

# Application of Operations Research in Sustainable E-Commerce: A Bibliometric Systematic Literature Review

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## ABSTRACT:

This paper presents a Bibliometric Systematic Literature Review (BSLR) of how Operations Research (OR) is applied to sustainable e-commerce and retail. Data were drawn from the Scopus database and screened using the PRISMA framework, giving a corpus of 2,370 documents from 1,039 sources published between 2006 and 2026. Output has grown at 20.94% a year, and an exponential trend ( $R^2 = 0.9854$ ) fits the data far better than a linear one. Publication is concentrated in a single journal, Sustainability (Switzerland), which accounts for 11.9% of documents, and the United States and China lead geographically, while Sub-Saharan Africa, Central Asia and the Middle East record no output and international co-authorship stands at 24.81%. Thematic mapping shows no stable theoretical core, and “e-commerce” is not a prominent keyword, so the corpus reflects sustainable retail more broadly. OR is a minor constituent: optimization and e-commerce terms appear together in only 27 papers. Eight directions for future research are proposed, covering returns and packaging, demand and routing, sustainability accounting, strategic actors and fairness, digital technologies, end-to-end integration, emerging markets, and data and methods. Implications for theory, management, methodology and policy are discussed.

**KEYWORDS:** Operations Research; Sustainable E-Commerce; Bibliometric Analysis; Systematic Literature Review; Last-Mile Delivery; Reverse Logistics; Circular Economy.

## 1. INTRODUCTION

The rapid proliferation of electronic commerce has fundamentally transformed global trade patterns, reshaping consumer behaviour, supply chain architectures, and distribution logistics on an unprecedented scale. E-commerce has made it possible to sell goods and services online, which has in turn affected consumer behaviour, as well as supply chains and distribution channels. Notwithstanding the remarkable economic efficiencies introduced by this digital commercial revolution, including reduced overhead costs, accelerated delivery timelines, and expanded consumer reach, the environmental consequences of large-scale e-commerce operations have emerged as a critical concern for scholars, practitioners, and policymakers alike. The escalating volume of last-mile deliveries, excessive and single-use packaging waste, energy-intensive data centre infrastructure, and fragmented reverse logistics collectively contribute

to a mounting carbon footprint that stands in direct tension with global sustainability commitments, particularly those enshrined in the Paris Agreement and the United Nations Sustainable Development Goals (SDGs). Research examining packaging systems in e-commerce contexts has further demonstrated that consumer disposal behaviour and material perceptions are directly shaped by the sustainability credentials of packaging choices, underscoring the systemic nature of the environmental challenge.

At the same time, the discipline of Operations Research (OR) — encompassing methodologies such as linear programming, multi-objective optimization, simulation modelling, multi-criteria decision analysis (MCDA), resource allocation models, and heuristic algorithms — offers a rigorous and quantitatively grounded analytical foundation for addressing these complex sustainability trade-offs. Operations Research has been effectively used to solve complex problems with multiple variables including military, manufacturing, management, healthcare, and financial planning. Its application to sustainable e-commerce supply chains, green last-mile logistics networks, and circular economy design problems presents a compelling, practically significant, and underexplored frontier. Despite the existence of such computational techniques, the level of application of OR techniques in addressing sustainability issues in e-commerce has not been sufficiently explored in previous literature.

Notwithstanding this surge in scholarly interest, a significant methodological gap persists. Existing reviews on sustainable e-commerce tend to be either narrative in orientation or thematically selective, and do not employ systematic bibliometric tools to rigorously map the structural patterns, intellectual evolution, prominent contributors, and emerging research frontiers of this interdisciplinary field. While bibliometric work has been conducted in adjacent areas such as CSR and retail sustainability and circular economy trends in e-commerce, to date no research has performed a bibliometric synthesis that focuses specifically on OR-informed sustainable e-commerce research across the years 2006 to 2026. There is, therefore a need for a Bibliometric Systematic Literature Review (BSLR). The BSLR must bring together this landscape in a way that is clear repeatable and based on solid evidence. With a BSLR scholars can see not what has already been studied, but also how ideas have changed over time, where most studies are focused and where important gaps still exist.

The current corpus shows this problem clearly. It covers 2,370 papers from 1,039 sources over twenty years. These papers appear in different journals from operations management to food science to environmental policy. No single researcher can find their way through this spread without a map. Without bibliometric analysis, a scholar entering this field would have no way of knowing that a single journal accounts for nearly 12% of all published output, that two countries produce a disproportionate share of the world's research while several major regions contribute nothing measurable, or that the most-used keyword in the corpus is a broad umbrella term rather than a precise indicator of OR application. These hidden patterns. The geographic focus, the dominance of journals and the vague terms. Are invisible when reading alone.. A bibliometric analysis makes them clear. These patterns decide which gaps are real and which are only seeming

This paper addresses that need directly. Employing a structured dual-string keyword search protocol on the Scopus database via the Publish or Perish software interface, an initial Scopus search conducted in August 2026 retrieved 800 records, which were reduced to 542 peer-reviewed journal articles following deduplication and screening. Subsequently, an updated Scopus export was conducted for the final bibliometric analysis, producing a corpus of 2,370 documents spanning 2006–2026. This 2,370-document corpus forms the basis of the bibliometric results reported in the present study. This methodological approach is consistent with prior bibliometric reviews in related domains, and extends them by focusing

explicitly on the intersection of OR methods with sustainable e-commerce. Keywords deployed across both search strings included: "e-commerce," "ecommerce," "electronic commerce," "sustainab\*," "green logistics," "circular economy," "optimization," "operations research," "operational research," "decision making," "resource allocation," "logistics," and "supply chain." The corpus was subsequently expanded to 2370 documents covering 2006–2026 following a Scopus export. Analysis of the final corpus was conducted using bibliOShiny (via R Studio) and VOSviewer, enabling annual scientific production trend analysis, co-occurrence network mapping, thematic evolution tracking, and cluster visualization.

The primary objectives of this review are fourfold: (i) to map the annual scientific production trend of OR-related sustainable e-commerce research across the 2006–2026 corpus; (ii) to identify and profile the most productive authors, high-impact journals, and leading contributing nations; (iii) to visualize the conceptual and thematic structure of the field through co-occurrence networks and thematic mapping; and (iv) to provide a structured, evidence-based agenda for future research grounded in identified intellectual gaps. The remainder of this paper is organized as follows: Section 2 presents the Literature Review. Section 3 details the Research Methodology. Section 4 presents the Data Analysis. Section 5 proposes a Future Research Agenda. Section 6 concludes the paper.

## **2. LITERATURE REVIEW**

Sustainable e-commerce has become an increasingly important area of research because the convenience of online shopping depends on a large operational system involving inventory, warehousing, packing, transportation, delivery and returns. Every stage requires resources, and decisions made at one stage can affect costs and environmental performance at another. Customers generally expect deliveries to be fast, reliable and inexpensive, while firms are under increasing pressure to reduce fuel use, congestion, packaging waste and carbon emissions. This makes sustainable e-commerce more than an environmental issue; it is also a decision-making problem. Operations Research (OR) is relevant because it provides methods for dealing with limited resources, uncertainty and competing objectives. The recent 2026 studies in the RIS literature show a gradual movement from conventional efficiency-based decisions towards models that bring cost, service quality and sustainability into the same operational framework.

One of the most visible areas in this literature is last-mile delivery. The final stage of an online order is particularly difficult because delivery speed, route length, vehicle utilization, customer convenience and environmental impact can conflict with one another. Kaur et al. (2026) examine barriers to sustainable last-mile delivery in online retail using Spherical Fuzzy AHP. Their study considers a range of operational and infrastructural barriers rather than treating sustainability as a single measurable factor. Pathak et al. (2026) similarly use Fuzzy AHP to evaluate last-mile delivery performance through criteria including environmental cost reduction, process management and customer satisfaction. These studies show how multi-criteria decision-making can be useful when operational managers have to compare alternatives that cannot be judged only by cost or distance. Bălan and Munthiu (2026), through a systematic review, also emphasize the role of retailers and consumers in encouraging more environmentally sustainable last-mile behaviour.

