time, and the smoothening of the curve after 2024 indicates the milder growths in future years as the industry matures. Hence, the trend line should be interpreted as representing the growth until 2023 rather than predicting future growth. Hence, 90.5 percent of all scientific papers appeared after the year of 2019.3.

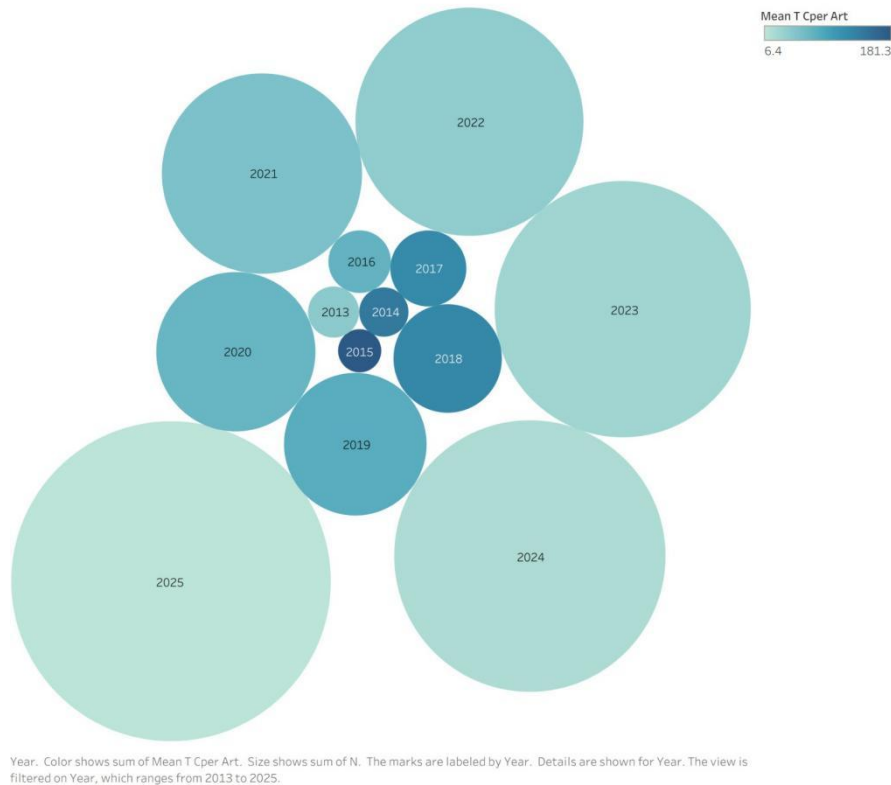
2. Pre-COVID versus Post-COVID Comparison

Phase	Years	Articles	Share	Mean citations per article	Median citations
Pre-COVID	2013-2019	261	9.5%	100.4	47
Pandemic	2020-2021	351	12.7%	60.0	37
Post-COVID	2022-2026	2,149	77.8%	14.3	5

The diagram displays three different periods. Before 2020, the number of published papers per year averaged 37; during 2020 and 2021 it increased to 176; and in 2022-2026 to about 430, which means that the publication volume increased nearly twelve times in comparison to the pre-Covid period. In contrast to that, the citation impact reduces. The average number of citations per paper was 100.4 before the Covid pandemic and subsequently fell to 60.0 and 14.3. The median also decreased: from 47 to 37 and then to 5. This change primarily relates to the time factor, as the newer papers do not have enough time to be cited. The bubble chart shows that clearly: the size of the bubbles indicates number of published papers while the colour indicates citations number; thus, the higher pale bubbles of 2021-2025

contrast with the smallest dark bubbles of 2013-2019 with the darkest bubble of 2015 that received 181.3 citations and the lightest one of 2025 that received only 6.4 citations.

