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Literature Review

Unveiling the Landscape of Sustainable Logistics Service Quality: A Bibliometric Analysis

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ABSTRACT

Sustainable Logistics Service Quality (SLSQ) has emerged as a critical focus in supply chain management, driven by increasing environmental concerns and consumer demand for responsible business practices. This study conducts a bibliometric analysis of 546 Scopus-indexed documents published between 1994 and 2024, systematically uncovering key research trends, thematic clusters, and gaps in SLSQ. Findings reveal a marked increase in SLSQ research since 2013, spurred by regulatory pressures, advancements in digital technologies, and growing consumer expectations for sustainable logistics. Dominant themes include the integration of cutting-edge technologies such as artificial intelligence (AI), big data analytics, blockchain, and sustainable transportation methods, which collectively enhance logistics service quality while reducing environmental impacts. Additionally, a notable trend is the alignment of logistics services with sustainability goals, reflecting both academic interest and industry imperatives to lower carbon footprints and improve resource efficiency, particularly in sectors like e-commerce. Despite these advancements, the study identifies significant gaps, particularly the lack of multidimensional metrics capable of comprehensively evaluating SLSQ across social, environmental, and economic dimensions. This highlights an urgent need for standardized and holistic frameworks to guide logistics providers in achieving operational efficiency and sustainability objectives. By bridging service quality and sustainability, this research addresses an underexplored area and provides a foundation for future scholarly work in SLSQ. Practical implications include guiding logistics providers and policymakers in formulating sustainable practices that align with regulatory requirements and enhance customer satisfaction. For academia, it offers a pathway to develop robust SLSQ metrics and frameworks, advancing sustainable logistics strategies and fostering a more efficient, eco-friendly, and customer-centric logistics ecosystem.

Keywords: Sustainable logistics service quality, supply chain management, digital technologies, bibliometric analysis

INTRODUCTION

Background of Study

The global business landscape is undergoing a significant transformation, driven by heightened awareness of sustainability and its integration across various industrial sectors, particularly within supply chain management (SCM). Notably, in the logistics sector, which forms the backbone of global supply chains, Sustainable Logistics Service Quality (SLSQ) emerges as a critical enabler for industries to meet both sustainability and performance targets. This makes SLSQ a vital component for ensuring competitive advantage and resilience in industrial

operations. In this context, SLSQ has become a crucial element within industrial systems by providing a framework for sectors such as manufacturing, retail, and e-commerce to enhance operational efficiency while minimizing environmental impacts [1]. For example, recent studies indicate that in industries like the hotel sector, logistics resources significantly influence service quality and ultimately drive sustainable competitive advantage [2]. Moreover, in e-commerce, last-mile logistics plays a pivotal role in promoting social sustainability by ensuring customer satisfaction through dimensions such as tangibility and reliability [3].

Traditionally, logistics strategies focused on performance metrics such as speed and cost-effectiveness; however, these metrics have proven insufficient in addressing the broader environmental and social impacts of logistics operations [4]. The growing environmental concerns, such as resource depletion and climate change, coupled with rising greenhouse gas emissions, have compelled businesses to integrate sustainability into their core strategies [5]. Furthermore, as consumers become increasingly environmentally conscious, the rise of the internet and 24-hour news cycles has made unsustainable practices within supply chains more likely to be exposed, risking damage to brand reputation and shareholder value [4]. Consequently, companies are recognizing the need to incorporate environmental considerations into organizational performance [5]. For instance, green service quality (GSQ) practices in India's logistics sector have enhanced customer satisfaction through eco-friendly approaches [6]. Similarly, in the agri-food supply chain, aligning logistics service quality with environmental sustainability has been vital for supporting rural economies, as demonstrated in Ukraine [7]. Thus, companies have implemented rigorous measures and policies when selecting logistics service providers, understanding that effective sustainable logistics services reduce costs, improve product quality, and provide a competitive advantage [8].

The evolution of SLSQ represents a significant shift in the logistics industry, emerging in the early 21st century as a response to heightened awareness of environmental degradation and regulatory pressures from global climate initiatives like the Kyoto Protocol [9]. This shift has driven a focus on sustainable development, incorporating key elements of SLSQ, such as time, product condition, sustainable transportation, and collaboration [1]. Consequently, logistics stakeholders began reassessing traditional practices through an eco-centric lens, prioritizing transparency, accountability, and sustainable development [10]. Building on this shift toward sustainability, global efforts to enhance supply chain and logistics sustainability have become essential due to escalating climate change impacts and resource overconsumption [1]. In response, organizations are under increasing pressure to adopt environmentally friendly practices that reduce their ecological footprint while addressing the need for long-term sustainability in logistics operations [11]. These measures, extending beyond traditional performance metrics, reflect a growing commitment to integrating sustainability into global logistics strategies [1].

