

The Applications of Operations Research in Sustainable E-Commerce and Reverse Logistics

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Abstract: The present review is a systematic literature review-cum-bibliometric analysis of sustainable e-commerce, read against the much larger literature on reverse logistics, the circular economy and sustainable supply-chain management. Records were taken from Scopus on 11 September 2026, screened under the PRISMA framework and mapped using Biblioshiny and VOSviewer. The mapped set comprises 867 documents (747 articles and 120 reviews) written by 2,595 authors. Reverse logistics is the largest author keyword (403 occurrences) and circular economy follows (177), while e-commerce appears in only 19 documents. The co-occurrence maps show clusters on decision methods, closed-loop network design and optimisation, waste recovery, and digital technologies. India, Brazil and China lead in country output. The review identifies gaps in empirical testing of digital tools, consumer and social perspectives, and the labelling of e-commerce research, and sets out a future research agenda.

Keywords: Sustainable E-Commerce; Reverse Logistics; Circular Economy; Closed-Loop Supply Chain; Industry 4.0; Waste Management.

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I. INTRODUCTION

Electronic commerce has changed how goods are sold, shipped and returned. The shift was already underway before 2020. COVID-19 then moved a large share of purchases from shops onto platforms (Deng, 2024) (Zennaro, 2022). The environmental cost is not uniform. Online retail produces more packaging waste per unit of retail value than store selling, and easy returns add to that waste (García-Arca, 2025). Fichter had already set out the environmental consequences of electronic commerce in 2002 (Fichter, 2002). Later carbon comparisons find that not all e-commerce emits equally, and academic estimates do not match what consumers believe about online versus store retailing (Rai, 2023) (Klein, 2023). Sustainable electronic commerce, on this evidence, is an attempt to hold environmental, social and economic performance together, trade-offs included (Oláh, 2019).

Last-mile delivery, packaging and returns are reverse-logistics problems, so the e-commerce papers sit inside a wider literature on reverse logistics, the circular economy and sustainable supply-chain management. End-of-life responsibility is treated there as a costly operating task, circular supply chains are traced back to reverse logistics and green supply chains, and quantitative models for sustainable

supply-chain decisions remain among the most cited items in the field (Dutta, 2020) (Prajapati, 2022c), (Daultani, 2022). Waste electrical and electronic equipment is a recurring product class, and Industry 4.0 has been proposed as a way to put circular models into manufacturing practice (Prajapati, 2022b) (Prajapati, 2022a). The same heading also covers work that is not about vans or boxes: cross-border pilot zones and industrial pollution, European readings against SDG 2, SDG 12 and SDG 13, blockchain supply-chain finance, and rural income effects in China (Kwilinski, 2023) (Lahkani, 2020) (Qiu, 2024).

Reviews already exist, and they stay inside their own bounds. Last-mile work has its urban, stakeholder and business-to-consumer reviews, and a bibliometric overview of sustainable e-commerce logistics (Mucowska, 2021)(Kiba-Janiak, 2021)(Nogueira, 2025)(Cano, 2022). Packaging and returns have theirs, covering packaging reviews, returnable transport items and fashion returns (Escursell, 2021) (Clement, 2025) (Marriott, 2025)(Dutta, 2020). Digitalisation, blockchain and artificial intelligence in e-commerce logistics have also been reviewed (Mashalah, 2022) (Wan, 2022). None of these reviews places the e-commerce keyword inside the much larger Scopus literature on reverse logistics, circular economy and sustainable development, and then reads the two scales together.

The present review does that. It uses a systematic review under the PRISMA framework, because the point of that design is to identify and combine research on a defined issue without repeating it. Records were taken from Scopus on 11 September 2026 and limited to English-language journal articles and reviews. The mapped set used in Biblioshiny and in the keyword analysis is 867 documents, 747 articles and 120 reviews, written by 2,595 authors. Science mapping is done in Biblioshiny after reference cleaning in Mendeley, and keyword co-occurrence is mapped in VOSviewer. The contribution is structural. The review does not estimate emissions, return rates or abatement.

The review is organised as follows. The next section presents the literature review, followed by the research objectives and the research methodology. The results report annual production, countries, the thematic map and keyword co-occurrence. The discussion answers the three research questions and sets out implications, which is followed by a future research agenda, the conclusion and the limitations of the study.

II. LITERATURE REVIEW

Electronic commerce has completely transformed the ways in which goods are sold, shipped, and returned to their suppliers, and this importance increased even further during the COVID-19 pandemic when many purchases took place via the internet instead of physical shops (Aboumejd et al., 2026; Zennaro et al., 2022). However, this increase in popularity comes with environmental expenses. Online retail creates much more waste due to packaging as compared to retail value through physical stores, and the existence of easy returns worsens the situation (Yang et al., 2023). The concerns of people about this issue are not new because Fichter (2002) was studying the environmental impact of electronic commerce already. Other studies have already compared the carbon footprints of online and in-store purchases (Rai et al., 2023), contrasted academic data and consumer understanding of online and offline retailing (Klein et al., 2023), and proved that sustainable electronic commerce can be achieved by balancing environmental, social, and economical aspects.

Since return, packing, and last miles are related to reverse logistics, study on sustainable electronic commerce uses the broader studies on reverse logistics, circular economy and sustainable supply chain management. In this review the broader field is mapped first with the help of bibliometric evidence.

➤ *Bibliometric Profile of the Literature*

The documents examined include 867 documents included in Scopus database published from 2014 to 2026 (747 article and 120 reviews), written by 2595 authors and analysed using Bibliometrix. The annual output increased from just 29 documents published in 2014 to 112 in 2015, with an annual growth rate of about 13%, while 167 documents had already been published in 2026 when the data had been collected. Major publishing sources include Sustainability (77 documents), Journal of Cleaner Production (53), Cleaner Logistics and Supply Chain (19), Logistics (15) and International Journal of Logistics Management (14). Most authors were affiliated with India, Brazil, USA, China and UK.

Most cited papers include reviews and conceptual papers rather than empirical e-commerce papers themselves and include such studies as Brandenburg et al. (2014) on the application of quantitative model in the field of sustainable supply chain management (1,085 citations), Nascimento et al. (2019) on Industry 4.0 and business models of circular economy (896), Batista et al. (2018), Islam and Huda (2018) on circular supply chains and reverse logistics of the electronic waste (375 and 347).

➤ *Keyword Co-Occurrence Analysis*

The mapping of author and index keywords was done through co-occurrence analysis in VOS viewer in order to narrow down the important ideas as shown by the size of the node, which indicates the frequency of the keywords. Figure 1 shows the initial tangled diagram consisting of 96 keywords, while Figure 2 illustrates the finished and simplified map with just 68 words.

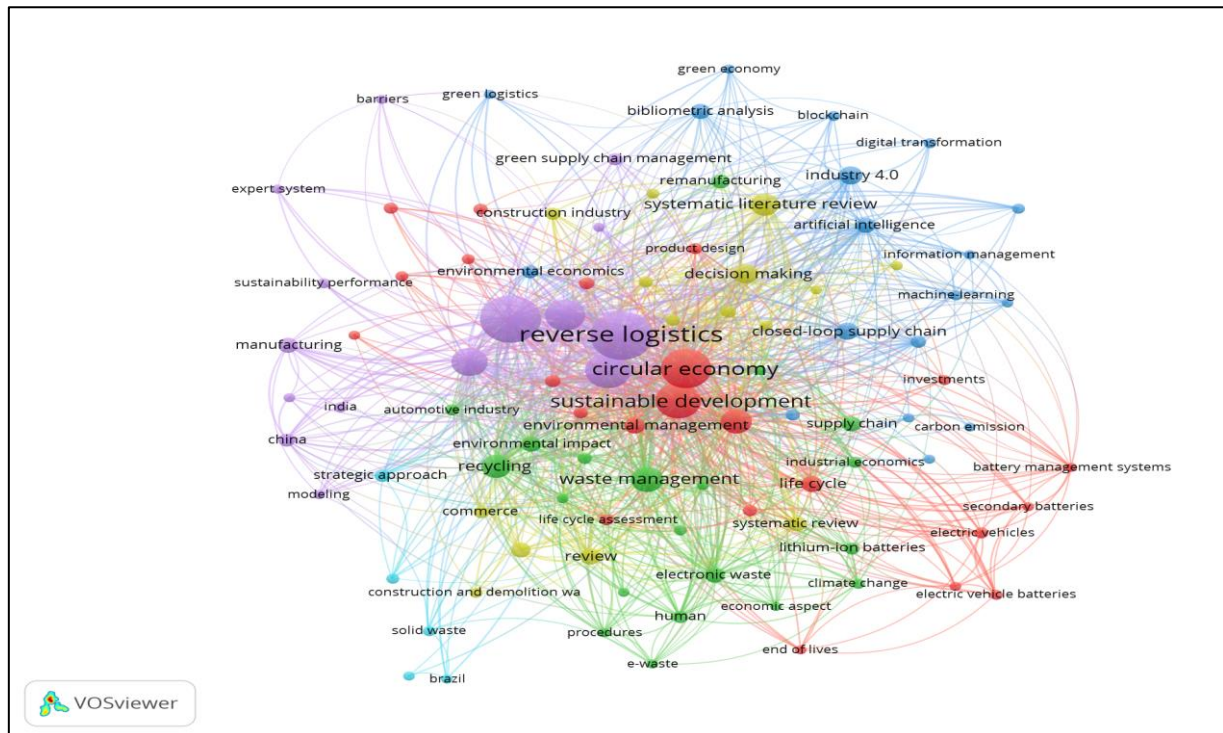


Fig 1 VOS Viewer Keyword co-Occurrence Map of 96 Keywords (Author's Work).