Evolution of last mile delivery

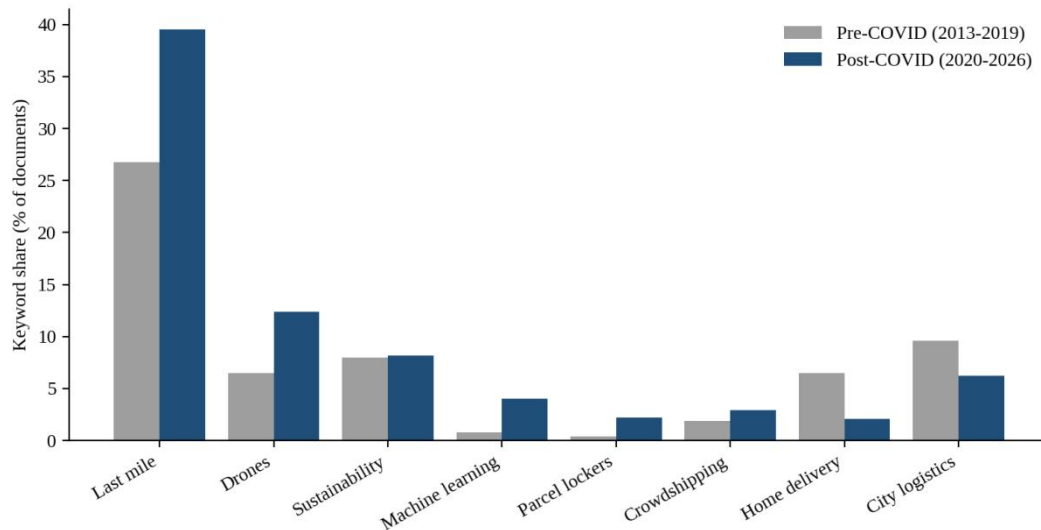


Notably, this trend also indicates that early studies are based on a limited number of core publications. Among the five most cited studies, all deal with the routing of drones and electric vehicles. (Murray & Raj, 2020) The flying sidekick traveling salesman problem published in 2015 had the largest amount of citations - 1,671. Two papers discussing the vehicle routing problem for drone delivery published in 2017 follow, Jason Lee, and others' work has 1,270 citations, and The electric vehicle routing problem with time windows and recharging stations from 2014 has even fewer citations – 1,262. The remaining two papers with fewer than 1,000 citations (953 and 585 respectively) were published in 2018. The only one published during the pandemic is the 2021 paper, A survey of last-mile delivery concepts viewed from an OR perspective, (Boysen et al., 2021) with 565 citations. according to the research, there are 146 papers that feature the keywords COVID-19 or related terms in their title/abstract, so it's evident that this issue has been relevant for some time.

3. Change in Vocabulary

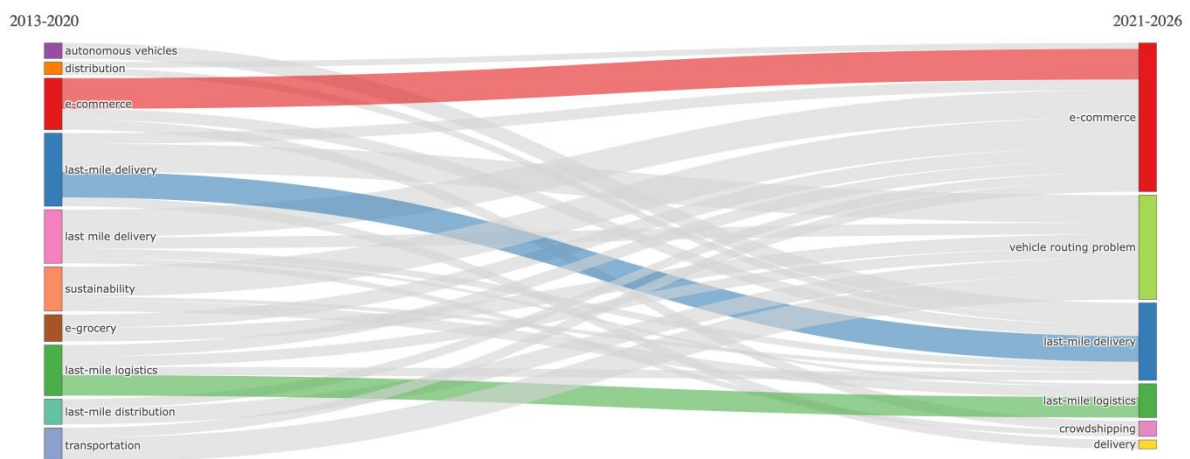
The share of documents containing last mile phrases confirmed the transition took place post-2019. The share of papers using last mile terms increased from 26.8 percent to 39.5 percent, meaning that the subject has transformed from a sub-topic of city logistics to a major one. Drones increased from 6.5 percent to 12.4 percent, machine learning from 0.8 to 4.0 percent, parcel lockers from 0.4 to 2.2 percent and crowdshipping from 1.9 to 2.9 percent. At the same time, home delivery decreased from 6.5 to 2.1 percent, while city logistics decreased from 9.6 to 6.2 percent. Hence, the vocabulary has changed from

general terms of urban freight and home delivery to technological and alternative delivery models.(Bruni et al., 2023)