The question of delivery speed becomes especially important when customer expectations are considered. Nguyen, Azmat and Hadeed (2026) examine the trade-off between speed and green delivery options in UK retail and logistics. Their work draws attention to the difference between the sustainability objectives of firms and the delivery choices that customers actually see at the point of purchase. A faster delivery option may be attractive to customers but can make consolidation more difficult, while a greener option

may require greater flexibility from customers. From an OR perspective, this is a multi-objective problem rather than a simple cost-minimization problem. Ahemad et al. (2026) address a similar issue in sustainable transportation planning for perishable goods by combining fuzzy decision-making with route selection and multi-objective considerations. Fugihara et al. (2026) examine vehicle routing with backhauls in retail, showing the importance of using return journeys more effectively. Together, these studies suggest that route decisions can be used not only to reduce distance but also to improve utilization and limit unnecessary transportation.

The literature also shows that sustainability is increasingly being incorporated into inventory decisions. Online retailers need to maintain sufficient stock to meet uncertain demand, but excessive inventory can lead to higher storage costs, deterioration and unnecessary resource use. Rani, Maheshwari and Sharma (2026) develop a sustainable inventory model for perishable products that combines preservation investment with environmentally responsive demand. Naik and Naik (2026) similarly integrate promotional efforts, preservation technology and green investment into retail inventory optimization. Keswani et al. (2026) introduce reliability and green efforts into a fuzzy inventory model for deteriorating items. These studies extend the traditional inventory problem because the objective is no longer limited to finding an economically efficient replenishment policy. Environmental considerations, preservation investment, demand behaviour and uncertainty are increasingly being considered together. This makes OR useful for examining how a change in one decision, such as investment in preservation technology, can influence both operating cost and environmental performance.

Green investment and carbon regulation form another connected stream of research. Hasan et al. (2026) study emissions-control investment in inventory systems, while De and Poddar (2026) examine pricing and green investment decisions in a two-echelon supply chain under carbon-emission considerations. Ma et al. (2026) consider financing and carbon-emission reduction under cap-and-trade and reward-penalty policies. These studies show that environmental decisions are increasingly being treated as part of the core business problem rather than as an external requirement. A firm may have to decide whether investing in cleaner technology, changing prices or modifying replenishment policies can provide sufficient operational or environmental benefits. OR models provide a way to represent these relationships and examine different combinations of decisions under constraints. This is particularly relevant for e-commerce because large delivery networks can create environmental impacts even when individual transactions appear small.

Another important development is the growing attention to reverse logistics and closed-loop supply chains. Product returns are a major feature of online retail, and the environmental impact of an order does not necessarily end when the product reaches the customer. Ho et al. (2026) combine predictive analytics with network optimization for flexible reverse logistics in retail. Their approach is significant because it connects two different stages of decision-making: predicting returns and then deciding how the reverse network should be organized. Lalremruati and Khanna (2026) examine a closed-loop supply chain with dual recycling and multi-channel retailing, bringing recycling decisions into the operational model. Vishnoi et al. (2026) also consider a closed-loop supply chain with two warehouses, dynamic demand, trade credit and emissions constraints. These studies show that sustainable e-commerce increasingly involves managing both forward and reverse flows. Circularity may reduce waste and resource use, but it also introduces additional transportation, storage and processing decisions that need to be coordinated.

The recent literature further shows a growing connection between Operations Research and artificial intelligence. Bhavikatta and Goluguri (2026) use LSTM-based forecasting for sustainable supply-chain

planning, illustrating how machine learning can improve information about future demand. Kumar and Khedlekar (2026) develop a hybrid framework that combines AI, blockchain, reinforcement learning, stochastic demand forecasting and sustainable supplier selection. Iurchenko et al. (2026) focus on stochastic decision-support modelling under demand and lead-time uncertainty. These studies suggest that AI and OR can perform complementary roles. Machine learning can help predict what may happen, while OR can use those predictions to determine what should be done within operational constraints. This distinction is important because forecasting alone does not decide how much inventory to hold, how vehicles should be assigned or where resources should be placed. The combination of prediction and optimization can therefore make sustainable e-commerce decisions more responsive to changing conditions.

The literature also raises questions about how sustainability should actually be measured. Much of the OR research can quantify cost, distance, delivery time and carbon emissions relatively easily, but social outcomes are harder to represent. Raikar et al. (2026) discuss the ethics of AI-based supply-chain optimization and highlight the need to balance efficiency with fairness. This broadens the sustainability discussion beyond environmental performance. A decision that reduces delivery cost or emissions may still create concerns if it is difficult to explain, unfairly distributes resources or negatively affects workers and communities. Similarly, the effectiveness of sustainable technologies depends on the operating context. Electric vehicles, consolidation centres, recycling facilities or alternative delivery modes may not produce the same results in every market because demand density, infrastructure and customer behaviour differ. OR is useful in such situations because it allows different conditions and constraints to be represented rather than assuming that one solution will work everywhere.

This shift is also important for the practical relevance of the field. E-commerce companies rarely make sustainability decisions in isolation. A change in delivery policy can affect warehouse workload, vehicle requirements, customer satisfaction and return rates at the same time. Similarly, a decision to hold more inventory closer to customers may shorten delivery distances but increase storage requirements. The literature therefore supports a broader view of OR in which operational decisions are evaluated according to their effects across the wider system. This makes the topic relevant not only to researchers developing optimization models, but also to managers who have to translate sustainability targets into everyday operational decisions.

Taken together, the 2026 literature can be viewed through several closely connected streams: sustainable last-mile delivery and routing, inventory and green investment, reverse and closed-loop logistics, and the integration of AI with operational decision-making. These are not separate problems in practice. Demand affects inventory, inventory affects fulfilment, fulfilment affects transportation, transportation affects emissions, and returns create additional reverse flows. This interconnected nature of e-commerce explains the increasing interest in integrated models. At the same time, some gaps remain. Research is still more concentrated on logistics and last-mile delivery than on areas such as warehouse energy use, packaging and the social dimension of sustainability. Many models also simplify real operations by assuming known demand or fixed travel conditions, even though e-commerce is highly dynamic. Future research can therefore make greater use of stochastic, robust and dynamic optimization and can connect inventory, warehousing, packing, routing, delivery and returns in end-to-end models. Overall, the recent literature suggests that the role of Operations Research in sustainable e-commerce is shifting from optimizing individual activities towards coordinating an entire system in which economic, environmental and social objectives have to be considered together.

### 3. RESEARCH METHODOLOGY

A Systematic Literature Review (SLR) is a systematic way of examining the existing body of research on a particular subject by analysing patterns, trends, relationships and developments within published literature (Paul & Rialp, 2020). The current study aims to understand the past patterns, trends and development of sustainable retail research, and how these trends can be used to identify potential areas for future research. As sustainable retail is a growing field of research, a systematic literature review can provide useful insights into how the subject has developed over time, which areas have received greater academic attention, and how different disciplines and concepts are connected within the field. The study uses a bibliometric approach to systematically examine the existing literature on Sustainable Retail.

#### ***Article selection, inclusion and exclusion criteria***

For conducting the bibliometric study, we used Scopus, Microsoft Excel, R, RStudio and Biblioshiny at different stages of the research process. Scopus was used as the main source for collecting the research papers related to sustainable retail.

We then used R and RStudio to access Biblioshiny, which is an interface used for bibliometric analysis. Biblioshiny was used to conduct the main bibliometric analysis of the selected literature. Through Biblioshiny, we were able to examine different aspects of the research field, including publication trends, research themes, keywords, authors, countries, sources and relationships between different areas of research. Using these tools together helped us move from the initial collection of literature to the organisation and analysis of the data in a systematic manner. This also ensured that the bibliometric analysis was based on the final dataset selected through the inclusion and exclusion criteria

The data selection was conducted using Scopus, one of the largest databases of peer-reviewed academic literature. Scopus was selected as it provides access to a large collection of academic publications and allows researchers to identify and screen relevant literature in a systematic manner. This helped us ensure that the research used for the study was relevant and academically reliable.