According to Figure 1, reverse logistics and circular economy are the two most important nodes, with sustainable development, waste management and recycling coming afterwards. A total of six clusters are created based on the relationship between group of the selected terms. The first one in purple is created by reverse logistics, manufacturing, green supply chain management, barriers, China and India, indicating that there is focus on operational and emerging economies. In the red cluster include the terms circular economy, sustainable development, environmental management, life cycle assessment and electric vehicles

batteries, which are used for the purposes of environmental assessment. The third green cluster is built by terms related to recycling, waste management, remanufacturing and electronic waste implying the material recovery process. The technology oriented blue cluster is created from Industry 4.0, artificial intelligence, blockchain, digital transformation and closed-loop supply-chain. The yellow cluster reflecting the methodology includes systematic literature review, decision-making and review. The last cyan cluster is related to solid waste and Brazil, which is the term ensuring strategic approaches.

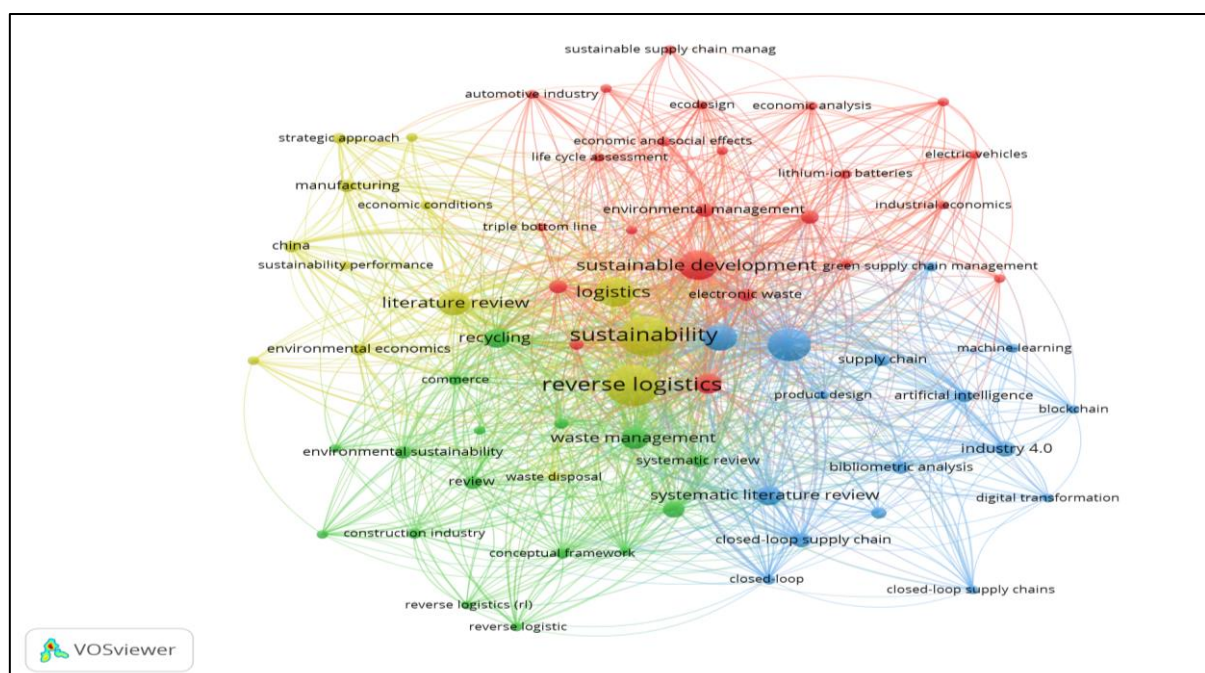


Fig 2 VOS Viewer Keyword co-Occurrence Map of the Final 68 Keywords (Author's Work).

In Figure 2, the network is divided into four clusters and sustainability is placed opposite reverse logistics. The yellow cluster (sustainability, reverse logistics, logistics, literature review, manufacturing) represents the conceptual hub. The red cluster (sustainable development, environmental management, life cycle assessment, eco-design, triple bottom line, electric vehicles) represents environmental performance and product development. The green cluster (recycling, waste

management, environmental sustainability, construction industry, conceptual framework) shows waste-related issues and the blue cluster (closed-loop supply chain, Industry 4.0, artificial intelligence, blockchain, digital transformation) provides insight into digital issues. Selected keywords are listed in Table 1 according to their frequency and important of words.

Table 1 Main Keywords Selected From the Co-Occurrence Maps.

Keyword	Author-keyword frequency	Position in the maps
Reverse logistics	403	Largest node in both maps; linked with manufacturing, barriers and green supply chain management
Sustainability / sustainable development	310 / 25	Core of the yellow and red clusters; environmental management, life cycle assessment, triple bottom line
Circular economy	177	Dominant node in Figure 1; connected to product design and end-of-life management
Closed-loop supply chain	39	Digital cluster; linked with Industry 4.0 and blockchain
Recycling / waste management	39 / 35	Material-recovery cluster; electronic waste, remanufacturing, batteries
Industry 4.0 / artificial intelligence	31 / 16	Technology-enabled cluster; digital transformation, machine learning
E-commerce	19	Peripheral term; connects to last-mile delivery, packaging and returns studies

Source: Bibliometrix export (n = 867) and VOS viewer maps.

➤ Thematic Strands in the Literature

• Reverse Logistics, Circular Economy and Sustainability

Reverse logistics is connected with circularity conceptually. A taxonomy of the critical success factors of reverse logistics proposed by Julia Nelli et al. (2020) highlights that the responsibility for the end-of-life products represents a significant cost and complex process in the circular economy. Batista et al. (2018) establish that the concept of the circular supply chain originated in earlier sustainability stories, such as reverse logistics and green supply chains. Brandenburg et al. (2014) indicate how quantitative models have been created for sustainable decisions in supply chain management. Recent reviews show the integration of reverse logistics with sustainable design (Melo et al., 2021) and closed-loop network optimisation (Lozano-Oviedo et al., 2024).

• Waste Management, Recycling and Product Recovery

Islam and Huda (2018) conducted a study where they examined 157 research papers, concluding that reverse logistics along with closed-loop supply chains are fundamental to waste management, especially in terms of electronic waste as an important product type. Nascimento et al. (2019) investigate how Industry 4.0 technologies can be integrated into circular economy principles for transforming materials, particularly for e-waste. Agrawal and Singh (2020) also focus on the Indian electronics sector wherein they analyse the correlation between the prediction of product returns and reverse logistics triple bottom line performance.

• Digital Technologies

The blue cluster of both maps highlights the increasing focus on digital technologies. In terms of different digital

technologies in the context of last mile and first mile reverse logistics, Agnusdei et al. (2022) determine Industry 4.0 to be important for achieving sustainability in circular supply chains. In particular, with respect to e-commerce, Mashalah et al. (2022) make a review of the influence that digitalization has on the supply chains, while Wan et al. (2022) analyses the potential of blockchain application for sustainable value co-creation within supply chains in the context of e-commerce. Aboumejd et al. (2026) also conducted a review of the use of artificial intelligence in e-commerce logistics, who found that the traditional logistics models turned out to be insufficient after the increase in demand due to the pandemic. Ho et al. (2026) build on the previous studies and propose the application of predictive analysis and network optimization for flexible reverse logistics in retail.

• Sustainable E-Commerce: Last-Mile Delivery, Packaging and Returns

Specifically, the studies that have named e-commerce centre around three issues. First, the last-mile delivery: Mucowska et al. (2021) comments on environment-friendly urban solutions; Kiba-Janiak et al. (2021) make an analysis of stakeholders' views; Nogueira et al. (2025) synthesize research related to business-to-consumer deliveries; and Cano et al. (2022) provide a bibliometric overview of sustainable e-commerce logistics. The second discussion is on packaging. Escursell et al. (2021) paper reviews strengths and weaknesses of sustainability in e-commerce packaging; Yang et al. (2023) identifies Canadian best practices for transport packaging waste, and Clement et al. (2025) simulates the management of returnable transport items.

The third area deals with returns and reverse logistics. In their study, Marriott et al. (2025) examined the anatomy of

returns in fashion related e-commerce while Mishra and Dutta (2026) analysed as many as 240 publications related to return management and reverse logistics in online markets and suggested that better handled returns and reuse and recycling networks could help in reducing wastes. Related studies cover such issues as stakeholder perspective on sustainable e-commerce reverse logistics design (González Romero et al., 2025), strategic decisions on returned products (Aryee et al., 2024) and circular economy practices in quick-commerce last mile operations (Chavhan & Dutta, 2025).

• *Consumer and Social Perspectives*

A relatively smaller body of literature investigates buyers and society. For example, Schleiden et al. (2020) test if sustainability is important in cross-border online purchases; Bharani et al. (2024) analyse consumer preferences regarding sustainable e-commerce practices. Other authors, like Cordes et al. (2023), describe how e-commerce allows fostering sustainability as a way of fighting poverty in Sub-Saharan Africa; Zhang et al. (2023) discuss the successes and failures in the field of sustainability transitions in e-commerce.

➤ *Research Gaps*

There are three gaps in the research. Firstly, e-commerce has been given little attention in this research study as evident in the limited distribution of the term in the published articles, with only 19 out of the total of 867 articles mentioning 'sustainable e-commerce'. Thus, most of the articles on sustainable e-commerce refer to general issues of reverse logistics or the circular economy. Secondly, many articles examining technology are reviews or conceptual papers; hence, this suggests the need for empirical verification of the role of AI, blockchain, and analytics in the sustainability of returns and delivery. Finally, the clusters highlighted primarily discuss environmental and operational aspects, while there is no cluster focusing specifically on consumer behaviour and social sustainability, despite the fact that consumer preferences and social aspects of sustainability play an important role.