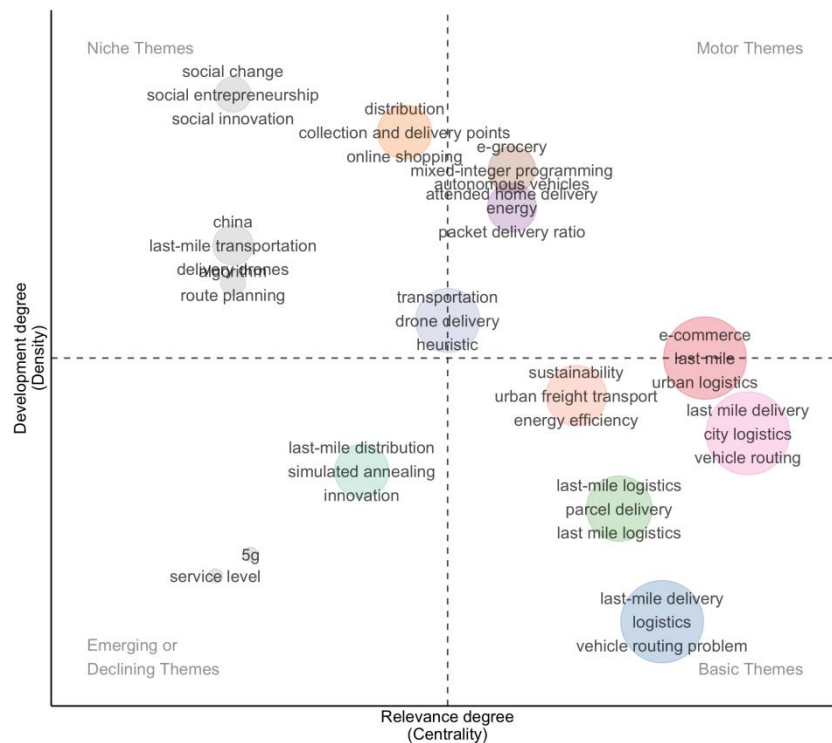
4. Thematic Evolution

The thematic evolution chart splits the corpus in the year 2020, comparing the years 2013-2020 to the years 2021-2026. In the first era the map has numerous little themes in it including autonomous vehicles, distribution, e-grocery, sustainability, transport and last mile distribution. In the second period, those themes are merged into a few bigger clusters: e-commerce, vehicle routing problem, last mile delivery, last mile logistics, crowdshipping and delivery. The main connections are in e-commerce from e-commerce, last mile delivery to last mile delivery and last mile logistics to last mile logistics, while some of the previously established ideas have gone into e-commerce and vehicle routing.



The strategic maps give more in-depth information. Between the years 2013 and 2020 the motor themes were a combination of e-grocery, mixed-integer programming, autonomous vehicles, and attended home delivery, whereas the basic themes consisted of e-commerce, urban logistics, city logistics, vehicle routing, and sustainability. Meanwhile, the niche themes included social innovation and the China-based

drone and route planning studies as well as the 5G service level that can be found in the quadrant of emerging or declining.(Murray & Raj, 2020)

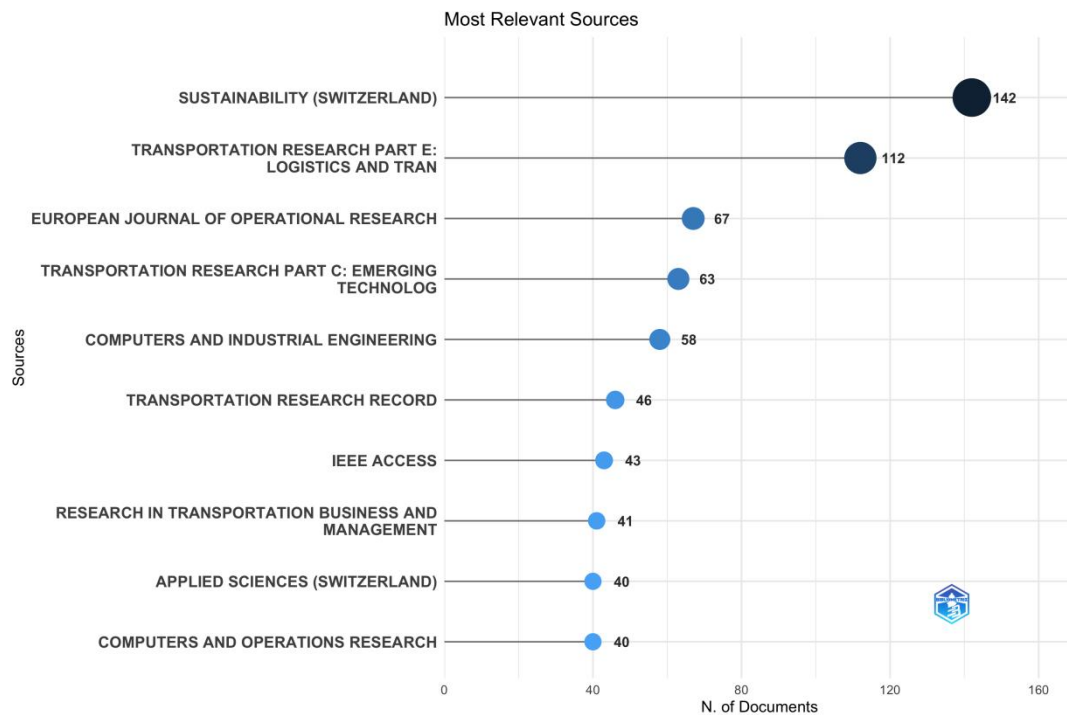


The focus of motor themes during 2021-2026 will shift towards vehicle routing as well as last-mile delivery integrated with urban logistics and machine learning.(Deutsch & Golany, 2018) The topics of e-commerce, logistics and last-mile delivery will remain constant in the literature while parcel lockers, autonomous delivery robots and crowdshipping will continue to have an emerging or declining status(Mangiaracina et al., 2019) shows that these topics are still relatively young and not fully develop.