Simultaneously, the logistics sector, despite not being directly involved in manufacturing, has acknowledged its substantial environmental footprint and the associated long-term sustainability risks [12]. Logistics operations contribute significantly to air and water pollution, hazardous and solid waste disposal, and fuel consumption [13], [14], with transportation being the largest contributor [13], [15]. To mitigate these impacts, studies emphasize adopting sustainable reverse logistics practices, particularly in developing countries in Africa, where fewer studies have been conducted compared to developed regions in Europe, the USA, and Asia [16]. For instance, reverse logistics service quality (RLSQ) plays a critical role in improving customer satisfaction and operational efficiency. Additionally, green development strategies, such as those implemented in China, have set a global precedent for high-quality sustainable practices, reshaping logistics operations to align better with environmental sustainability goals [17].

Recognizing these challenges, industrial stakeholders are increasingly demanding transparency, accountability, and environmental responsibility from logistics service providers. This reinforces the critical role of SLSQ frameworks in enhancing both logistics performance and environmental sustainability [1]. According to the Global Logistics

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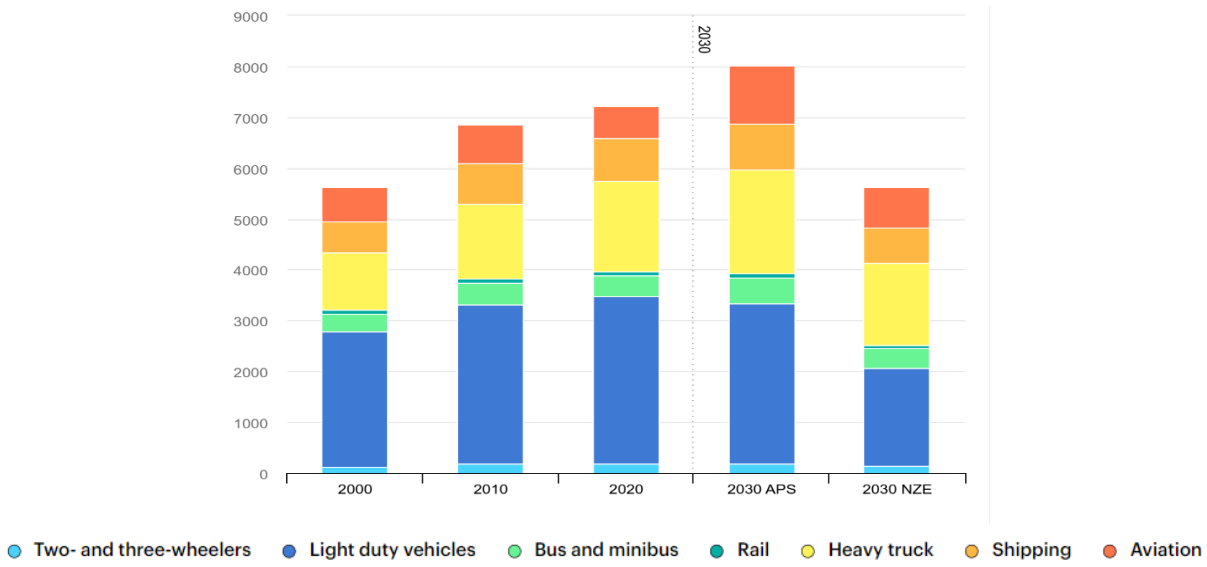

Figure 1. Global CO2 emissions from transport by subsector, IEA 2021

Emissions Council (GLEC), freight transportation and logistics are responsible for 8 to 11% of total energy-related greenhouse gas emissions worldwide. Furthermore, freight transport activity (measured in ton-kilometers) is anticipated to increase by 150% by 2050 unless the global economy is reshaped with climate change mitigation in mind through concerted and coordinated action [18]. Figure 1 illustrates global transport CO2 emissions by subsector, as reported by the International Energy Agency in 2021.

In response to these challenges, industries strive to provide superior logistics services by emphasizing Logistics Service Quality (LSQ), which focuses on delivering speed, accuracy, and reliability while adapting to sustainable practices that meet customer demands and enhance competitive advantage [1]. However, achieving sustainable product and service quality requires significant effort due to innovations, globalization, and customer demands [19]. Therefore, businesses must adapt their models to align with emerging sustainable trends, technologies, and customer needs to enhance operational efficiency and maintain competitive advantage [20].