India and Brazil's contribution to author affiliation is another proof that contexts of emerging economies should be given more attention in future research. Hence, all the studied aspects make this study place at the juncture of the areas of sustainable e-commerce, reverse logistics, and consumer behaviour.

➤ *Research Objectives*

The following research questions outline the scope of this review.

- RQ1: How has publication output developed from 2014 to 2025, and how should Biblioshiny's annual growth rate be read once the partial year 2026 is set aside?
- RQ2: What intellectual and thematic structure does the mapped corpus show, in countries, keywords, co-occurrence clusters and the thematic map?
- RQ3: Where does the e-commerce keyword sit in that structure, and what does that frequency imply for the claim that the corpus is a sustainable e-commerce literature?

III. RESEARCH METHODOLOGY

The systematic literature review (SLR) is the main research methods by many researchers in various fields. The systematic literature review is a systematic, step-by-step procedure that assists in identifying, evaluating, and combining relevant research on a particular issue. This method is useful because it guides researchers in planning a study building on already existing research and identifying areas for additional study and thus preventing other researchers from duplicating or conflicting research (Paul & Criado, 2020). Sustainable E-commerce has become a popular topic in recent years, as a growing number of entities are going online and customers are becoming increasingly aware of the requirement to buy responsibly in an environment-friendly manner. The current study involves the use of the systematic literature review to analyse the evolution of Sustainable E-commerce. This is an opportune and timely topic for review, as companies and researchers have started to evaluate the opportunities to produce digital retail more sustainably in response to concerns regarding packaging waste, the delivery network's carbon emissions, and ethical sourcing. The SLR was used by the authors to analyse the evolution of studies on the topic in the broader literature and to uncover the foundational ideas that connect these studies, as well as to discern the areas that still need to be addressed.

The SLR provided the researchers with a reliable and robust foundation, based on a large number of studies, so that they were able to work through the studies in an organised and repeatable manner and not in a scattered or informal way. The authors used a systematic search process according to the PRISMA framework (Moher et al., 2010) to perform the review. This system aims to reduce a large collection of articles to a subset of articles that meet a series of criteria through the process of eliminating articles from the collection by looking at the title and abstract. This process is essential because it controls the provenance of the articles used in the study, ensuring that a researcher can see what started a review and its potential premises.

➤ *Inclusion and Exclusion Criteria for Articles*

Data for this study were taken from Scopus database on 11 September 2026. The first search resulted in 1354 articles from the period 2014-2027 as the initial set for the review. The dataset was later trimmed in time by first eliminating 90 articles older or outside of the period of analysis, resulting in 1264 out of 1354 articles for the review. Then a document type filter, which exclude articles that are not typology of articles and reviews as they are the most peer reviewed and academic, leaving the data set to 1264 and now 893. Then a language filter was used, only counting on articles that were written in English, which is the language that the researchers of this study speak, resulting in 866 records. Then a source type filter was used, using only studies that are published in a journal as they are the most peer reviewed and excluding studies in books or trade publications, resulting only in 861 studies used for bibliometrics analysis.

Out of an initial 1354 articles, 493 records were eliminated. These results highlight the importance for the screening process to narrow down the initial search and ending with a set of studies manageable and relevant to our study Sustainable E-commerce. All these steps can be seen in a PRISMA flow diagram that gives a visual summary of the number of studies that were excluded at each stage and the

resultant number of studies at the end of every stage, which will help to understand the exact path on how this study arrived at 861 studies from 8,359 studies that were identified in the preliminary search.

The PRISMA diagram below shows how we screened literature and arrived at the final number of studies.

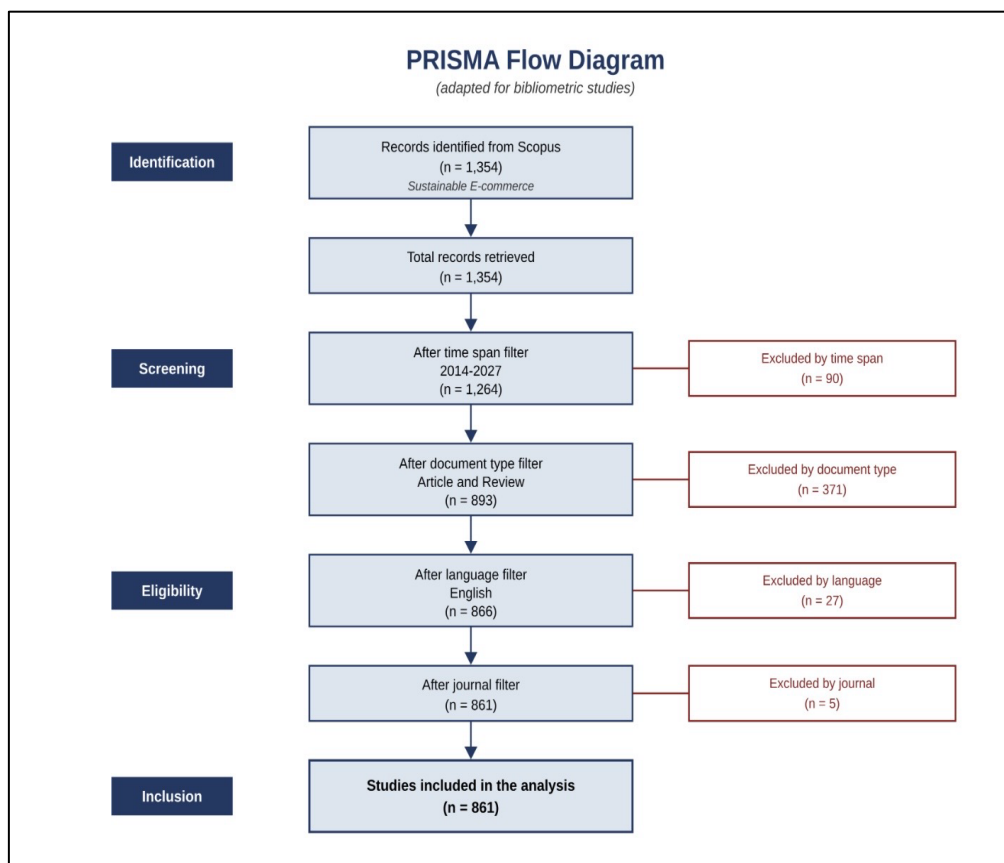


Fig 3 PRISMA Flow Diagram of the Screening Process (Author's Work).

➤ Bibliometrics Review

Since the final sample comprised a large number of articles, it was not feasible to read the entire studies. The researchers decided, after consultation, to carry out a bibliometric analysis in addition to the SLR. In general, a bibliometric study allows to search for patterns and relationships in the data in a large amount of papers, and to show an overall context of a research area or topic without reading each paper (Donthu et al., 2021). This method turned out to be very useful in the case of Sustainable E-commerce, where the literature is extensive and scattered in different research fields such as business, environmental studies, information systems and logistics. After obtaining the dataset from Scopus, it was imported to Mendeley (a free reference management tool that allows to store, organize and cite academic articles, as well as to screen for and merge multiple copies of articles, and store the data collected in a safe and systematic area).

To understand the evolution of Sustainable E-commerce, the dataset was exported as BibTeX files and imported into Biblioshiny, an online application based on bibliometrix R package. The tool was selected because it

enables scientists to conduct a comprehensive science mapping without requiring advanced coding skills and can produce a variety of outputs using a simple point and click interface, from the resulting point and click dashboard. In this study, Biblioshiny was employed to create the keyword co-occurrence map, co-citation map, and a thematic map that depicts the evolution of research themes in Sustainable E-commerce. These outputs can then be combined to show the general structure of the field, including the topics and keywords that are in vogue, as well as the evolution of publications over the years, and to display core and related literature and the related links between authors, institutions, and countries. In brief, Biblioshiny uses raw citation data to generate insights that are much easier to read and understand than having to go through the literature by hand, but not to the exclusion of close reading. The SLR was useful to the researchers in determining which studies were most relevant to include and the bibliometric analysis was useful in understanding the broader patterns, relationships, and trends of research growth in their field of Sustainable E-commerce.