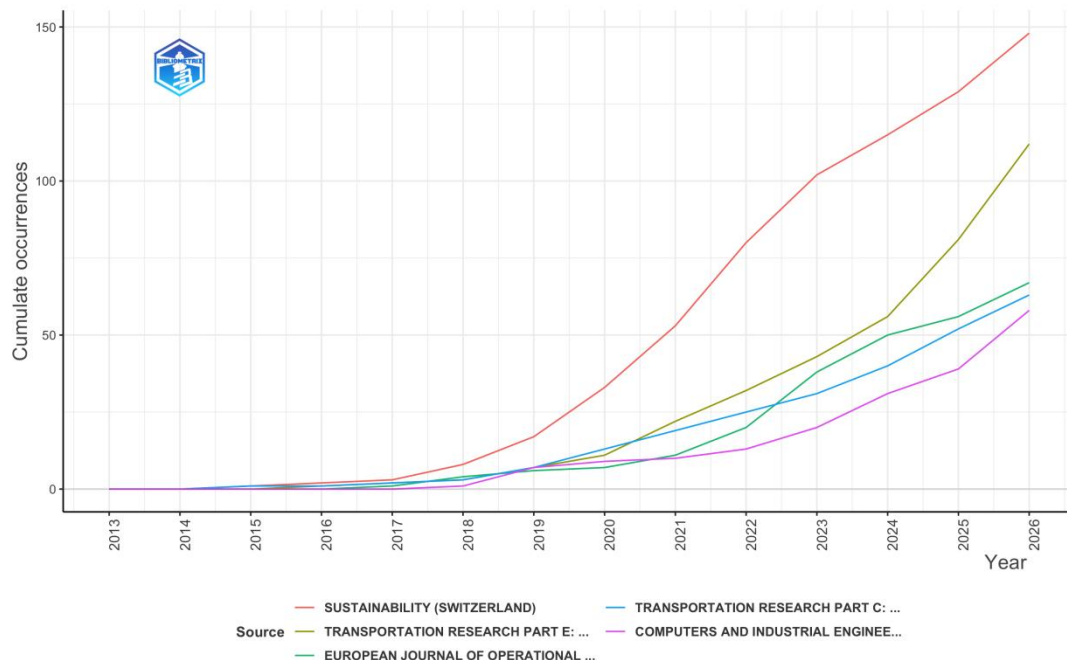
5. Sources

reports are issued from 789 sources, only 16 percent of which belongs to five prominent journals. In first place according to the quantity of published documents is the journal Sustainability (Switzerland) with 142 papers, followed by Transportation Research Part E (112), European Journal of Operational Research (67), Transportation Research Part C (63), and Computers and Industrial Engineering (58). Finally, in the list of the ten most productive journals are Transportation Research Record (46), IEEE Access, (43), Research in Transportation Business and Management (41), Applied Sciences (40), and Computers and Operations Research (40).



The source dynamics image demonstrates the shift of leadership over time. Before 2020, Sustainability was already the leader with 17 publications, which was more than Transportation Research Record (10 publications) and Transportation Science (8 publications). the Sustainability journals went on to accumulate an additional 125 more documents afterwards, which resulted in its angle being the steepest in the image. Transportation Research Part E also greatly increased its output going from about 11 documents in total in 2020 to over 110 in 2026, with 105 of its documents published post 2019. What's more, the European Journal of Operational Research and Transportation Research Part C (with routing and optimization information as their subject matter) have increased their output of documentation from a very low base to over 60 publications each

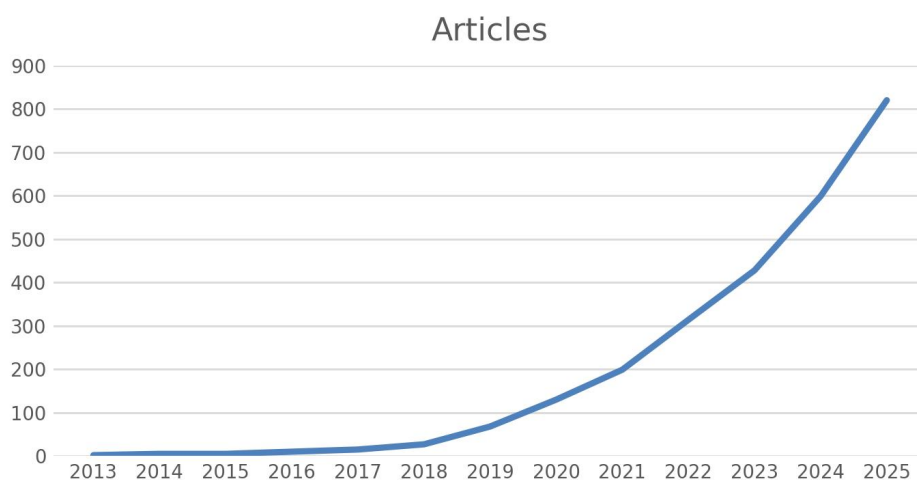
Sources' Production over Time



6. Production of Countries Over Time

The statistics of countries represent the cumulative number of articles written in the top five countries. The respective figures are represented in the line graph and data table provided below. Since the vertical axes in the figures differ among each other, slopes should be compared according to the figures rather than visually observing them.