The Data selection process was conducted on 16th September 2026. It was conducted on Scopus, Using PRISMA framework(Moher et al., 2010), which is a widely used way of conducting a bibliometric study where the data base selection is cut into a four-phase diagram. The four phases being- Identification, Screening, Eligibility, and Inclusion. The PRISMA flowchart is given in figure 1

The first of the 4 phases was identification. The data base search on Scopus using the keywords retail AND Sustainability turned up 3685 papers from 2027-1991. The next step is screening where we filter the database, but we chose to pick papers from 2006-2026 to keep the data relevant. During the initial examination of the Scopus results, we found that research related to sustainable retail was spread across a wide range of subject areas. The results included research connected to fields such as medicine, agriculture, mathematics, arts, sociology, dentistry and several other disciplines. This was an important finding because it demonstrated that sustainable retail is not restricted only to commerce or management. Instead, sustainability within retail can be connected to different industries and academic disciplines. Therefore, we chose not to exclude specific subject areas, allowing the study to capture the interdisciplinary nature of sustainable retail research.

The Scopus database also contained different document types, including articles, books, conference papers and other forms of academic publications. The presence of multiple document types indicated that sustainable retail has generated interest across different forms of academic and professional research. However, for the purpose of maintaining a consistent and manageable dataset, the selection criteria were applied to identify the literature relevant to the objectives of the study.

The next selection criterion was language. Although the majority of the identified literature was published in English, the database also contained publications in Spanish, German, Chinese, French and other languages. We chose to include only English-language papers, as these were the papers that could be consistently reviewed and analysed by the researchers. Papers published in other languages were therefore excluded from the final dataset. At the same time, the presence of multiple languages in the initial search demonstrated that sustainable retail is being researched internationally and is not limited to a single geographical or Western academic context.

The Scopus database also contained different sources of publication, including journals, conference proceedings, books and other publications. We chose to include only journal publications and exclude all other sources of publication to ensure that our database maintained a high level of academic quality and consistency.

We chose to use a bibliometric study for our literature review because it allowed us to study the existing research on sustainable retail in a more systematic and structured way. Since sustainable retail is a growing research field with a large number of publications, a bibliometric study helped us analyse the past patterns, trends and development of research in this area. It also allowed us to understand how research on sustainable retail has changed over the years and which areas have received greater attention from researchers. Another reason for choosing bibliometric analysis was that the research on sustainable retail is spread across different industries, subject areas and geographical regions, making it difficult to understand the overall development of the field through a traditional literature review alone. Through bibliometric analysis, we can identify important research trends and areas of interest within the existing literature and use these insights to understand possible directions for future research.

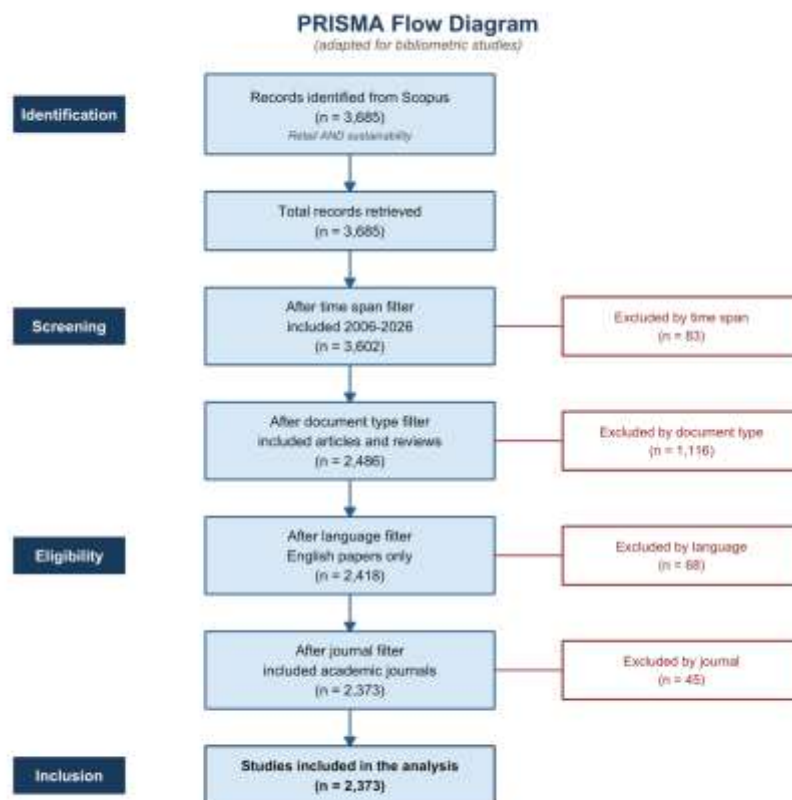


**Figure 1. PRISMA flow diagram (adapted for bibliometric studies)**

### ***Limitations***

Although the study provides useful insights into the development of sustainable retail research, there are certain limitations that need to be considered. Firstly, the study uses Scopus as the only database for collecting research papers. Although Scopus provides a large collection of academic literature, it does not include every publication available across different academic databases. Therefore, some relevant studies published in databases other than Scopus may not be included in the analysis.

Secondly, the study includes only English-language publications. Research published in other languages was excluded because of the difficulty in consistently reviewing and analysing it. This may result in the study not fully representing research conducted in different countries and languages.

Another limitation is that the study focuses only on journal publications and excludes conference papers, books, book chapters and other sources. While this was done to maintain consistency and academic quality within the dataset, it may have resulted in the exclusion of some relevant research and emerging ideas.

The study also uses the keywords “retail” AND “sustainability” for identifying the initial literature. As a result, studies that discuss sustainable retail using different terminology or related concepts may not have been captured in the search. The results of the bibliometric analysis are therefore dependent on the keywords and search strategy used.

## **4. DATA ANALYSIS AND RESULTS**

### **4.1 Corpus Overview**

The corpus contains 2370 documents in 2006-2026 from 1039 sources (journals, books, etc.). 2200 of these 2370 are articles and 170 are reviews. It contains 6394 Keywords Plus terms (ID) and 7317 author keywords (DE). There are no cited references in this export (References = 0 in the Main Information summary). The number of citations per document averages 24.55, while the average age of a document is 4.54 years, according to the source tool, which calculated these values.

7219 unique author identifiers are present in the corpus, with 3.56 co-authors per document, on average. 259 authors are responsible for single-authored documents (documents with only one author). 278 single-author documents (11.7% of the corpus) are present, too. These are two separate ways of measuring the same thing, and that is why they are presented separately, to avoid mixing them up. The international cooperation rate equals 24.81% (the percentage of documents with authors from more than one country), which means that approximately every fourth document has been co-authored internationally.

| <b>Metric</b>                   | <b>Value</b> |
|---------------------------------|--------------|
| Timespan                        | 2006–2026    |
| Sources (journals, books, etc.) | 1,039        |
| Documents                       | 2,370        |
| Annual Growth Rate              | 20.94%       |
| Document Average Age            | 4.54 years   |
| Average citations per document  | 24.55        |

|                                      |                                  |
|--------------------------------------|----------------------------------|
| References                           | 0 (not populated in this export) |
| Keywords Plus (ID)                   | 6,394                            |
| Author's Keywords (DE)               | 7,317                            |
| Authors                              | 7,219                            |
| Authors of single-authored documents | 259                              |
| Single-authored documents            | 278 (11.7%)                      |
| Co-authors per document              | 3.56                             |
| International co-authorships         | 24.81%                           |
| Document type – article              | 2,200 (92.8%)                    |
| Document type – review               | 170 (7.2%)                       |

**Table 1. Main information about the corpus**

## 4.2 Annual Publication Trend

The number of documents increased yearly from 9 documents in 2006 to 403 documents in 2026 (Table 2, Figure 2). The growth trend was slow and uneven during the first decade – the output almost doubled from 9 to 20 in 2006-2009, slightly reduced to 19 in 2010, grew significantly in 2011 to 38, and slowly declined to 30-60 from 2012 to 2017. Since 2018, the second growth phase has begun (100 documents, the first year surpassed 100 documents), and it has been going quite steady until 2026 (403 documents), with only one year (2019 to 2020: 120 → 121) showing no significant year-to-year change.