IV. DATA ANALYSIS AND RESULTS

➤ Overview of the Dataset

The Biblioshiny overview indicates that the dataset covers the period 2014-2027 and contains 867 documents published across 342 sources, demonstrating a relatively broad research base. The dataset includes 2,595 authors, with 2,323 authors keywords and 3,108 keywords plus, indicating substantial thematic diversity within the literature. The annual growth rate of -18.59% implies that there is a general reduction in the production of works during the observed period. However, it should be noted that the growth rate was affected by the fact that the 2027 data were incomplete. Thus, it should be used with caution when comparing with the graph

➤ Publication Trends Over Time

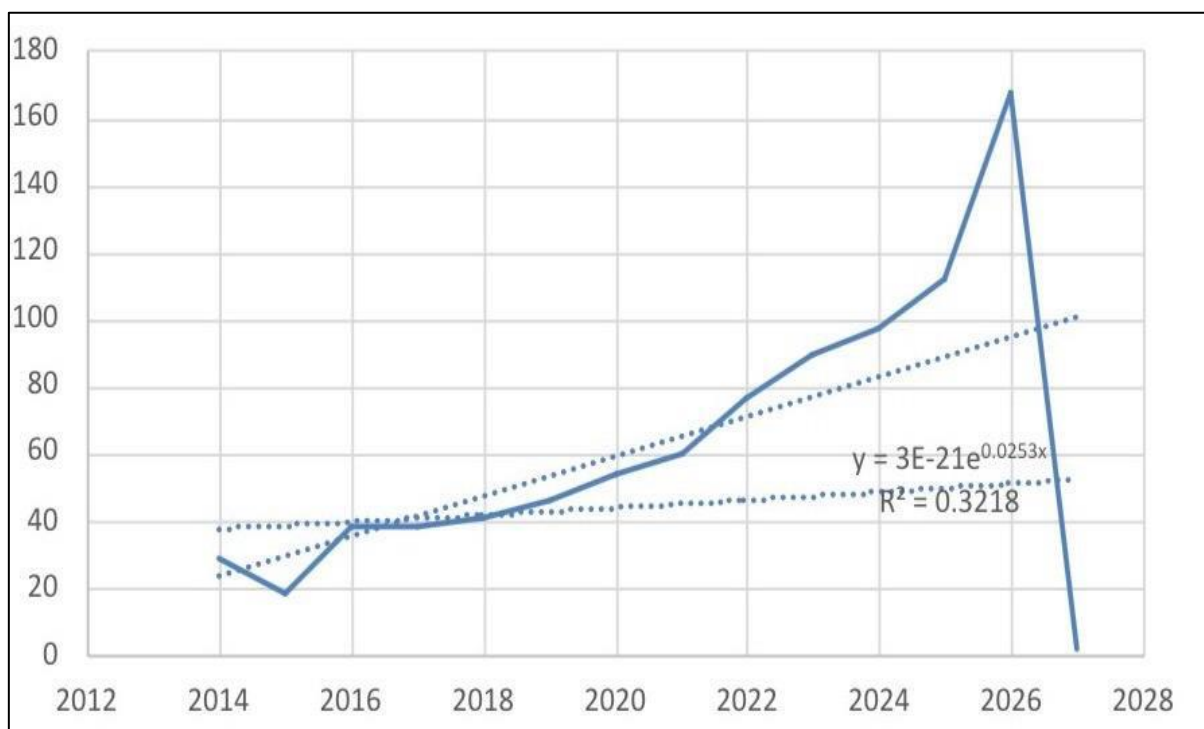


Fig 4 Annual Scientific Production

The dataset contains 865 articles from 2014-2026, with and additional entry of 2 articles may represent an incomplete /future record or a data - entry issues and should not be used in the trend analysis.

Annual Scientific production is a standard bibliometric indicator used to examine the development and growth of a research field over time. (Seuring et al., 2022)

The publication output shows an overall increasing trend from 2014 to 2026, despite a decline in 2015. Publication increased from 29 articles in 2014 to 167 articles in 2026, representing an increase of approximately 47.6%. The lowest publication output was recorded in 2015, with 18 articles, after which production generally increased. From

of the annual production. The document has an average age of 3.94 years, indicating that the dataset is relatively recent. The literature receives an average of 37.04 citations per document, suggesting considerable academic visibility and scholarly impact. The high number of authors compared with documents, along with 3.56 co-authors per document, indicates that collaborative research is an important characteristic of the field. Furthermore, 32.99% international co-authorship shows that nearly one-third of the publications involve collaboration across countries, reflecting a meaningful level of international research cooperation. Overall, the overview demonstrates a large, relatively recent, and collaborative research field with substantial citation impact and considerable thematic diversity.

2016 onwards, the field demonstrates sustained growth, rising from 38 articles in 2016 to 60 in 2021. A stronger growth phase is visible from 2022 onwards, with publications increasing from 76 in 2022 to 89 in 2023, 97 in 2024 and 112 in 2025. 2026 records the highest output with 167 articles, representing a 49.1% increase over 2025. This sharp rise indicates substantially greater publication activity in the dataset during the latest year. The compound annual growth rate (CAGR) from 2014 to 2026 is approximately 15.7%, indicating strong long-term expansion in publication volume. Publication count trends can be used to identify the temporal development and changing research activity of a field. (Tran, 2024) The R^2 value of 0.3218 indicates that exponential model explains about 32.18% of the variation in annual publication output.

➤ *Contributing Authors, Countries and Keywords*

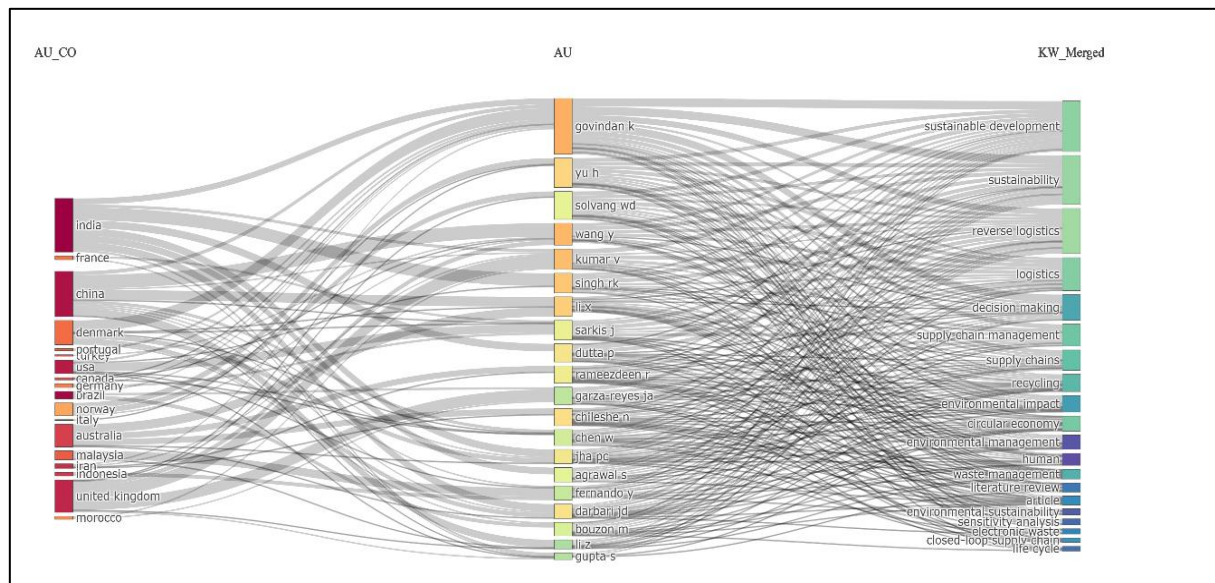


Fig 5 Three Field Plot

The Three-Field Plot demonstrates a clear relationship between authors' countries (AU_CO), authors(AU), and keywords (KW_Merged), helping identify how geographical research activity connects with key contributors and research themes (Seuring et al., 2022).

India has the strongest presence among the countries shown, indicating a substantial contribution to the research area. Other contributing countries include Denmark, France, China, Portugal, USA, Canada, Australia, Malaysia, Brazil, and the United Kingdom. Among the authors, Govindan K shows one of the most prominent connections, with links extending to several countries and sustainability-related

keywords. Other visible authors include Yu H, Solvang WD, Wang Y, Kumar V, Singh HK, Sarkis J, and Duarte AP. The keywords field shows that the literature is strongly centred, on substantial development, sustainability, reverse logistics, supply chain management issues, recycling, and circular economy. The connection indicate that research is moving from sustainability concepts towards practical supply-chain and environmental-management issues, particularly reverse logistics, recycling, waste management and circular economy. Overall, the plot suggest that sustainability and sustainable supply chain practices focus, with reverse logistics and environmental management acting as important interconnected themes.

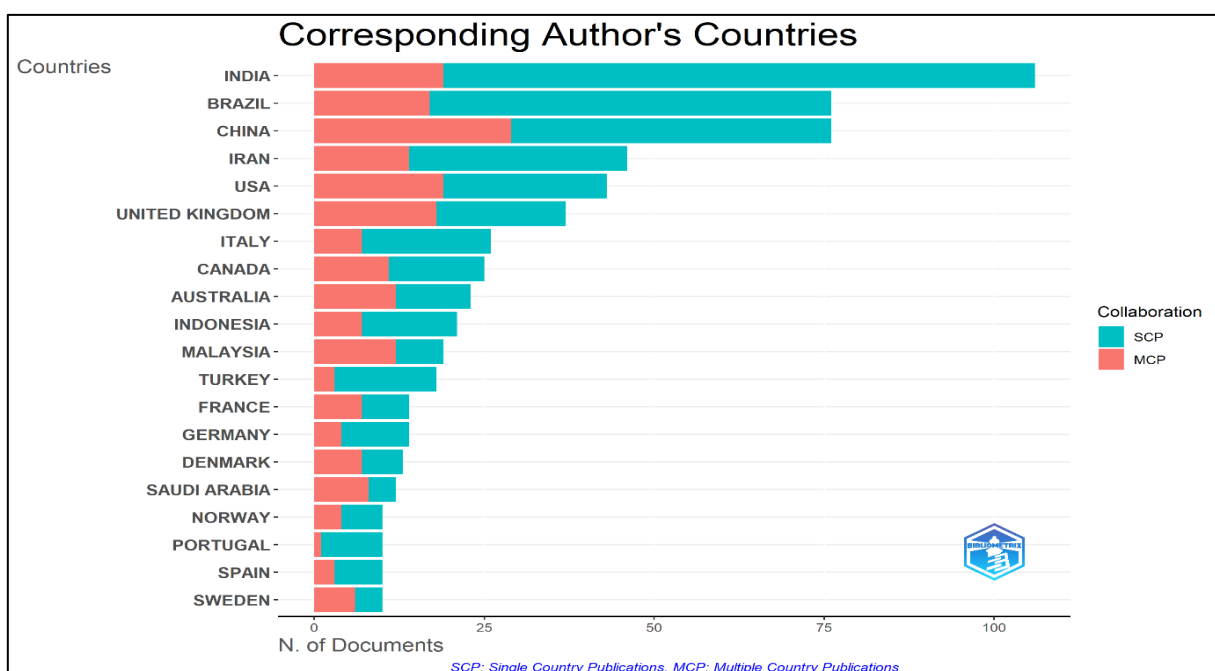


Fig 6 Corresponding Author's Countries

The graph presents the country-wise distribution of corresponding authors, separating publications into Single Country Publications (SCP) and Multiple Country Publications (MCP). In bibliometrix, SCP refers to publications whose authors are affiliated within a single country, while MCP represents publications involving authors from multiple countries. The corresponding author's country is derived from the affiliation information in the bibliographic record.(Kocherlakota, 2026)