China's statistics started in a low position with just 15 articles published in 2017, but the number gradually increased to 68, 130, and 820 in 2019, 2020, and 2025 respectively, which accounts for the highest figure compared to other countries. Also, the number of articles published in China increased from 115 to 221 between 2022 and 2025



Year	2013	2014	2015	2016	2017	2018	2019
Articles	2	5	5	10	15	27	68
Year	2020	2021	2022	2023	2024	2025	
Articles	130	199	314	428	599	820	

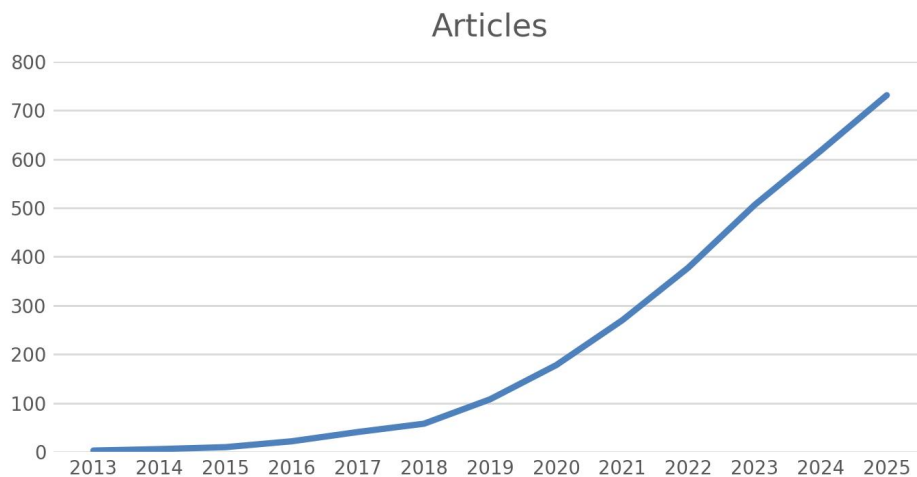
Italy's growing figures were more modest. It issued 32 documents in 2019, 78 in 2021, and 253 documents in 2025, which is nearly eight times higher than its figure for 2019.

Year	2013	2014	2015	2016	2017	2018	2019
Articles	3	4	5	5	8	16	32
Year	2020	2021	2022	2023	2024	2025	
Articles	41	78	101	147	180	253	

in comparison, the United Kingdom rose from 16 to 32 documents in the period from 2017 to 2018, and by 2025 it had reached 245, which is about six times higher than the index for 2019. It overtook Italy only in 2025 (245 vs 253)

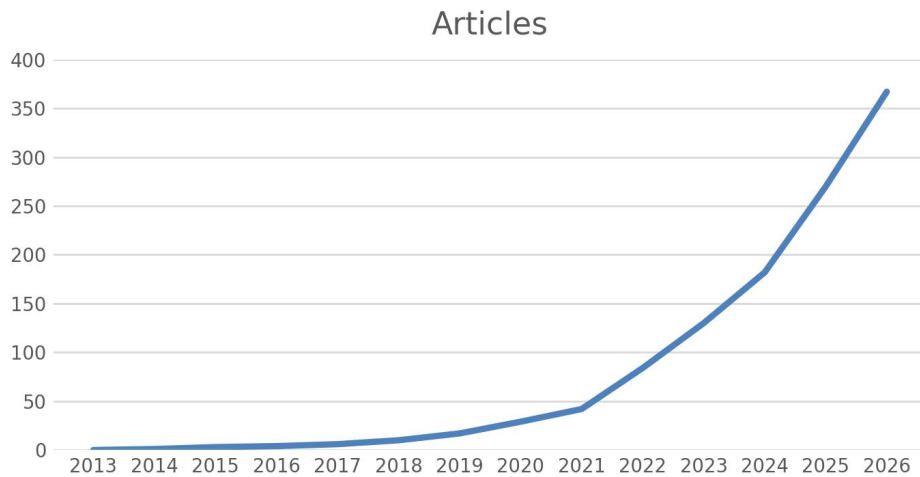
Year	2013	2014	2015	2016	2017	2018	2019
Articles	2	3	4	8	16	32	41
Year	2020	2021	2022	2023	2024	2025	
Articles	75	99	126	165	201	245	

The USA had been the leader before the pandemic, having issued 108 documents by 2019 and lagging behind China (68). The volume increased to 270 in 2021 and to 617 and 731 in 2024 and 2025, respectively, but remained stable between 108 and 128 documents in the period 2022-2025. The USA was thus overtaken by China in 2025 (820 vs 731), while in 2024 it remained behind (599 vs 617). China's share in the overall five countries' output increased from 25.6% to 35.4% and the US share—from 40.6% to 31.5%.