| Year | Articles | Year | Articles |
|------|----------|------|----------|
| 2006 | 9        | 2017 | 63       |
| 2007 | 9        | 2018 | 100      |
| 2008 | 16       | 2019 | 120      |
| 2009 | 20       | 2020 | 121      |
| 2010 | 19       | 2021 | 173      |
| 2011 | 38       | 2022 | 181      |
| 2012 | 30       | 2023 | 213      |
| 2013 | 46       | 2024 | 262      |
| 2014 | 56       | 2025 | 382      |
| 2015 | 52       | 2026 | 403      |
| 2016 | 57       |      |          |

**Table 2. Annual publication counts, 2006–2026**

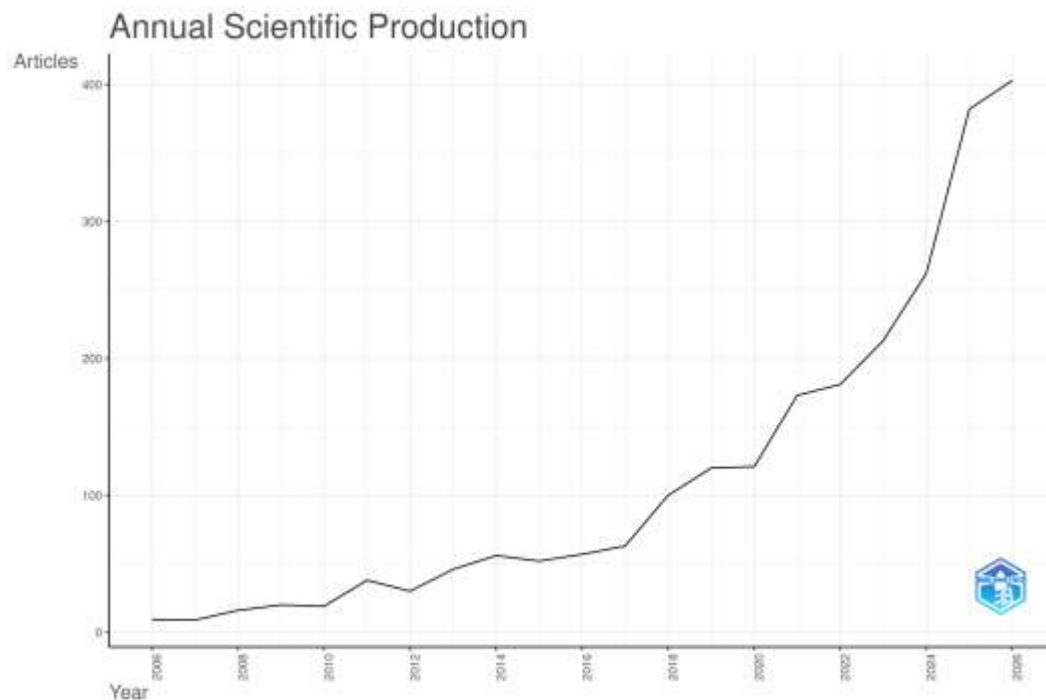


**Figure 2. Annual scientific production, 2006–2026**

Two trend lines were fitted to the whole 21-year series. A linear model is nearly useless here ( $R^2 = 0.7909$ ), explaining barely any of the variance in the data; moreover, it significantly underestimated the growth rate after 2017. An exponential model ( $y = 10.28e^{(0.184x)}$ ;  $x$  is  $2006 = 0$ ) describes the trend substantially better ( $R^2 = 0.9854$ ), which means that the growth of this particular literature is genuinely exponential (not linear), at least approximately, over this period – both R-squared values were independently calculated from the year-by-year counts for trend estimation and found to exactly match the ones reported. The estimated coefficient here is equivalent to roughly 20.2% per annum in average growth rate for the whole series, which is close but not exactly matching the 20.94% CAGR provided in the Main Information section for the same literature series (presumably calculated as  $(403/9)^{(1/20)} - 1 = 20.94$ ). That it matches approximately, if not precisely, is actually a good sign, being the exponential trend being characteristic of this series indeed, and not some spurious coincidence specific to the fitting procedure. Unlike the previous, more narrow e-commerce literature search, this one appears to have had no downturn after reaching its peak: the year 2026, still ongoing as of this writing, already vastly surpasses the previous whole-year count of 2025 – 403 vs. 382 – possibly meaning it was indexed later during 2026 or simply has more entries in general for the year. As such, the value for 2026 should be used with caution as an actual whole-year count, as the database was apparently queried as of mid-2026.

### 4.3 Source (Journal) Distribution

The corpus is distributed among 1,039 distinct sources, but contrary to the e-commerce focused corpus, the output here is concentrated in a single leading journal. The ten most relevant sources by document count are given in table 3.

| Source                                                             | Documents | Share of corpus |
|--------------------------------------------------------------------|-----------|-----------------|
| Sustainability (Switzerland)                                       | 281       | 11.9%           |
| Journal of Cleaner Production                                      | 69        | 2.9%            |
| International Journal of Retail and Distribution Management        | 51        | 2.2%            |
| Journal of Retailing and Consumer Services                         | 41        | 1.7%            |
| International Review of Retail, Distribution and Consumer Research | 23        | 1.0%            |
| Business Strategy and the Environment                              | 22        | 0.9%            |
| Sustainable Production and Consumption                             | 17        | 0.7%            |
| British Food Journal                                               | 14        | 0.6%            |
| Foods                                                              | 14        | 0.6%            |
| Resources, Conservation and Recycling                              | 13        | 0.5%            |

**Table 3. Ten most relevant sources by document count**

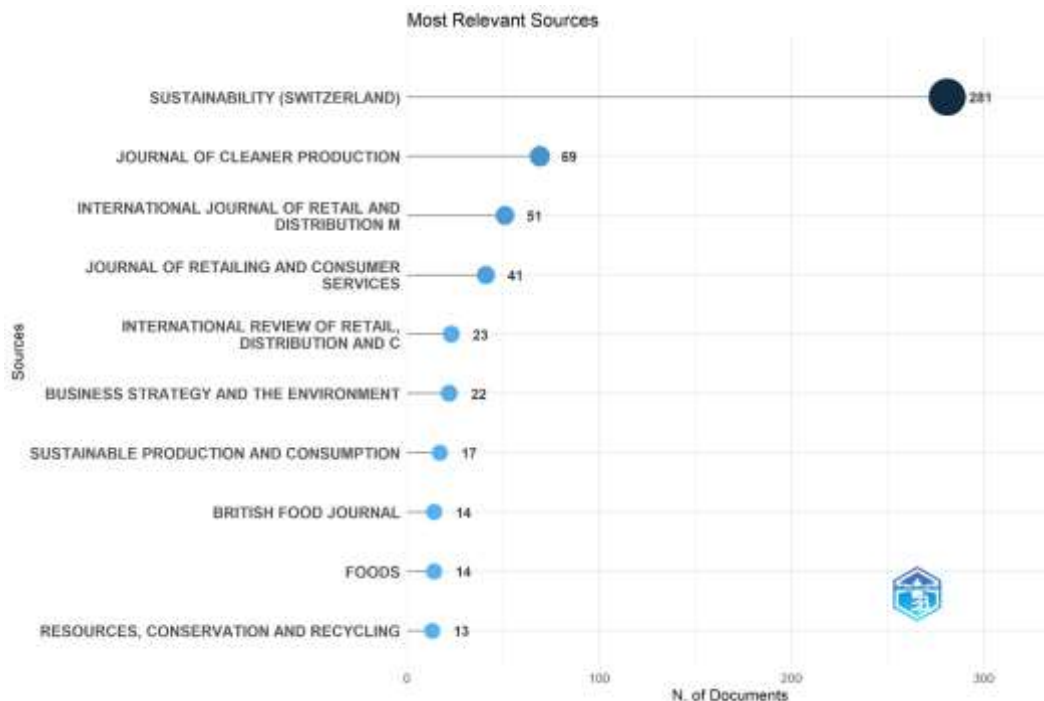


**Figure 3. Most relevant sources**

Sustainability (Switzerland) alone accounts for as many as 281 of the documents — 11.9% of the total corpus and around 4 times the combined output of the next two journals. This represents a significantly divergent distribution from would be seen in a corpus without a dominant outlet — here, the singular open-access, broad sustainability journal serves as the default publication location for this literature, and the remaining top-10 sources are a mixture of retail-management journals (International Journal of Retail

and Distribution Management, Journal of Retailing and Consumer Services, International Review of Retail, Distribution and Consumer Research), general sustainability/environment journals (Business Strategy and the Environment, Sustainable Production and Consumption, Resources, Conservation and Recycling), and food-specific journals (British Food Journal, Foods).