India has the highest publication contribution, with approximately 106 documents, followed by Brazil (76) and China (75). This indicates that these three countries are the major contributors within the dataset. The large SCP component for India suggests that much of its research output is produced through domestic collaboration. India is particularly dominated by SCP, with approximately 87 SCP and 19 MCP publications. This indicates a substantially larger share of nationally produced research compared with internationally co-authored research in this dataset. China shows a comparatively stronger international collaboration component, with approximately 46 SCP and 29 MCP publications. Thus, although China has a similar overall publication volume to Brazil, a larger proportion of its corresponding-author output involves researchers from multiple countries. Brazil records around 59 SCP and 17 MCP publications, indicating that its research output is also primarily based on single-country collaboration, although international collaboration contributes a noticeable share. Iran and the USA occupy the next positions, with approximately 46 and 43 documents, respectively. Both countries show a mixture of SCP and MCP publications, indicating participation in both domestic and international research networks. The United Kingdom, Italy, Canada and Australia form the next group of countries in terms of publication volume. Their SCP and MCP distributions demonstrate that international collaboration is present across established research-producing countries rather than being restricted to the countries with the largest publication totals. At the lower end of the graph, countries such as Portugal, Spain, Norway and Sweden have smaller publication counts. Their presence nevertheless indicates that the research area has participation from a geographically diverse set of countries. Overall, the graph demonstrates a strong concentration of publication output in a small group of countries, particularly India, Brazil and China, while the remaining countries contribute smaller volumes. At the same time, the presence of MCP across many countries indicates that the research field has an international collaborative dimension. The distinction between SCP and MCP is important because publication volume alone does not describe the collaborative structure of a research field.

➤ Country Scientific Production

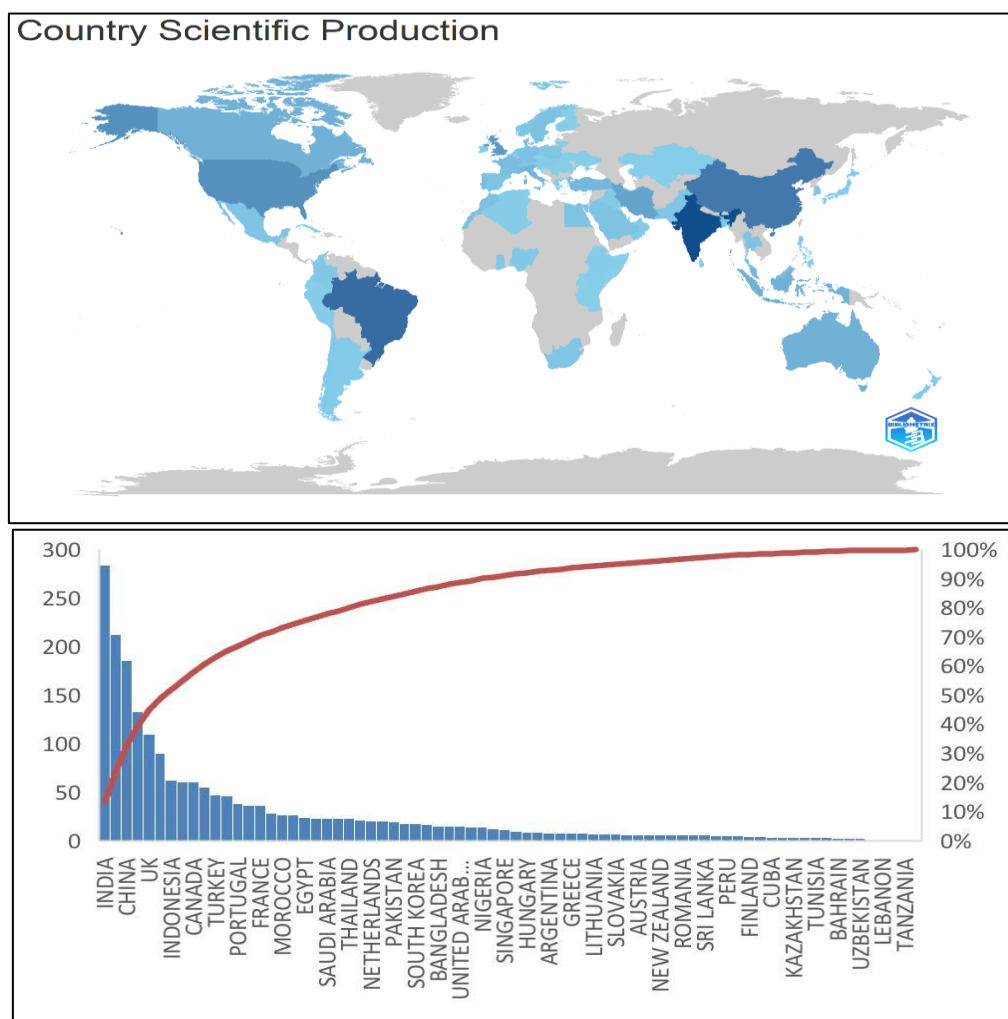


Fig 7 Country Scientific Production

The Country Scientific Production map shows the geographical distribution of research output in the selected dataset. India has the highest scientific production with 284 publications, followed by Brazil (213) and China (186). The USA (133) and the UK (110) also make substantial contributions. Other notable contributors include Iran (90), Indonesia (62), Australia and Canada (61 each), and Italy (55).

The darker shades on the map indicate countries with higher publication frequencies, showing that research activity

is concentrated particularly in Asia, South America, and North America, with additional contributions from European and other regions. This pattern indicates that the research topic has achieved broad international participation, although publication output remains concentrated in a smaller group of countries. Bibliometrix defines country scientific production based on the countries represented by author affiliations, meaning that internationally co-authored papers can contribute to the production counts of multiple countries.(Bhimavarapu, 2025).

➤ Thematic Map

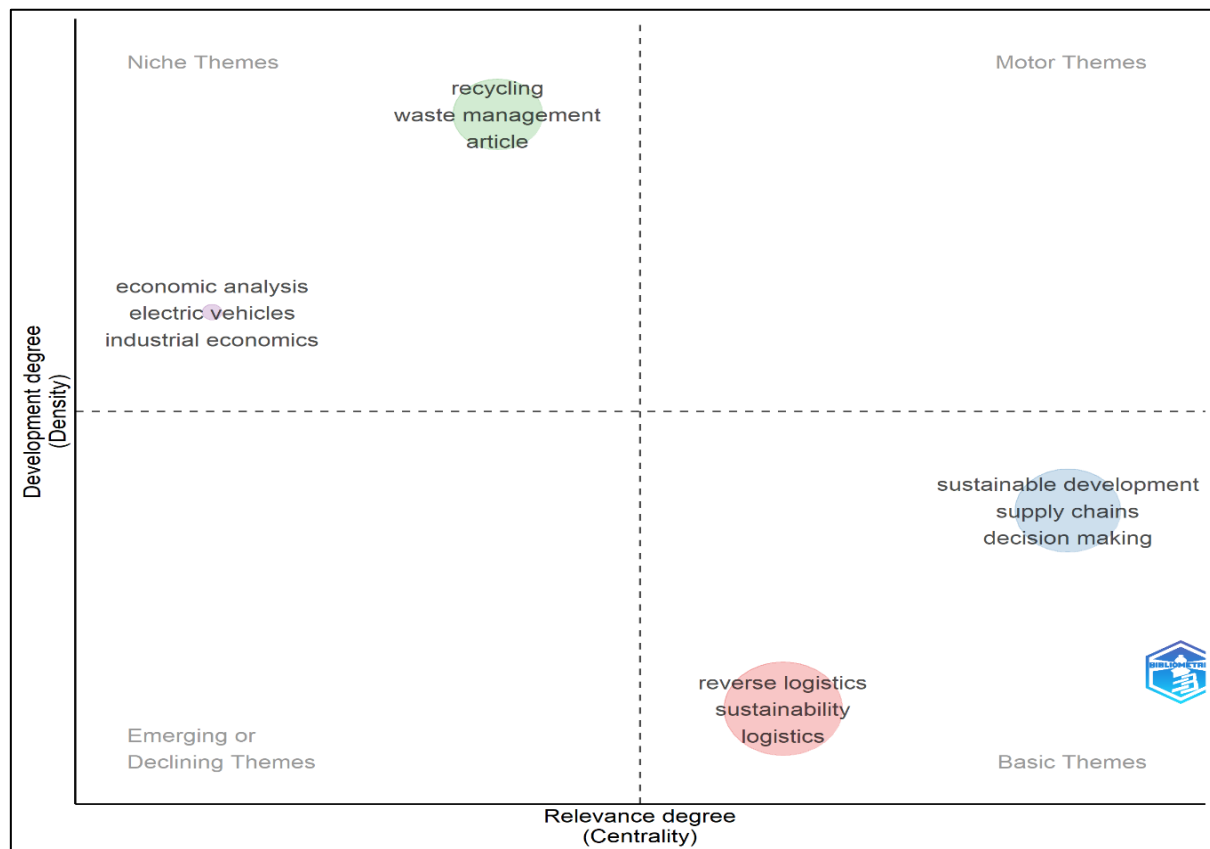


Fig 8 Thematic Map

The thematic map classifies research themes according to centrality (relevance) and density (development), with four quadrants: motor, niche, basic, and emerging/declining themes.