Year	2013	2014	2015	2016	2017	2018	2019
Articles	3	6	10	22	41	58	108
Year	2020	2021	2022	2023	2024	2025	
Articles	178	270	378	506	617	731	

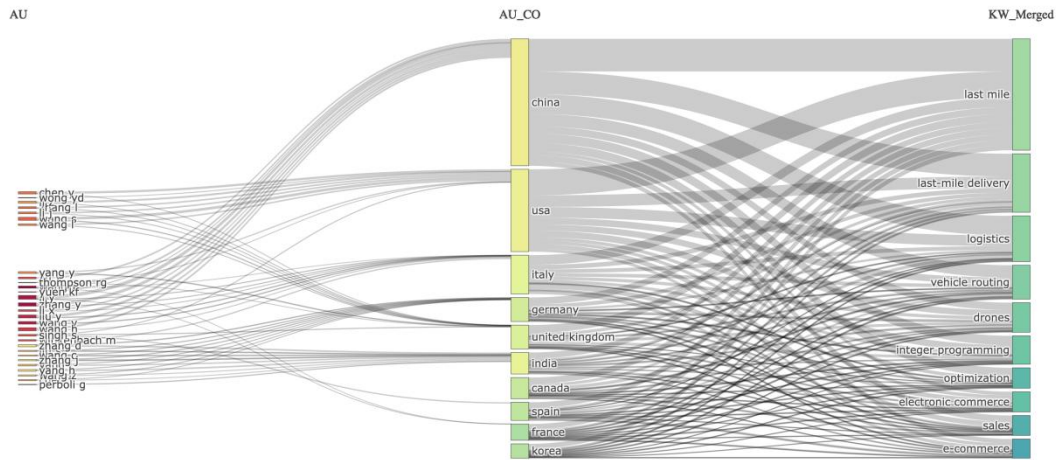
India shows the fastest relative growth. Last among the five in 2019 (17 documents), it rose to third with 270 documents in 2025, about sixteen times its 2019 level, and reached 367 in 2026. Comparisons stop at 2025 because 2026 exists only for India.



Year	2013	2014	2015	2016	2017	2018	2019
Articles	0	1	3	4	6	10	17
Year	2020	2021	2022	2023	2024	2025	2026
Articles	29	42	84	130	182	270	367

7. Authors, Countries and Keywords

The triad field graph depicts connections between authors, their countries and keywords associated with them. China and the United States represent the largest nodes among countries as well as being connected to almost every keyword, in turn being followed by Italy, Germany, the United Kingdom, India, Canada, Spain, France, and Korea. As for keywords themselves, last-mile and last mile logistics dominate the list, closely followed by logistics, vehicle routing, drone delivery, integer programming, optimization, e-commerce, and sales. The most notable authors are Wang X (43 papers), Zhang Y (34), Li Y (33), Wang Y (31), Liu Y, and Yuen KF (29). Still, frequent surnames and initials interrelate various scientist. Nevertheless, the graph indicates that the field is occupied by asian and north-American groups engaged in route planning, optimization, and logistics activities



Future Research Agenda

The study looked at over two thousand seven hundred journal articles and it shows last mile delivery research started out pretty focused on city logistics but now covers more things like routing along with new delivery technologies and customer services. Topics such as drones and machine learning along with parcel lockers and crowdshipping seem to have picked up after 2019. One issue stands out though because most of the proposed solutions get tested only through simulations. There is not much proof about how they actually perform during real deliveries. I think future work needs to look more at what works and for who and under what conditions.

The agenda they set uses this 5W1H model to outline priorities from an operations research view. It feels like some parts could use more detail on the real world side.

5W1H Framework

What Why Who Where When How	Improve routing, delivery technology, collection options and customer service.
	To test whether suggested solutions reduce costs and delays without increasing environmental harm.
	Researchers working with retailers, logistics firms, drivers, customers and city authorities.
	Urban delivery networks, including congested Indian cities and smaller towns.
	Across ordinary workdays, peak demand and disruptions, with attention to post-COVID habits.
	Use actual delivery data, optimisation models, simulation, surveys and small-scale field trials.

Smarter routing under real operating conditions

Vehicle routing remains one of the topics in last-mile delivery research. A good next step is to look at what happens when vehicle routing routes need to change during the day. Traffic delays, customer orders failed delivery attempts and vehicle breakdowns can make a vehicle routing route that looks

efficient on paper hard to follow. Researchers could compare fixed routes with flexible Vehicle routing models that change decisions as new information comes in. Machine learning may help predict demand or delivery times. Vehicle routing worth should be measured compared to planning methods. Studies should report cost per delivery distance travelled, on-time performance and the time needed to compute a new Vehicle routing route.

Balancing cost, delivery speed and sustainability

The literature often misses a link between money, service and the planet. If a fast delivery service wants to deliver it may need more vehicles.. A low-emission delivery alternative could cost more at first or make longer trips. Future studies could use a model that looks at goals at once to compare these trade-offs. Than picking just the cheapest route researchers could show all the options when delivery time, operating cost and emissions are considered together. Research on vehicles gives a good starting point. Comparisons must use the assumptions, about distance, vehicle capacity charging needs and failed deliveries so that the results make sense for delivery firms.