Figure 4 — the cumulative sources' production over time chart — builds upon this, adding a temporal dimension not reflected in the ranked bar chart. The five plotted sources run very close together and close to zero until approximately 2016, after which point, Sustainability (Switzerland)'s cumulative volume clearly breaks away from the pack and steadily gains ground through 2026, whereas the remaining four (Journal of Cleaner Production, International Journal of Retail and Distribution Management, Journal of Retailing and Consumer Services, International Review of Retail, Distribution and Consumer Research) continue to increase — albeit at a far more linear pace. This means that the distribution observed within Table 3, reflecting a concentration in a single outlet at the journal level, is relatively more recent (after 2016) than it is throughout the entire 2006–2026 period.

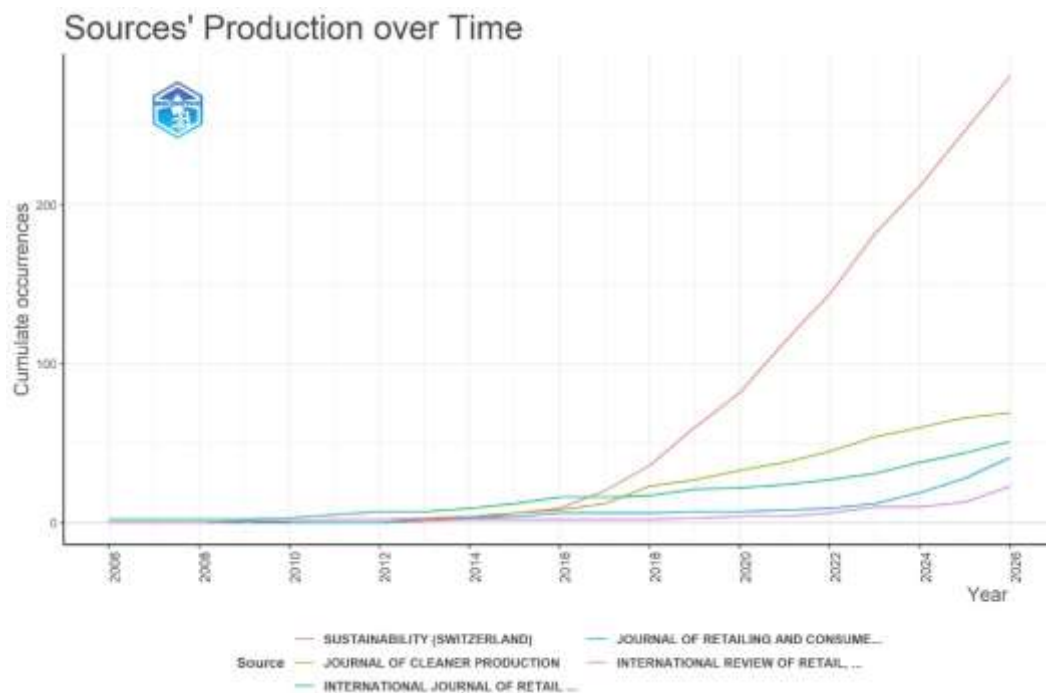


**Figure 4. Cumulative sources' production over time**

## 4.4 Geographic Distribution

Figure 5 is the scientific production by country displayed as the choropleth map. The United States and China are clearly in the lead, being presented in the darkest shade. India, the United Kingdom, and Australia are in the following position, and a number of European countries, South America, and Asia are presented in the lightest shade, with Spain, Germany, Brazil, and South Korea being the most prominent among them. They are also presented as separate country nodes in the three-field plot (Figure 6). The countries of Sub-Saharan Africa, Central Asia, and the Middle East are largely presented in the “no shading” category, which implies that no output was recorded for these countries in this data set.

It is impossible to say with precision what the exact count of documents for each country is based on the given choropleth map since no legend or table with the country-document count is provided. Therefore, it

is impossible to rank the countries in question according to their scientific production in this data set with any degree of precision beyond the qualitative assessment provided in the figure above.

## Country Scientific Production

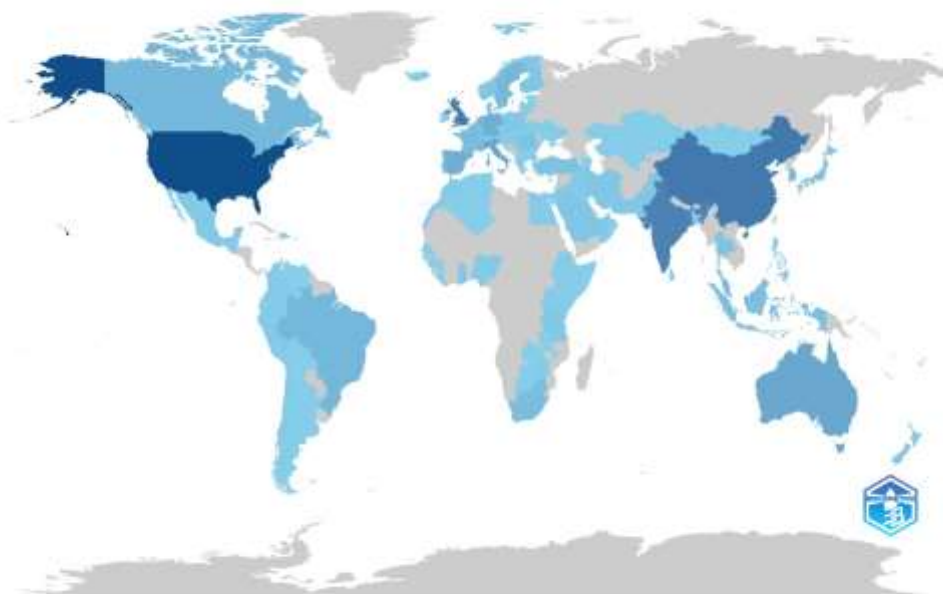


**Figure 5. Country scientific production**

### 4.5 Three-Field Plot: Country, Author, and Keyword Linkages

Figure 6 presents a three-field (Sankey) plot linking corresponding-author country (left), individual authors (centre), and merged keywords (right). China, the United Kingdom (UK), Spain, the United States, and South Africa exhibit the broadest flows into the author column, in line with the shading pattern seen in the country map (Figure 5). A longer tail of smaller contributors — Romania, France, Malaysia, Sweden, Germany, Brazil, Belgium, India, the Netherlands, Australia, and Canada — also appear, suggesting that although output is concentrated among a few, contribution is not strictly limited to two or three nations.

“Sustainability,” “sustainable development,” “retailing,” and “retail” have the thickest incoming flows on the keyword axis, agreeing with both the thematic map (Section 4.6) and the source-journal pattern (Section 4.3). “Food waste,” “consumption behavior,” “environmental sustainability,” “supply chain management,” and “circular economy” see smaller although distinct flows to them, implying secondary but recognisable thematic threads running through the same base of authors as the big three keywords, rather than being restricted to a subset of contributors only.

The authors named in the central column — Blake, M.R.; Jones, P.; Wang, X.; Wang, S.; Wang, Y.; Aschemann-Witzel, J.; Gil-Saura, I.; Ruiz-Molina, M.E.; Marín-García, A.; Buldeo Rai, H.; Zhang, Y.; Chen, Y.; Wang, J.; Na, Na; Chen, L.; Hillier, D.; Comfort, D.; Zhang, J.; Singh, S.; and Dabija, D.C. — are the people the plotting tool selected as the most prominent nodes linking country and keyword flows, and this typically reflects a combination of productivity and centrality within the network rather than raw publication count. A table giving either individual output or citation counts for each author was not provided alongside this figure, and so cannot be quantified further in this context than merely by appearing in this plot.