The rise of information technology and data analytics, such as AI and big data analytics, alongside sustainable transportation technologies, has been integral to advancing SLSQ, enabling industries to optimize supply chains and reduce environmental impacts [21]–[23]. Moreover, recent advancements in Logistics 4.0 technologies, such as AI, blockchain, IoT, and big data analytics, allow industries to integrate sustainability into logistics frameworks while maintaining high service quality levels [24]. These innovations offer greater flexibility and efficiency, particularly in emerging economies like India and Vietnam, where sustainable logistics practices are increasingly adopted to meet both environmental and service performance goals [6], [25]. For instance, in Indonesia, the development of sustainable logistics performance models using system dynamics highlights the importance of economic and social factors in driving operational improvements [26]. Meanwhile, India's integration of GSQ demonstrates how eco-friendly practices can enhance customer satisfaction while advancing sustainability [6]. Furthermore, blockchain and AI adoption has been instrumental in improving transparency and operational efficiency across supply chains, as evidenced in studies from South Africa and China [27]–[30]. These technological advancements redefine logistics services by providing real-time tracking, smart sensors, and IoT-based automation for material handling [31]. Through IoT and big data analytics, industries can better manage environmental impacts, reduce carbon footprints, and meet rising consumer demands for sustainability [32]–[36].

These technological advancements, coupled with academic research and frameworks, have operationalized sustainable logistics practices, establishing SLSQ as a distinct study area [37]–[42]. The evolution of SLSQ

underscores a fundamental transition toward environmentally responsible logistics operations, emphasizing the need for continuous exploration and advancement of sustainable practices. Understanding the historical context and driving forces behind SLSQ's development is crucial for guiding future research aimed at fostering sustainability in logistics service provision.

Previous research has extensively examined logistics processes [35], [42]–[50], LSQ [51]–[57], and Sustainable Supply Chain Management (SSCM) [36], [58]–[64]. Similarly, significant research on Green Logistics [65]–[70] and sustainable logistics [71]–[73] exists. Despite this extensive body of work, an important gap remains in addressing the intersection of these two domains—Sustainable Logistics Service Quality (SLSQ), highlighting a critical area for further exploration. Building on this observation, most research on logistics service quality has primarily focused on traditional performance metrics like speed and cost-effectiveness. However, the growing emphasis on environmental responsibility underscores the need for a deeper understanding of how sustainability principles can be integrated into service quality evaluations [74]. While numerous studies address sustainable logistics or logistics service quality in isolation, there is a notable lack of research examining how sustainability practices directly influence logistics service quality [75]. Additionally, limited attention has been given to exploring LSQ and sustainability together or evaluating service quality post-implementation of sustainability practices [75].

This absence of integrated studies limits understanding of how sustainability practices enhance logistics service quality outcomes. A proposed Sustainable Logistics Service Quality (SLSQ) scale highlights the need for empirical validation of the model and its application in real-world logistics settings [75]. Moreover, the lack of empirical research in this area constrains understanding of how integrating sustainability principles into logistics service quality can influence operational outcomes [1]. Researchers have also stressed the need for integrated frameworks evaluating both sustainability and service quality in logistics [1]. However, research has remained fragmented, leaving a clear gap in empirical studies exploring SLSQ holistically.

In summary, SLSQ offers a promising platform for addressing the dual objectives of enhancing service quality and promoting sustainability within logistics operations. As businesses increasingly integrate sustainable practices into their logistics frameworks, evaluating SLSQ will be crucial for achieving both customer satisfaction and environmental sustainability [76]. However, the lack of research underscores the need for further investigation into how SLSQ can be effectively implemented and measured in practice. Developing comprehensive SLSQ models will not only improve customer satisfaction but also promote cooperation between Logistics Service Providers (LSPs) and their clients in achieving long-term sustainability goals [24].

Overview of Research Theme

Logistic Service quality

Logistics Service Quality (LSQ) refers to the ability of logistics service providers to deliver services that meet or exceed customer expectations, often measured across various dimensions such as timeliness, accuracy, and reliability [77]. LSQ is essential for enhancing a company's competitive advantage by improving operational efficiency, customer satisfaction, and overall business performance [78], [79]. In today's rapidly evolving global market, LSQ plays a pivotal role in supply chain management by ensuring the smooth flow of goods and information from raw material acquisition to final customer delivery [80]. Building on this modern significance, the origins of LSQ can be traced back to the mid-20th century, when logistics primarily served military purposes. However, as global commerce grew, logistics evolved to encompass civilian applications, becoming a critical driver of competitiveness in sectors such as manufacturing, retail, and e-commerce [81]. Perreaul and Russ [82] first conceptualized LSQ through their "7R" principles, focusing on delivering the right product, to the right customer, at the right time, place, quality, and cost. Over time, its scope expanded to include efficient storage and movement of products, services, and

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information throughout the supply chain [83]. Modern scholars have since broadened this foundational definition, emphasizing the integration of logistics with customer service, transportation management, inventory control, order fulfillment, and information flow to form the backbone of efficient logistical operations and drive customer satisfaction [84].