Testing drones, electric vehicles and autonomous delivery

The group's findings show growing attention to drone delivery. Interest in drone delivery does not prove that drone delivery is ready for everyday use. Further research must decide where drone delivery, electric vans, cargo bicycles and delivery robots can work well and where traditional transportation methods are still better. Operations Research models may look at the following factors: route planning, battery limits, carrying capacity charging times and delivery windows. Field experiments also need to consider weather, rules, road infrastructure and maintenance costs. For example a truck and drone delivery system could be compared with a van delivery system that serves the customers.

Understanding parcel lockers and crowdshipping

Parcel lockers and crowdshipping appear as themes in the analysis. Both could cut down on doorstep visits. They depend on whether customers and delivery partners are ready to use parcel lockers and crowdshipping. More work, on parcel lockers could examine how location, walking distance, accessibility and pickup hours affect demand building on network design. Crowdshipping studies could explore payment, courier availability, trust and the reliability of delivery promises. Survey findings should be checked against behaviour where possible. Researchers could then use location-allocation and capacity-planning models to decide where parcel lockers and crowdshipping are most likely to succeed.

Examining delivery preferences after COVID-19

The pandemic made more people interested in having things delivered to their homes and other choices like picking things up themselves.. It's not clear what will happen in the long run with how people behave. There have been changes in how people are involved and how they get deliveries after the coronavirus and this gives a starting point for more research. Future studies might ask if people still care most about getting things or if things like delivery fees how reliable the service is and easy places to pick things up are more important. Doing surveys again and looking at orders could help tell the difference between things people do for a short time and things they really prefer. These preferences could then be used in predictions about how people want things and in plans for delivering them. This would let

companies make decisions based on what customers want instead of thinking that everyone wants the fastest delivery possible.

Developing solutions for Indian cities and smaller firms

From the results of looking at the data set it is obvious that India is becoming a place where people are doing research on the last part of delivering things. This creates the chance to see how models made in countries work when they are used in local situations. For example it would be helpful to test the ways of sending things and collecting them in Indian cities and smaller towns taking into account traffic problems, small roads, differences in what needs to be delivered and changes that happen with the seasons. It would also be helpful to look at differences between the online shopping companies and the smaller delivery companies especially when it comes to how many vehicles they have and what kind of software they use. This is a few ideas for future tests, not things that came from the current data set.

Moving from simulations to practical trials

The biggest thing that keeps coming up in all these topics is using data from operations. Simulations are still helpful for new technologies that are not used a lot yet but results that are based only on guesses about how many people want something and on perfect travel conditions might not be easy to use. Future research could start with data about routes and orders from delivery companies that is kept private create a model, for making things better and then check how this model works compared to how the company is doing things now. A small test could then see if the new ideas are easy for drivers and customers to use. Researchers should pay attention to times when deliveries don't work and extra costs happen just like they do for the times when things go well. Sharing both the good and the bad results would give companies an idea of whether they should try a new system.

Suggested Direction for the Next Study

One next step for a feasible research project is to study the delivery routes of a city courier service using a dynamic optimization model. The study will measure delivery costs, on-time performance and emissions, on both days and busy days. Customer feedback will explain any delivery failures. This approach can close the gap identified by the group about whether the methods that look promising in research papers still work well in real last-mile delivery.

Conclusion

The aim of this research set was to sketch the evolution of last-mile delivery research from 2013 to 2026 and to ascertain whether the pandemic altered the trajectory of this. The paper studied scientific production based on 2771 journal publications derived from Scopus data and analysed using “Biblioshiny” to examine annually scientific production from years of 2000 to 2018, pre-COVID, pandemic and post-COVID and the difference in the vocabulary and themes of science, most productive sources, countries and literature citations. In general the results reveal that last mile delivery has evolved from a special issue in city logistics to a large concern.

As for the first research question, annual production increased from 14 papers in 2013 to 548 in 2025, with a very close fit of an exponential growth line $y = 6.8643e^{0.3454x}$ ($R^2 = 0.9555$), indicating that production was growing at around 41 percent annually. The number of papers published has been fairly consistent since 2013 (31 to 63), started to increase in 2018 (doubling to 63), and increased further in

2019 (to 109). The publication of papers fell in a range of 90.5 percent from the beginning of 2020. These increases have continued in 2020 and 2021 (25 percent in each year), but the growth began in advance of 2020, so it is best to read this increase as a COVID-19 reinforcement of an existing trend. This aligns with the argument that the pandemic has forced consumers to go online and, along with it, led to surging interest in last-mile solutions (Wang et al., 2023). Between 2024, the actual output (395 papers) was lower than the fitted output (433 papers), indicating that growth is declining as the field develops. The following trend line should therefore be taken as an indication of growth up to 2023, rather than as a forecast.