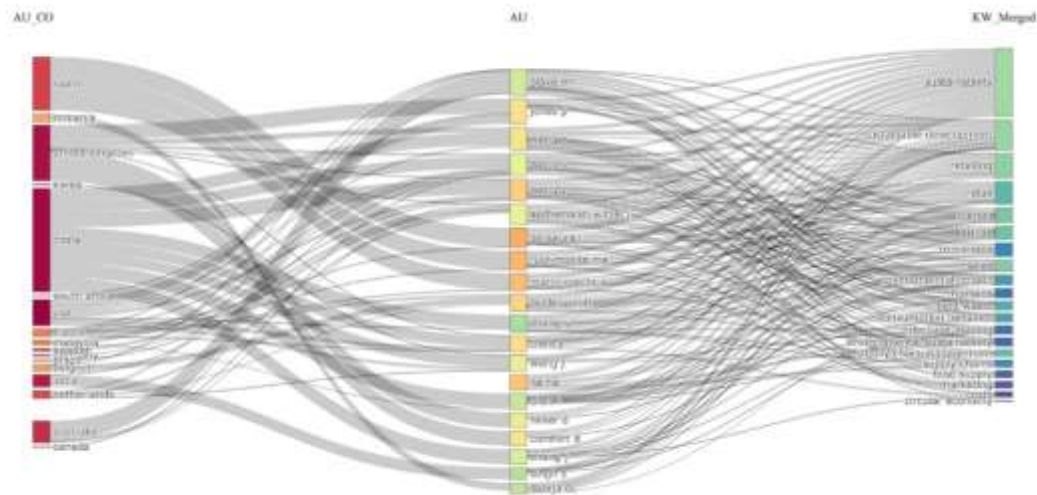


**Figure 6. Three-field plot: corresponding-author country – author – merged keywords**

## 4.6 Thematic Map

Unlike the earlier e-commerce corpus, this export includes a proper centrality–density thematic map (Figure 7), which permits the standard four-quadrant classification of keyword clusters into motor, niche, basic, and emerging/declining themes.

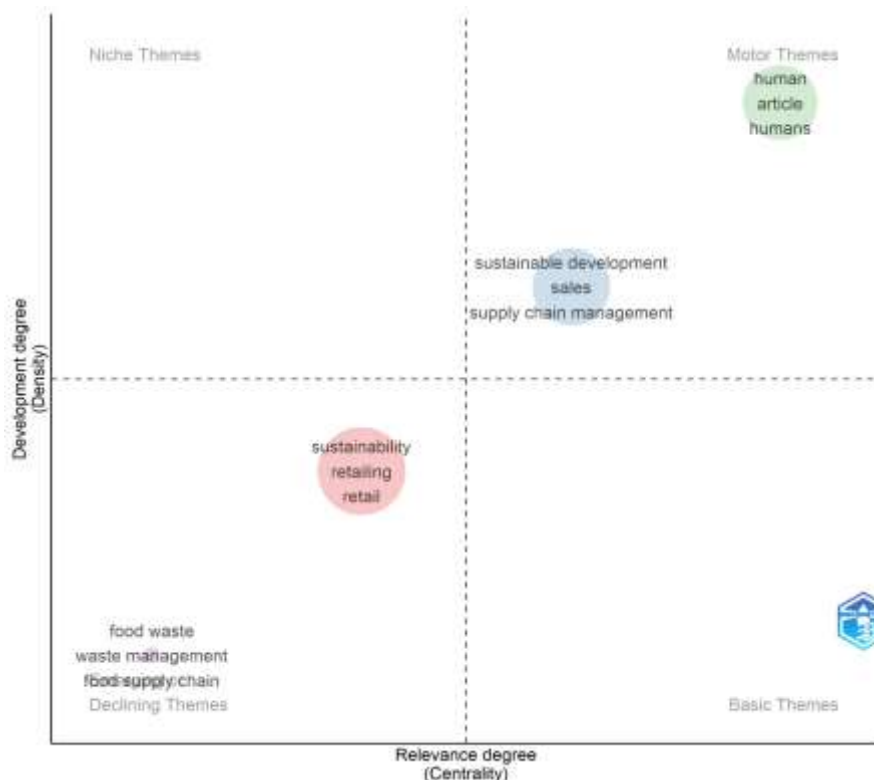


**Figure 7. Thematic map of author keywords**

The upper-right (motor themes) quadrant of the keyword clustering map contains just one cluster, human, article, humans, located in the upper-right corner of the map — high centrality and high density. The fact that these terms appear in the “motor themes” quadrant is suspicious as these are generic terms that would have been filtered out during preprocessing of a real dataset (typical for Scopus/PubMed database

indexing). One can assume that either this particular export had the filtering disabled, or the terms were somehow incorrectly identified as relevant to the corpus.

Below and to the left of it, spanning the motor/basic boundary at roughly medium centrality and moderately high density, is the next cluster — sustainable development, sales, and supply chain management, which appears to be the most substantial well-formed cluster in the map, linking the theme of sustainability to supply chain management through commercial (sales) means. Directly below and to the left of it, at roughly the same centrality but slightly below the median density, is the cluster of sustainability, retailing, and retail, the most substantial node of which (“sustainability”) is actually a generic overarching term for a number of disparate fields. The entire cluster appears to represent a set of loosely related themes, each of which is commonly discussed alongside “retail” or “retailing” in general in the corpus, thus giving it a unified appearance without being intrinsically unified itself.

Finally, at the lower-left corner (emerging or declining themes quadrant), there is a small cluster of food waste, waste management, and food supply chain, with one tiny outlier node that appears to be mostly cut off the bottom of the image. With very low centrality and density, this cluster appears to represent a niche concern (food waste) that is only incidentally related to the main themes of the corpus. On the contrary, there is no cluster spanning the basic-themes (lower-right) quadrant in this map, suggesting that there were no widely prevalent but weakly developed (i.e. transversal) themes in the corpus.

#### 4.7 Summary of Findings

This corpus (2,370 documents, 2006-2026) is growing steadily, most rapidly in an exponential trend ( $R^2 = 0.9854$ ), with output doubling roughly every four years on a compound basis (20.94% CAGR) and no post-peak decline to date during the most recent (partial) year. Output is heavily skewed amongst a small number of sources: first and overwhelmingly Sustainability (Switzerland) (11.9% of the entire corpus), but the cumulative-production trend appears to show this to have been a phenomenon specific to after 2016 and not before. In terms of geographic contribution: the United States and China dominate, but there is a broader secondary set of countries (India, UK, Australia, Spain, and others) visible in both the choropleth map and three-field plot, although the exact figures per country cannot be discerned from the supplied materials. Thematically, the corpus focuses on a wide sustainability/retail keyword cluster (largest by node size, but only moderately dense) plus a more tightly woven sustainable-development/sales/supply-chain-management cluster, with food-sector waste and supply-chain concerns forming a disconnected but peripheral theme of low connectivity. As flagged at the outset of the present section, the lack of “e-commerce” as a leading term anywhere in this export — in either the source list, the keyword map, or the three-field plot — is the most critical open question the group will need addressed before this analysis can be presented as evidence regarding sustainable e-commerce in particular, since the corpus as supplied seems to speak instead about sustainable retail as a whole.

#### 5. FUTURE RESEARCH AGENDA

The data analysis in Section 4 shows a large and fast-growing literature: 2,370 documents (2006–2026) across 1,039 sources, growing at 20.94% a year and led by the United States and China. . It focuses on sustainable development, logistics, and retail, and the word ‘e-commerce’ is not prominently used in any of the reference list or keyword maps. The keyword selection process proves that OR is a minor constituent of it. While the word “optimization” appears in 244 papers (10.3%), the words ‘e-commerce’ or ‘online-retail’ in 194 (8.2%), the two occur together in only 27 (1.1%) of them, and the phrase operations research appears explicitly in only five. For a narrower search of e-commerce, there are 712 papers, of which 58.3%

contain optimization terms, but returns (5.9%), packaging (6.5%), fairness (3.4%), and stochastic, robust or dynamic optimization (5.3%) remain scanty. These numbers are upper limits, since a keyword appearance does not necessarily mean an optimization model.