This evolution highlights LSQ as a multi-dimensional construct comprising elements like order accuracy, order condition, order timeliness, and order quality. These dimensions collectively shape customer perceptions of logistics services, influencing satisfaction and loyalty [85]. Notably, the difference between expected and obtained services is often referred to as LSQ [86]. Kotler [87] defines, service quality encompasses activities provided by an organization to its clients, impacting business outcomes and driving customer satisfaction. Critical Success Factors (CSFs), such as order accuracy and timeliness, are pivotal when choosing a logistics service provider (LSP). Firms prioritize LSPs capable of delivering high-quality services, as this significantly influences sustainability and future market success [88]. Additionally, Cronin and Taylor [89] emphasize the need for comprehensive measurement scales for physical distribution services. This underscores LSQ's importance, not only in physical distribution but also in its customer-facing components, making it an indispensable tool for companies to enhance reputation, trust, and competitiveness [90].

To further understand service quality, the SERVQUAL model introduced by Parasuraman et al. [91] provides a valuable framework. It defines service quality as the gap between customer expectations and perceptions, measured across five dimensions: Tangibles, Reliability, Responsiveness, Assurance, and Empathy. This model applies directly to LSQ, where both objective quality (adherence to LSP standards) and subjective quality (client perceptions) influence service outcomes [92]. Extending this understanding, research by Metzer et al. [77] introduced a comprehensive scale to evaluate LSQ, identifying nine core dimensions: information quality, ordering procedures, order release quantities, timeliness, order accuracy, order quality, order condition, order discrepancy handling, and personnel contact quality. These dimensions have since become benchmarks for evaluating LSP effectiveness and their ability to meet customer needs efficiently. Moreover, Millen and Maggard [93] highlighted that improvements in LSQ directly contribute to increased customer satisfaction, a critical factor for sustaining long-term relationships between businesses and LSPs. Similarly, Rajagopal et al. [94] emphasized the importance of competition in the capabilities of LSPs, particularly regarding sustainability, as it enhances both performance and customer satisfaction.

With the rise of globalization and increasingly complex supply chains, LSQ has become more intricate, demanding logistics service providers to be both innovative and responsive to rapidly changing client demands [95], [96]. This evolution underscores that LSQ is no longer solely about operational efficiency but also about integrating customer perspectives, which is vital for achieving long-term business success in competitive markets. As logistics transitions from an operational necessity to a strategic tool, its role in enabling customer-centric business models has grown exponentially, driven by rising customer expectations for timely, reliable, and flexible service offerings [78]. To meet these demands, logistics providers are compelled to maintain high standards in service delivery, with those excelling in LSQ setting themselves apart in the market through improved brand loyalty and competitive positioning [97]. Furthermore, in response to evolving market demands and global challenges, logistics providers must now integrate sustainability into their LSQ frameworks [24]. This integration involves balancing traditional service quality metrics with broader environmental and social goals, aligning logistics operations with sustainability principles to ensure long-term success [1].

Sustainability In Logistics

Sustainability, defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [98], has become a cornerstone of modern industries. As technological

changes, globalization, population growth, and environmental challenges such as climate change and resource depletion intensify, the logistics industry has increasingly embraced sustainability [99]. This shift is driven by global challenges, including environmental degradation, resource scarcity, and rising consumer expectations for environmentally responsible practices [4].

In logistics, sustainability integrates environmental, economic, and social dimensions, making it a vital aspect of modern supply chains [75]. The logistics sector plays a significant role in national economies, contributing 8.5% of GDP in the United States and up to 27% in Indonesia [100]. However, as businesses strive to balance economic growth with environmental preservation, the need for sustainable logistics practices has become urgent [1]. Sustainable logistics focuses on reducing environmental impacts by optimizing resources and minimizing waste, pollution, and carbon emissions [99]. For example, the use of renewable energy in transportation and green logistics technologies has become essential for reducing the carbon footprint of logistics service providers [101].