- **Niche Themes:** Recycling, waste management, and article show high density but lower centrality, indicating well-developed yet relatively specialized research areas.
- **Basic Themes:** Sustainable development, supply chains, and decision making have high centrality but lower density. These are important and widely connected topics, but they remain less internally developed.
- **Emerging/Declining Themes:** Reverse logistics, sustainability, and logistics appear in the lower-left

region, suggesting comparatively weak development and connectivity. These themes may represent emerging areas or topics receiving declining attention; the map alone cannot distinguish between the two.

- **Motor Themes:** No major cluster is clearly visible in the upper-right quadrant, suggesting the dataset does not show a strongly developed and highly central theme.

Overall, the map indicates that sustainability and supply-chain-related concepts form the central foundation of the research field, while recycling and waste management are more specialized areas.

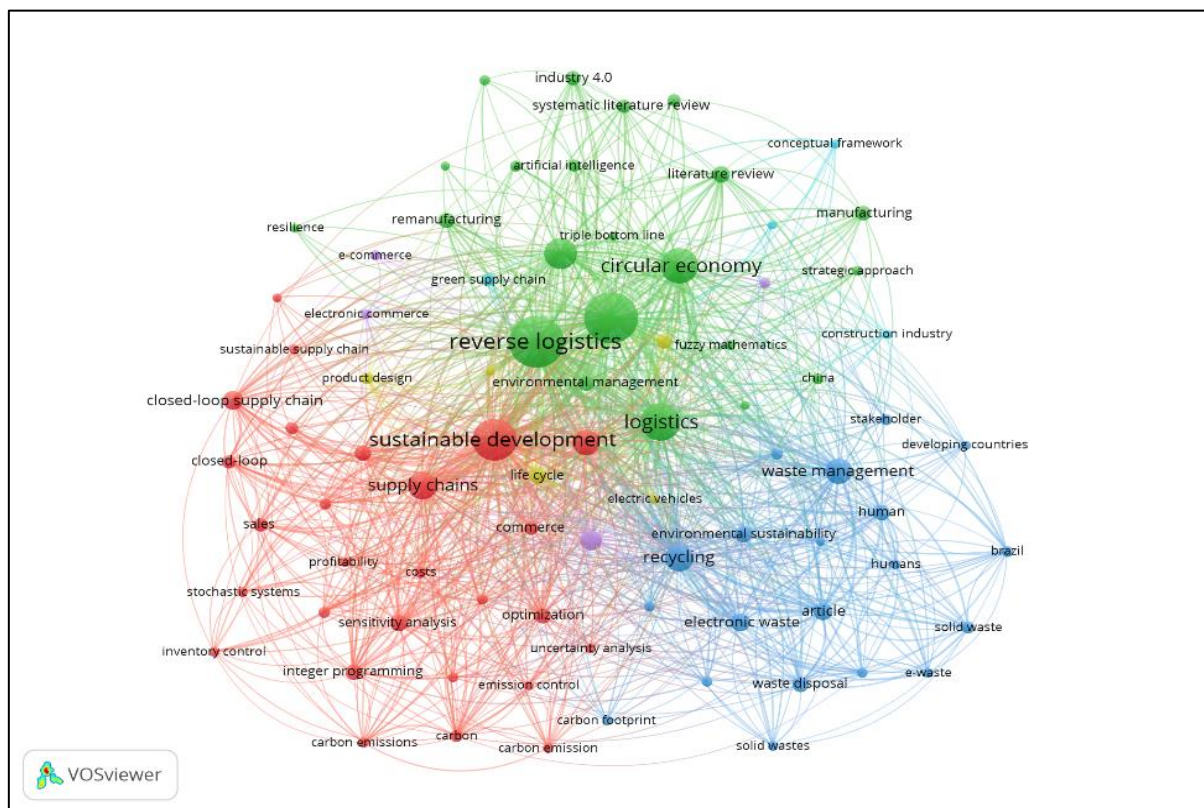
➤ *Keyword Co-Occurrence Analysis*

Fig 9 Co-Occurrence Network (Minimum Occurrence of Keyword 15)

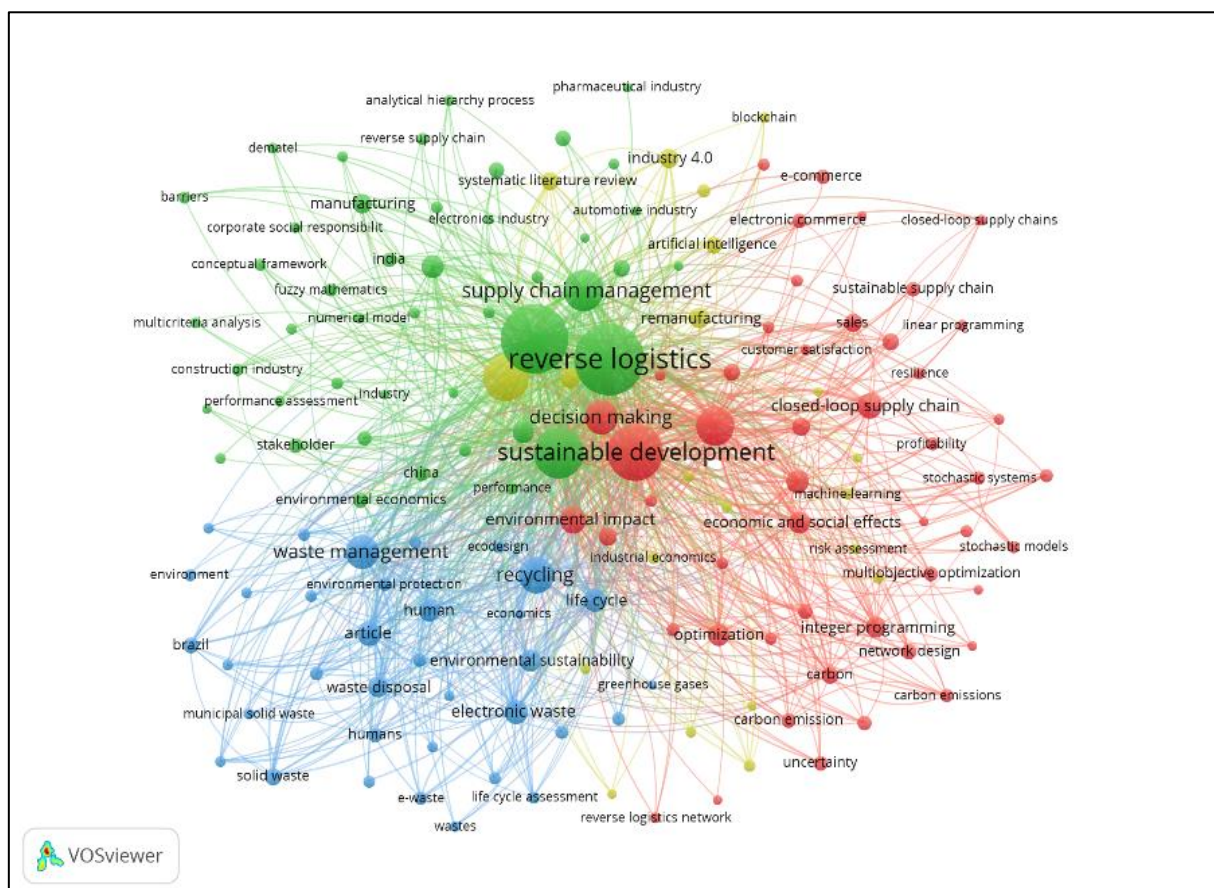


Fig 10 Co-Occurrence Network (Minimum Occurrence of Keyword 10)