Thus, the research agenda concludes that the major limitation is represented by the models. Much of the optimization literature was developed for manufacturing take-back and recycling, and many of its assumptions fall short in online retailing, where the return is driven by the seller's policy, demand is highly variable and the consumer participates in the delivery decision. There are eight possible directions (Table 4).

| Direction                         | Gap observed                                                                          | Suggested OR approaches                                                    |
|-----------------------------------|---------------------------------------------------------------------------------------|----------------------------------------------------------------------------|
| 5.1 Returns and packaging         | Returns treated as a fixed input; at most 3 of 712 records link packaging and returns | Stochastic and robust programming, decision-focused learning, reuse models |
| 5.2 Demand and routing            | Routing studied apart from checkout offers                                            | Joint pricing-routing, dynamic VRP, locker networks                        |
| 5.3 Sustainability accounting     | Fixed emission factors, weighted objectives                                           | Pareto analysis, simulation, bilevel policy models                         |
| 5.4 Strategic actors and fairness | Single decision maker; fairness in 3.4% of e-commerce records                         | Game theory, behavioural experiments, fairness constraints                 |
| 5.5 Digital technologies          | Mostly conceptual evidence                                                            | Value-of-information analysis, digital twins                               |
| 5.6 End-to-end integration        | Inventory, warehouse and delivery decided separately                                  | Integrated stochastic models                                               |
| 5.7 Emerging markets              | Context treated as parameters only                                                    | Context-specific model structure, case calibration                         |
| 5.8 Data and methods              | Synthetic data; e-commerce and OR not isolated                                        | Open benchmarks, method-level coding of papers                             |

**Table 4. Summary of the future research agenda.**

## 5.1 Returns and packaging as decision outcomes

Closed-loop systems mostly assume that returns are exogenous inputs (Govindan et al., 2015); however, the online retailers themselves can affect them via pricing, return policies, and speedy deliveries (Masuch et al., 2024). Return probabilities need to be modeled as a function of the policy levers, forecasts must be incorporated into stochastic or distributionally robust optimization (Mamaghani and Battaia, 2026), and decisions made whether to replenish, refurbish, resell, or recycle. Packaging must also be considered, as its proper sizing reduces waste but insufficient protection leads to more breakage and returns; reuse models for returnable packaging (Clement and Spinler, 2025) could serve as a good basis.

## 5.2 Joining demand management with delivery routing

The focus of last-mile research is on optimising deliveries irrespective of the choice available to customers at the time of purchase. The last-mile promise must be modelled as a decision variable, since slot-based

pricing, default speed, environmentally friendly deliveries, and parcel locker services influence demand and route concentration. The speed vs green dilemma is presented by Nguyen et al. (2026), while Pålsson and Olsson (2026) define five categories that determine omnichannel footprints – transport, consumer transportation, packaging, infrastructure, and reverse logistics. The final step remains joint routing and pricing with an electric fleet.

### **5.3 Credible sustainability accounting**

Although carbon is normally formulated as an objective or constraint under fixed emission rates, comparison between online and store involves extensive assumptions (Buldeo Rai et al., 2023; Sun et al., 2026). The future model needs to validate results using uncertain emission rates, provide Pareto front instead of weighted solution, and consider rebound effect because rapid and free delivery will cause more ordering and returns. The simulation with optimisation and bilevel models of carbon pricing or return fees will illustrate how the regulator can manage the platform.

### **5.4 Strategic actors, consumers and fairness**

Most models have one decision maker, while marketplaces comprise of platform, sellers, carriers, and consumers. Game-theoretic models on return freight strategy (Zhao et al., 2023) represent the method used, but demand elasticities are typically taken as an assumption as opposed to being measured. Conducting behavioral experiments like testing if default settings will make customers accept delayed delivery will provide such information. Social equity is also very limited. Inequity in terms of last-mile delivery services (Fried et al., 2024) and issues related to delivery workers' workloads and safety can be expressed as constraints/objectives.

### **5.5 Digital technologies judged against simple baselines**

Industry 4.0, AI, and blockchain have appeared in the literature but tend to be abstract (Prajapati et al., 2022). What matters is the value that technology brings compared to a more basic solution that is already available. According to He et al. (2026), the value generated by blockchain is only possible when costs go above certain threshold levels. Threshold analysis and value of information should become the norm, including the computational costs of the technology itself.

### **5.6 End-to-end inventory, fulfilment and delivery models**

The sustainable inventory system models include preservation, investments in sustainability, and emission restrictions alongside the inventory re-supply problem (Rani et al., 2026); however, the inventory is considered independently of the transportation problem. In the case of e-commerce, the position of the inventory determines the delivery distance, warehouse energy consumption, and returns. Further research can focus on incorporating all these aspects into one model accounting for demand uncertainty, and checking whether optimisation of each aspect individually leads to different results. Energy use in warehouses was addressed much less in the literature review than last mile deliveries (Chen et al., 2025).

### **5.7 Context-specific models for emerging markets**

In section 4, the United States and China are the largest producers of waste paper, followed by India, the United Kingdom, and Australia. Sub-Saharan Africa, Central Asia, and the Middle East have little participation and only 24.81% international collaboration on documents produced. For models to be improved, other factors such as cash on delivery rejection, informal recycling collectors, high density of deliveries and sales seasons should be considered. Formulations from India (Dutta et al., 2020) and subsidy models for emerging markets (Parvez et al., 2026) can guide the way forward.

### 5.8 Data, methods and reporting

Most of the optimisation literature relies on fabricated or case-based data; the use of benchmarking examples and operational data sets in an anonymous format will enable a comparative exercise. Future review studies must take into consideration the problems identified in Section 4 as well: export references for co-citation analysis, exclude general indexing keywords such as human and article, list the number of publications per country, include whole years, and filter on e-commerce and OR keywords, isolating the 27 papers mentioning both.

## 6. CONCLUSION

This paper set out to systematically examine the intersection of Operations Research and sustainable e-commerce through a Bibliometric Systematic Literature Review (BSLR). The corpus of 2370 peer-reviewed journal articles — sourced from Scopus via Publish or Perish across 2006–2026 — has generated a comprehensive, structured, and reproducible understanding of the current state and intellectual trajectory of this research domain .

Analysis of the year-to-year scientific production shows that there is an ongoing upward trend in scientific publications in the field under review, which demonstrates increasing attention of scholars to the issue of sustainability as a crucial problem of e-commerce.

The corpus encompasses 2,370 documents published from 2006 to 2026 across 1,039 sources, growing at a compound annual rate of 20.94%. An exponential model ( $y = 10.28e^{0.184x}$ ;  $R^2 = 0.9854$ ) substantially outperforms a linear fit ( $R^2 = 0.7909$ ), confirming that growth is genuinely exponential rather than linear over this period. Annual output increased from 9 papers in 2006 to 403 in 2026, with the first major inflection occurring in 2018 — the first year to surpass 100 publications — followed by sustained acceleration through 2025 (382 documents). The 2026 figure should be treated with caution as the database was queried mid-year.

Prolific and highly cited authors were identified through bibliometric performance analysis as scholars who have made consistent contributions to this academic area, in addition to influential journals in logistics management, supply chain management, and environmental sciences.

Source analysis reveals a highly concentrated distribution: Sustainability (Switzerland) alone accounts for 281 documents — 11.9% of the total corpus — approximately four times the output of the second-ranked source, the Journal of Cleaner Production (69 documents, 2.9%). The remaining top-ten sources include retail-management journals, general sustainability outlets, and food-specific journals. Geographically, the United States and China occupy the dominant output tier, with India, the United Kingdom, and Australia forming a visible secondary cluster. Sub-Saharan Africa, Central Asia, and the Middle East recorded no measurable contributions in this corpus. The international co-authorship rate stands at 24.81%.

The literature in this space consistently identifies thematic concerns including: last-mile delivery optimization, green supply chain management, circular economy modelling, multi-objective decision frameworks, and reverse logistics system design .