The second research question was related to sources, authors and countries. It is not dominated by a few very large outlets, as five of the 789 sources in the field are core journals accounting for 16 percent of the documents. Leading journals were Sustainability (Switzerland), Transportation Research Part E, (112 papers), the European Journal of Operational Research (67 papers), Transportation Research Part C (63 papers) and Computers and Industrial Engineering (58 papers). The browse tree for Sustainability finds a place more suitable to the relevance of the environmental issue agreed on by Ranieri et al. (2018) and Patella et al. (2021), and the high number of operations research journals indicates the tradition associated with the routing. In terms of number of articles pubbed, China had surpassed USA in 2025, with 820 articles published, while 731 were published in USA. India took the third place and Italy and the United Kingdom finished the top 5. India was not far behind, with its articles up 141-fold from 17 in 2019 to 270 in 2025. Except for the largest author nodes with the greatest numbers of papers (Wang X, 43 papers; Zhang Y, 34 papers; and Li Y, 33 papers), China and the United States were the largest author–country–keyword network nodes.

The third research question dealt with themes and vocabulary. The number of documents with last mile terms increased from 26.8 to 39.5 percent following 2019, showing that last mile is becoming a central topic of the city logistics field and not a sub-topic anymore. The growth slowed down in the fields of home delivery (from 6.5 to 2.1 percent) and city logistics (from 9.6 to 6.2 percent), but in other segments, the numbers went up. Drones grew from 6.5 to 12.4 percent, machine learning from 0.8 to 4.0 percent and parcel lockers from 0.4 to 2.2 percent; in crowd shipping the figure rose from 1.9 to 2.9 percent. This is a similar evolution in the thematic analysis. In 2013–2020 the field consisted of various manysmall themes, including autonomous vehicles, distribution, e-grocery and sustainability, whilst from 2021-2026 these themes came together into a few big clusters on e-commerce, vehicle routing, last-mile logistics and crowdshipping. In the later period, parcel logistics, and autonomous delivery robots and crowdshipping were in the emerging or declining quadrant, indicating that they are still at the very beginning of development and not well-matured or established. Vehicle routing and machine learning emerged as motor themes. The topics emphasized in the previous reviews (Alnaggar et al., 2021, Benarbia & Kyamakya, 2022, Mangiaracina et al., 2019) are all being followed here, as is the increased implementation of data driven methods (Bruni et al., 2023).

The fourth research question was related to citation impact. The mean number of citations per article decreased from 100.4 in the pre-COVID period to 60.0 in the COVID period and 14.3 after COVID; the median number of citations per article decreased from 47 in the pre-COVID period to 37 in the COVID period and 5 after COVID. The pattern should not be interpreted as a quality indicator for declining quality. This primarily includes a bias in time because there has not been as much time yet for newer papers to be cited, and the early studies are also influenced by a few studies on the core of drone and

electric vehicle routing Murray and Chu (2015). Therefore, these figures should be interpreted as a cumulative influence for the years 2013-2019, but not as a direct comparisons with recent years.

These results are significant for a number of reasons. The results have a number of consequences. For researchers, the development of drones, machine learning, parcel lockers and crowdshipping give ample opportunity to work on these topics. The review of 122 review papers also highlighted three areas that needed improvement—first, the use of simulated or benchmark data rather than operating data, second, using an integrated approach balancing the costs and the services and environmental targets, and third, the early phase of the applications of artificial intelligence and machine learning. Among practitioners and policy makers, the findings provide a short history of evidence for newer models of delivery, and reported gains in efficiency with newer models should, therefore, be viewed with a modicum of caution, pending further testing under actual operating conditions. The maps of jumps, of countries, of themes can help a student/researcher learn the location where main discussions in a field occur.

There are a number of potential limitations to be noted. First, Scopus was only included, so potentially relevant work that is indexed in other databases may not have been found. Secondly, articles and reviews in the English language in newspapers and magazines were included in the compilation, excluding 1,409 conference papers (of which 45 were interlingual Chinese and 10 Spanish), and 67 interlingual records (45 in Chinese, 10 in Spanish) which did not appear in English-language newspapers and magazines. The exclusion of Chinese language work is, however, under-estimates its contribution, since China is now the single biggest contributor. Third, a single keyword was used for searching the papers and papers describing the same subject with different words might not get into the search. Fourthly, the data for 2026 is provisional, because 2026 is not yet completed when the data was collected. Last, what bibliometric methods cannot do is determine the quality or results of any particular paper; and citation counts can vary greatly as a function of the age of the paper. The limitations lead to a number of future research suggestions. A merger of Scopus with Web of Science being made to get broader coverage, and incorporating papers from conferences and non-English languages to determine if similar patterns exist. The study suggests a content analysis of papers cited most would provide explanations for the impact of drone and electric vehicle routing studies. A comparison of citations would be useful however, again in a few years' time when papers have had time to collect citations, or age adjusted citation scores should be used. Lastly, empirical research assessing optimisation and machine learning models on real-world data, while also taking into account cost, service and environmental goals, would be valuable for determining if benefits highlighted in the literature are relevant when it comes to practice.

After summarizing this evidence from 2,771 journal publications, the research field of last-mile delivery can be said to expanded rapidly and was accelerated by the pandemic, eventually becoming more varied in terms of technology, delivery strategies (including non-traditional) and the sustainability. The field is maturing, but several of its most promising themes are still emerging and this affords useful empty space to continue in future.

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