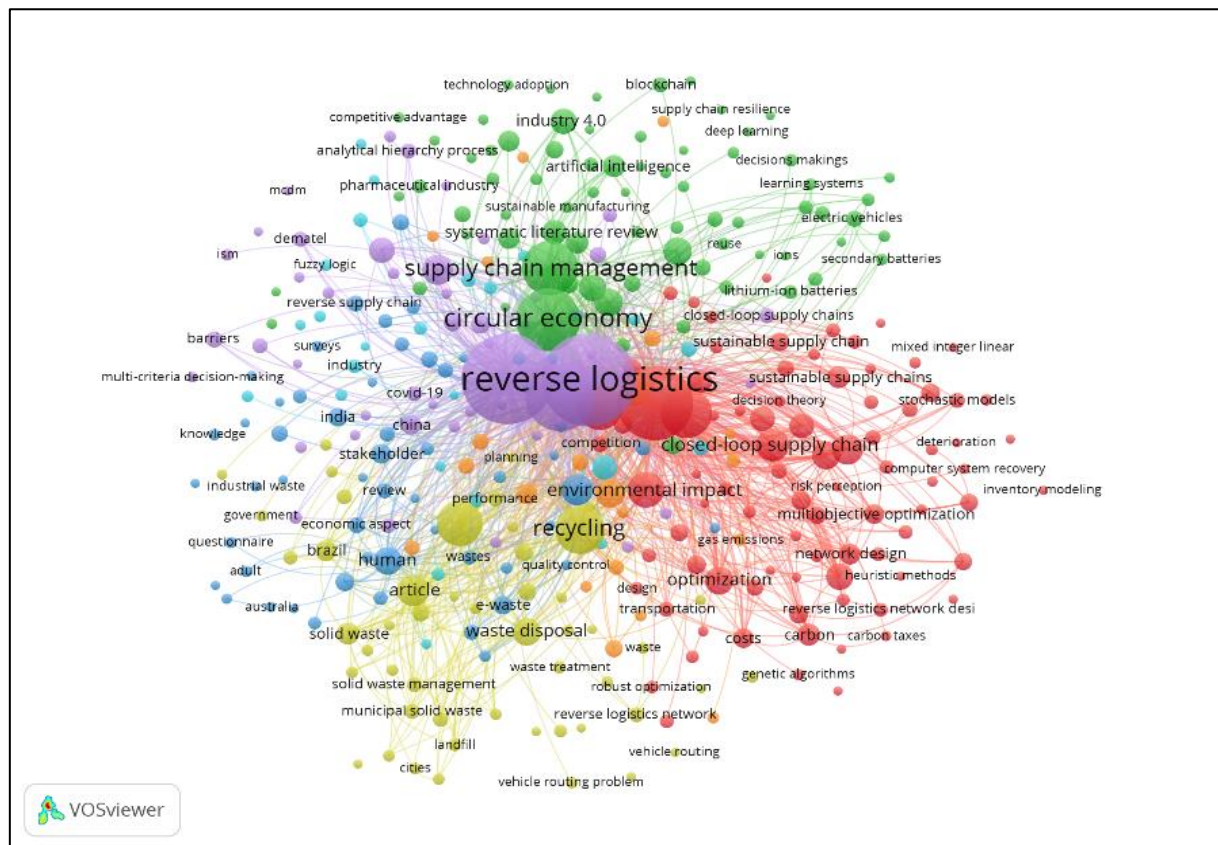


Fig 11 Co-Occurrence Network (Minimum Occurrence of Keyword 5)

The three VOSviewer maps represent keyword co-occurrence networks at minimum occurrence thresholds of 5, 10, and 15, respectively. In these maps, the size of a node reflects the selected weight/occurrence of a keyword, the thickness of links represents the strength of association between keywords, and keywords positioned closer together generally have stronger relationships. Different colours represent different clusters of closely related keywords.

The map with a minimum occurrence of 5 provides the most detailed representation because it includes a large number of frequently and moderately occurring keywords. The network is highly interconnected, indicating that the literature covers several overlapping dimensions of reverse logistics, circular economy, waste management and sustainable supply chains.

➤ Green Cluster – Supply Chain Management and Circular Economy

The green cluster is centred around major keywords such as supply chain management, circular economy, sustainable manufacturing, industry 4.0, artificial intelligence, blockchain, reuse, remanufacturing and supply chain resilience. This cluster represents the integration of reverse logistics with modern supply-chain practices and digital technologies. The strong relationship between circular economy, supply chain management and reverse logistics suggests that reverse flows are increasingly examined as mechanisms for recovering value from products and materials and supporting circular production systems.

➤ Purple Cluster – Reverse Logistics and Decision/Operational Approaches

The purple cluster is dominated by reverse logistics, with associated terms such as reverse supply chain, fuzzy logic, analytical hierarchy process, barriers, surveys, multi-criteria decision-making and stakeholder-related terms. This indicates a strong methodological dimension in reverse logistics research. Researchers appear to investigate not only the movement of returned products but also decision-making, barriers, stakeholder involvement and evaluation techniques. (Wang, 2021).

➤ Red Cluster – Closed-Loop Supply Chains and Optimization

The red cluster contains keywords such as closed-loop supply chain, sustainable supply chain, optimization, network design, stochastic models, decision theory, transportation, inventory modelling, carbon and multiobjective optimization. This cluster reflects the quantitative and operational side of the literature. Research in this area focuses on designing supply-chain networks that integrate forward and reverse flows while considering cost, environmental impact, uncertainty, transportation and inventory decisions. (Daultani, 2022).

➤ Yellow Cluster – Recycling and Waste Management

The yellow cluster is strongly associated with recycling, waste disposal, solid waste management, municipal solid waste, e-waste, landfill, waste treatment and vehicle-routing problems. This cluster represents the environmental and waste-management dimension of the research. It shows that

reverse logistics is closely linked with the recovery and treatment of discarded products and materials. The connection between reverse logistics, recycling and resource recovery is consistent with research describing reverse logistics as an important mechanism for moving away from the traditional take-make-dispose model. (Seuring et al., 2022).

➤ *Blue/Cyan Cluster – Environmental, Human and Contextual Dimensions*

The blue/cyan area contains terms such as human, industry, stakeholder, knowledge, India, China, Brazil, Australia, environment and economic aspects. This indicates that the literature also considers the social, geographical and organizational context in which reverse logistics and sustainability systems operate. (Seuring et al., 2022).

Increasing the threshold to 10 removes many less frequently occurring terms and produces a clearer representation of the dominant research themes.

➤ *Green Cluster – Reverse Logistics, Supply Chain Management and Industry 4.0*

The green cluster is dominated by reverse logistics and supply chain management, with related terms including manufacturing, industry, India, stakeholder, performance assessment, artificial intelligence, Industry 4.0 and remanufacturing. This cluster indicates that reverse logistics research is increasingly connected with manufacturing systems and technological transformation. The appearance of artificial intelligence and Industry 4.0 indicates growing interest in using digital technologies to improve the management of reverse flows.

➤ *Red Cluster – Sustainable Development and Closed-Loop Supply Chains*

The red cluster centres on sustainable development, closed-loop supply chain, decision making, economic and social effects, profitability, resilience, risk assessment and sustainability-related outcomes. This cluster represents the strategic sustainability dimension. It indicates that reverse logistics is being studied not simply as a waste-return process but as part of broader attempts to balance environmental, economic and social objectives. Sustainable closed-loop supply-chain research explicitly considers the environmental and social impacts associated with supply-chain activities alongside economic outcomes. (Seuring et al., 2022).

➤ *Blue Cluster – Waste Management and Recycling*

The blue cluster includes waste management, recycling, waste disposal, electronic waste, solid waste, municipal solid waste and environmental protection. Compared with the threshold-5 map, this cluster becomes more clearly focused on the central relationship between reverse logistics and waste recovery. The presence of e-waste and recycling indicates the importance of recovering materials from products at the end of their useful life. (Seuring et al., 2022).

➤ *Yellow Cluster – Environmental Sustainability and Life-Cycle Perspective*

The smaller yellow cluster contains terms associated with life cycle, environmental sustainability, greenhouse gases, environmental impact and related assessment concepts. This cluster suggests that sustainability research increasingly evaluates reverse-logistics systems through their environmental consequences across the product life cycle, rather than considering transportation or recovery activities in isolation. (Zhang, 2023).

The threshold of 15 provides the most concentrated view of the research field. Many peripheral keywords disappear, leaving the terms that occur most consistently across the literature.

➤ *Green Cluster – Reverse Logistics and Circular Economy*

The green cluster is centred on reverse logistics and circular economy, with important associated terms including logistics, remanufacturing, green supply chain, environmental management, triple bottom line, artificial intelligence, Industry 4.0 and literature review. This cluster represents the core conceptual foundation of the research field. The strong presence of reverse logistics and circular economy demonstrates their close conceptual relationship. Reverse logistics facilitates the return, recovery, reuse and recycling of products and materials, thereby supporting circular-economy objectives. (Prajapati, 2022).

➤ *Red Cluster – Sustainable Development, Closed-Loop Supply Chains and Optimization*

The red cluster contains sustainable development, supply chains, closed-loop supply chain, sales, profitability, costs, optimization, integer programming, carbon and carbon emissions. This cluster represents the economic and decision-oriented dimension of the field. The literature connects sustainable supply-chain design with optimization techniques used to address costs, network structures, carbon emissions and operational decisions. Recent reviews specifically highlight optimization models as an important component of sustainable closed-loop supply-chain research. (Seuring et al., 2022).

➤ *Blue Cluster – Waste Management, Recycling and Environmental Protection*

The blue cluster contains waste management, recycling, electronic waste, waste disposal, solid waste, e-waste, environmental sustainability, environmental protection and Brazil. At this higher threshold, the cluster becomes more compact and focuses primarily on waste recovery and environmental management. The continued presence of recycling and waste management even after raising the threshold indicates that these concepts are persistent themes within the literature rather than peripheral topics.

➤ *Yellow Cluster – Life Cycle and Environmental Assessment*

The smaller yellow cluster is associated with life cycle, environmental sustainability, uncertainty analysis and related environmental indicators. Its position between the sustainability, reverse-logistics and waste-management areas

suggests a bridging role between operational reverse-logistics decisions and their broader environmental consequences.

V. DISCUSSIONS AND IMPLICATIONS

➤ Findings

• Answer to RQ1

Publication output rose over the closed window 2014 to 2025. The count moves from 29 articles in 2014 to 112 in 2025, with a low of 18 in 2015 and 38 in 2016, then 60 in 2021, 76 in 2022, 89 in 2023 and 97 in 2024. The compound annual growth rate from 2014 to 2025 is 13.1 per cent. Because a compound rate uses only the endpoints, a second window is reported: from 2016 to 2025 the rate is 12.8 per cent. The 2015 to 2025 rate is higher, at 20.1 per cent, only because 2015 is the trough. Biblioshiny's annual growth rate of -18.59 per cent is not used. It is pulled down by an incomplete 2027 count in the software window, and it is not a contraction in the year-by-year series.