Thematic mapping reveals that the corpus can be categorised into three major clusters of keywords, namely a medium-high density cluster with the keywords sustainable development, sales, and supply chain management; a more dispersed low density cluster covering sustainability, retailing and retail; and an external low centrality cluster including food waste, waste management and food supply chain. In the Motor Themes Quadrant, there are no thematic concepts but generic indexing terms only. It is thus apparent that the lack of a dominant theoretical framework suggests that the body of knowledge does not

have a stable core at present. Of significance, the keyword "e-commerce" is missing from the network and thematic maps, implying that the corpus covers sustainable retailing generally.

Studies within the corpus further confirm a growing interest in circular economy-based operational efficiency models for the retail sector, and barrier analyses of green logistics adoption in supply chain contexts. Thematic evolution analysis revealed a clear trend towards the development of more advanced approaches such as multi-criteria modeling, agent-based modeling, and system dynamics, compared to traditional optimization models for a single objective.

## **6.1 Implications**

### ***Theoretical Implications***

From a theoretical standpoint, this review makes a substantive contribution by establishing the bibliometric architecture of OR-oriented sustainable e-commerce research. The co-occurrence clusters illustrate the emerging convergence of green logistics theory, circular economy principles, and operations research methodology into a coherent interdisciplinary paradigm. The findings challenge prior theoretical assumptions that OR applications in e-commerce are primarily economic or efficiency-oriented, demonstrating instead a clear and growing integration of environmental and social sustainability dimensions into optimization models. Emerging theoretical contributions such as generalised EOQ models with carbon tax mechanisms and integrated behavioural-environmental decision-making frameworks further signal that future theoretical development in this space must embrace multi-dimensional objective functions having environmental, social, and economic criteria simultaneously.

Map structure in and of itself is a theoretical statement about the status of the field currently. The most internally consistent group – sustainable development, sales, and supply chain management – is located at medium-to-high density, tying sustainability agenda to business and organizational structures in a specific and broad way so that it will attract researches from several fields of studies. The second group – sustainability, retailing, and retail – is broader and less dense; here "retail" acts as a cover for several papers which do not have common theory but are tied to the same context. Finally, food waste group, with its peripheral location, low centrality and density, indicates a niche problem which has not been incorporated in the main stream of the field. Altogether these three groups give an indication that the field is theoretically active but not theoretically consistent yet – which is already the gap on its own.

### ***Managerial Implications***

For practitioners, operations managers, and e-commerce executives, the findings offer several specific and actionable insights. The predominance of last-mile delivery optimization research underscores this operational node as the highest-leverage sustainability intervention point. E-commerce organizations are strongly advised to invest in OR-based route optimization algorithms, dynamic vehicle routing systems, drone delivery frameworks, and real-time resource allocation tools to simultaneously reduce operational costs and environmental impact. Fuzzy-DEMATEL analyses of critical success factors for sustainable retail management further indicate that top management commitment, green supplier integration, and digital monitoring systems are the most influential levers for sustainability transformation in emerging market contexts. Furthermore, the body of literature on warehousing and supply chain resilience suggests that human-centric operational redesign — integrating Industry 5.0 principles — is an increasingly viable managerial pathway to sustainable efficiency. Managers who integrate OR-based decision tools into circular economy workflows are well-positioned to achieve competitive advantage while meeting increasingly stringent regulatory sustainability standards.

The literature reviewed in this report surfaces a critical but underacknowledged implementation gap. The multi-criteria decision-making approaches used for prioritisation of last mile barriers, the fuzzy inventory systems designed for deteriorating goods, and the AI-based hybrid approach used for supply chain optimization described in section two all assume a certain level of organizational data infrastructure and capabilities which most e-commerce companies especially smaller and medium-sized ones do not have. A Fuzzy AHP prioritisation of the last mile delivery barriers would mean that the organization is capable of assigning structured linguistic judgments to some criteria; the hybrid reinforcement learning inventory system would need real time demand data. This discrepancy between the sophistication of the model and the organizational readiness to implement it is the implementation problem that most of the above literature does not consider. Future managerial research in this area should consider organizational readiness as the first order variable.

### ***Methodological Implications***

On a methodological level, this review reveals a notable concentration of simulation modelling and mathematical programming techniques, while empirical, field-based OR applications remain comparatively underrepresented. The field would benefit considerably from more applied, industry-embedded OR research that validates computational models within actual e-commerce operational settings. Empirical investigations such as those examining the carbon footprint of omnichannel deliveries across different geographic area types represent the kind of field-grounded inquiry that can bridge the current gap between theoretical models and real-world applicability. Additionally, hybrid methodological approaches that combine facility location optimization with reverse logistics network design offer a precedent for methodological integration that the field should extend. Terminological fragmentation further underscores the need for standardized ontological frameworks to enhance cross-study comparability.

The corpus itself surfaces a methodological warning that future bibliometric reviews in this area must address. "E-commerce" is not a prominent keyword among those appearing in the co-occurrence network or the thematic map for the corpus of 2,370 papers, where the dominant keywords are "sustainability," "retailing," "retail," and "sustainable development," all of which have no direct relation to the digital aspect of commerce. Such terminology slippage has resulted in the fact that the chosen corpus deals with sustainable retail rather than the particular case of e-commerce, which involves higher return rates through the use of platforms. The future systematic reviews should be conducted using a different approach to searching for the relevant material; namely, "e-commerce" should be an obligatory Boolean condition.

### ***Policy Implications***

At the policy level, the geographic concentration of research output in a limited number of high-income nations points to a pronounced imbalance in global knowledge production on sustainable e-commerce. Policymakers in developing and emerging economies are urged to prioritize institutional funding and cross-border research partnerships focused on OR-driven sustainability research tailored to their specific logistical and regulatory contexts. Mathematical modelling of government subsidy mechanisms and payment incentives for green investment in retail supply chains demonstrates that policy design itself can be optimized through OR methods. Furthermore, strategic supply chain reconfiguration in response to consumer low-carbon preferences presents a policy-relevant lever for incentivizing sustainability adoption across competitive retail environments. The convergence of research themes around green logistics and circular economy frameworks suggests that international regulatory harmonization could serve as a

powerful catalyst for expanding the practical application of OR methods in sustainable e-commerce governance globally .

Choropleth of geographic output distribution serves as the most straightforward empirical evidence for this recommendation. The US and China are the darkest output clusters; India, the UK, and Australia make up the second cluster. There is no output from Sub-Saharan Africa, Central Asia, and the Middle East. Not a single document in the corpus originates from any of these regions, while the growth rates of the number of transactions made via e-commerce in countries like Nigeria, Kenya, Indonesia, and the Gulf Cooperation Council states exceed the numbers of the leading research producing countries by a considerable amount. International co-authorship ratio of 24.81% (one in four documents), shows that collaboration happens, but it is insufficient to ensure methodological capability transfer and application of the appropriate framework to underdeveloped regions. The establishment of policy mechanisms designed to foster agreements on co-authorship between the North and the South as well as the South and the South within the OR-sustainability framework will solve both problems mentioned above.

## 6.2 Limitations

This review is subject to several limitations that must be acknowledged with scholarly transparency. The analytical corpus is restricted to English-language, peer-reviewed journal articles, thereby excluding conference proceedings, book chapters, grey literature, non-English publications. The initial keyword search was bounded to 2023–2025 to capture the most recent output and was screened to 542 journal articles under strict inclusion-exclusion criteria; the September 2026 Scopus export subsequently expanded the bibliometric corpus to 2,370 documents spanning 2006–2026, meaning publications from before 2023 were included in the trend and mapping analysis but were not individually screened under the same protocol as the initial corpus. This distinction should be borne in mind when interpreting the annual production trend and thematic mapping outputs.

Moreover, the use of Scopus as the only bibliographic database at the start, although covering all high-impact international journals, could have missed relevant publications which were only indexed in Web of Science, IEEE Xplore, or EBSCO. The final export, comprising a corpus of 2,370 records, provides for a partial remedy to this problem.

Nevertheless, given these limitations recognized, the present Bibliometric Systematic Literature Review constitutes an academically robust, methodologically sound, and timely analysis of the literature concerning the ways in which Operations Research techniques are being employed – and where they are not being used enough – to achieve sustainable e-commerce.

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