The Scopus extract is dated 11 September 2026, so 2026 is a partial year. The file already contains 167 articles for 2026. That figure is not annualised and is not used in either compound rate. A partial year that happens to be the largest count would inflate the rate if it were treated as a full year. The mapped set itself remains the 867 documents reported by Biblioshiny, 747 articles and 120 reviews, across 342 sources. Mean citations are 37.04 per document, the average document is 3.94 years old, and 32.99 per cent of publications involve international co-authorship. Those citation and collaboration figures describe the set. They are not growth rates.

The outlets and the cited core explain why the average citation count is high. Sustainability accounts for 77 documents, Journal of Cleaner Production for 53, Cleaner Logistics and Supply Chain for 19, Logistics for 15 and the International Journal of Logistics Management for 14. In the Scopus export loaded to Mendeley, the higher cited-by counts on e-commerce records sit with Lahkani and colleagues on blockchain supply-chain finance (163), Cano and colleagues on sustainable e-commerce logistics (75), Kwilinski on the EU SDGs (64) and Mucowska on urban last-mile delivery (61) (Cano, 2022; Kwilinski, 2023; Lahkani, 2020; Mucowska, 2021). Those counts are Scopus cited-by figures, not a local citation ranking from Biblioshiny.

• Answer to RQ2

Volume and the cited core are not the same geography. On the three-field plot India is the strongest country presence, with Brazil, China, the United States and the United Kingdom also large. Corresponding-author counts, read from the chart and therefore approximate, put India at about 106 documents, Brazil at 76 and China at 75. India's corresponding-author output is mostly single-country, about 87 against 19 multiple-country. China has the larger international share of the three, about 46 single-country and 29 multiple-country. Affiliation-based production, which can count one paper in more than one country, ranks India at 284, Brazil at 213, China at 186, the United States at 133 and the United Kingdom at 110.

Authors with wide links on the three-field plot include Govindan, Yu, Solvang, Wang, Kumar, Singh, Sarkis and Duarte. The keywords on that plot centre on sustainable development, reverse logistics, supply chain management, recycling and circular economy.

The co-occurrence maps are the stable part of the thematic evidence. At minimum frequencies of 5, 10 and 15 the spine holds: reverse logistics with circular economy, remanufacturing, Industry 4.0, artificial intelligence and blockchain; a decision-methods group around barriers and multi-criteria choice; closed-loop network design, optimisation, inventory, transport and carbon; and recycling, e-waste and waste treatment (Daultani, 2022). Reverse logistics is the largest author keyword, at 403. Sustainability is at 310 and sustainable development at 25. Circular economy is at 177. Closed-loop supply chain, recycling and waste management sit at 39, 39 and 35. Industry 4.0 and artificial intelligence sit at 31 and 16.

The thematic map is not used here as a result. Sustainability and sustainable development are split across the map, and a generic term, article, appears in the niche quadrant. That term is a cleaning failure, not a theme. Until those synonyms are merged and the stopword is removed, an empty motor quadrant cannot be read as evidence that the field has no developed core. The co-occurrence frequencies already show the core. It is reverse logistics and the circular economy, not a missing quadrant.

• Answer to RQ3

E-commerce is an author keyword in 19 of the 867 documents. Reverse logistics is an author keyword in 403. The project files do not record the Scopus query string, so the 19 count cannot yet be read as a retrieval failure. What it does show is that, inside the set that was mapped, the e-commerce term is rare relative to reverse logistics, circular economy and sustainability. If the query was broad, the sample is the neighbouring literature, and the paper's title overclaims. If the query required an e-commerce term, the keyword field is a poor record of that retrieval. Either way the query has to be reported before the 19 is treated as a finding about the field rather than a finding about the labels.

The documents that do name e-commerce cluster on three operations. Last-mile reviews cover urban solutions, stakeholder views and business-to-consumer delivery (Cano, 2022; Mucowska, 2021). Packaging work covers materials, Canadian transport packaging and returnable transport items (Clement, 2025; Escursell, 2021). Returns work covers fashion returns and reverse-logistics models for the Indian e-commerce market (Marriott, 2025)(Dutta, 2020). Digital papers in this strand are mostly reviews or proposals, including Industry 4.0 for first-mile and last-mile reverse logistics (Kiba-Janiak, 2021). Consumer and social papers are fewer. They cover cross-border purchasing, preferences, poverty alleviation and sustainability transitions (Oláh, 2019; Schleiden, 2020; Zhang, 2023). Keyword sparsity is not evidence that a practice gap exists. It is evidence that the label is sparse.

➤ *Implications*

For a platform or a logistics firm, the operational literature already names three levers: returns handling, packaging, and last-mile design. The returns reviews treat reuse and recycling networks as the route to lower waste. Packaging simulations and last-mile reviews are the other two bodies of evidence. Digital tools are visible on the maps and are still mostly untested on those three levers, so a claim that artificial intelligence or blockchain has made returns or delivery more sustainable is ahead of the studies in this set.

For a regulator, the cited core is about supply-chain carbon, e-waste and closed-loop design, not about a measured abatement effect of e-commerce. Pollution results attached to China's cross-border pilot zones, and the European readings against SDG 12 and SDG 13, are separate from the keyword map (Kwilinski, 2023; Song, 2024). Policy that treats “sustainable e-commerce” as a single instrument is not supported by this corpus.

➤ *Research Agenda*

Four tasks follow from the limits of the map, not from a forecast. First, publish the Scopus query and rerun the count of records that carry an e-commerce term in the title, abstract or keywords, so the 19 author-keyword hits can be interpreted. Second, merge sustainability with sustainable development, and e-commerce with electronic commerce, drop article as a stopword, and rerun the thematic map before any claim about motor themes. Third, test an artificial-intelligence, blockchain or analytics tool on a returns, packaging or last-mile outcome, rather than add another review. Fourth, use the country split that is already in the chart: India's corresponding-author papers are mostly single-country (about 87 against 19), while China has a larger multiple-country share. A collaboration design has a basis in that split. A claim that an Indian, Brazilian or Chinese field study would fill a measured practice gap does not.

VI. FUTURE RESEARCH AGENDA

This review set out to trace how research on sustainable e-commerce has evolved inside the broader body of work on reverse logistics and the circular economy. The 867 documents analysed (747 articles and 120 reviews) show a field that is growing steadily but is still centred on reverse logistics, which appears as an author keyword 403 times, while e-commerce appears only 19 times. The agenda below is organised into six areas, moving from the methodological to the substantive.

➤ *Establishing E-Commerce as a Distinct Domain*

The first gap lies in how the field is labelled. Only 19 of the 867 documents carry e-commerce as an author keyword, so it is unclear whether the low count is a real research gap or a matter of labelling. Future studies should publish the exact Scopus query and retrieve every record that mentions an e-commerce term in its title, abstract or keywords. Near-identical terms (sustainability and sustainable development, e-commerce and electronic commerce) should be merged, and generic words such as “article” removed, before the thematic map is run again.

➤ *Testing Digital Technologies with Real Data*

Industry 4.0, artificial intelligence and blockchain form their own cluster in the co-occurrence maps, but the papers behind it are mostly reviews, conceptual frameworks or analytical models (Agnusdei et al., 2022; Al Mashalah et al., 2022; Wan et al., 2022). Researchers should check whether these tools actually change outcomes in returns, packaging and last-mile delivery, using field data, case studies or simulations such as that of Clement and Spinler (2025).

➤ *Measuring Environmental Impact*

The most cited papers deal with closed-loop network design and carbon, yet few measure what e-commerce itself saves or adds in emissions. Comparisons of online and store retailing (Buldeo Rai et al., 2023; Klein & Popp, 2023) could be taken further through life-cycle assessment of returns, reusable packaging and delivery routes.

➤ *Bringing in Consumers and Social Issues*

None of the clusters is built around consumer behaviour or social outcomes. The few relevant studies look at sustainable purchasing preferences, poverty alleviation and cross-border buying (Bharani et al., 2024; Cordes & Marinova, 2023; Schleiden & Neiberger, 2020). Future work could ask how consumers behave when returning goods, whether they would accept slower delivery or reusable packaging, and what working conditions look like in last-mile operations.

➤ *Emerging Economies and Cross-Country Collaboration*

India leads on affiliation-based output with 284 documents, followed by Brazil (213) and China (186). Yet India's corresponding-author papers are mostly single-country (about 87 against 19 multi-country), whereas China has a larger international share (about 46 against 29). Comparative studies across India, Brazil and China would be useful, as would partnerships with regions that appear far less often, such as Sub-Saharan Africa (Cordes & Marinova, 2023).

➤ *Widening the Method*

This review searched only Scopus and kept only English-language journal articles and reviews. Later reviews could add Web of Science, include conference papers and book chapters, and track how themes change across time periods. The analysis should also be repeated once 2026 is a full year, since the data were collected on 11 September 2026.

VII. CONCLUSION AND LIMITATIONS

The present review has met its primary objective of reading the sustainable e-commerce literature against the larger reverse-logistics and circular-economy field, and of separating what the maps show from what they do not.

Reverse logistics remains the largest author keyword, at 403 occurrences. E-commerce remains an author keyword in 19 of 867 documents. On the closed window, output moved from 29 articles in 2014 to 112 in 2025.

The search is Scopus only, English only, and limited to journal articles and reviews. Collection on 11 September 2026 makes 2026 a partial year, and 2027 is not part of the growth calculation. Corresponding-author bars were read from a chart. Country production can count a co-authored paper more than once. The maps do not estimate emissions, return rates or abatement.

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