Sustainability in logistics also enhances service quality, directly linked to customer satisfaction and market competitiveness [11]. Studies across various regions highlight that integrating green logistics significantly boosts customer satisfaction and business performance [102]. This integration requires companies to adopt environmental, social, and economic measures. Environmentally, firms are implementing cleaner fuel standards, optimizing routes, and adopting reusable or biodegradable packaging materials [75]. Transparency and accountability are increasingly demanded by stakeholders, as reflected in the growing trend of sustainability reporting among logistics providers [103].

Economically, sustainability helps reduce operational costs while improving market competitiveness [75]. Measures like adopting electric vehicles and optimizing delivery routes have lowered fuel costs and emissions, enhancing brand image and aligning with international standards. Industry leaders like DHL and UPS have adopted green logistics strategies, achieving substantial cost reductions and customer loyalty gains [13]. Social sustainability, often overlooked, ensures employee health and safety, fosters stakeholder relationships, and improves customer satisfaction through sustainable services [104]. Examples include accident prevention strategies and ensuring driver well-being, highlighting the broader implications of sustainability beyond environmental and economic aspects [75].

Sustainable logistics involves managing all logistics activities to reduce environmental, economic, and social impacts [4]. As defined by Chang and Qin [105], it encompasses the planning, control, and implementation of logistics systems through advanced technologies and environmental management to minimize pollutant emissions. Similarly, Zhao et al. [106] describe sustainable logistics as improving resource use, reducing consumption and waste, and minimizing environmental pollution through rational planning and environmental technologies. Green logistics—a subset of sustainable logistics—focuses on reducing environmental pollution while considering social impacts [107]. This holistic approach enables companies to achieve long-term goals, maximize profitability, and enhance societal quality of life [108].

Research demonstrates that businesses prioritizing sustainability benefit the environment and improve overall performance [13]. For instance, companies with advanced sustainability practices report improved economic outcomes and brand image as environmental regulations and client expectations become stricter [16], [109]. In competitive markets, logistics performance is critical for overcoming barriers posed by global expansion and environmental concerns [110]. The trend of sustainability reporting underscores the pressure on logistics service providers (LSPs) to demonstrate their commitment to sustainability [111]. These reports enhance transparency and accountability, strengthening relationships with customers who increasingly prefer sustainable suppliers [112]. Moving forward, LSPs are expected to not only meet operational standards but also lead the charge in implementing sustainable logistics practices that balance environmental, social, and economic goals [113]. Despite these benefits,

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many LSPs face challenges in fully integrating sustainability into their operations [114]. High costs of new technologies, compliance with environmental legislation, and involving clients in sustainable initiatives remain significant barriers [128]. For example, investing in technologies like alternative fuel vehicles and 3D printing, which reduce waste and environmental impact, often entails substantial upfront costs [115].

Addressing these challenges requires transformative changes across technological, institutional, political, and economic dimensions [26]. The United Nations Sustainable Development Goals (SDGs) provide a framework for achieving sustainability by 2030, emphasizing the integration of sustainable practices into logistics activities, such as transportation, which significantly contribute to environmental impacts [116]. However, many companies lack comprehensive sustainability agendas. A recent study revealed that one-third of businesses either lack green initiatives or have initiatives with low maturity, highlighting the need for more robust frameworks [117]

While sustainability's importance is widely acknowledged, practical implementation remains challenging. LSPs must balance sustainability goals with cost efficiency, navigate regulatory requirements, and adapt to shifting customer expectations and technological advancements [118]. Consequently, the maturity of sustainability initiatives varies widely, with many companies still lacking actionable plans [94]. Moreover, most research on sustainable logistics emphasizes environmental aspects, often neglecting the integration of social and economic dimensions [94]. To address this issue, Brandenburg et al. [119] advocate for a more comprehensive approach encompassing all three pillars of sustainability to fully measure its impact on logistics performance. For companies that successfully incorporate sustainability into their logistics operations, the benefits are clear—they enhance their corporate image, achieve cost savings, and secure a competitive edge in markets that increasingly prioritize sustainable practices [120].

As sustainability becomes integral to logistics, service quality plays a critical role in ensuring these efforts align with customer expectations and regulatory standards [121], [122]. This convergence of sustainability and logistics service quality forms the foundation of Sustainable Logistics Service Quality (SLSQ), which is explored in the following section.

Sustainable Logistics Service Quality

Sustainable Logistics Service Quality (SLSQ) is an emerging concept that integrates traditional Logistics Service Quality (LSQ) with sustainability principles, providing a framework for logistics providers to meet customer expectations while adhering to environmental standards [1]. SLSQ encompasses functional and technical processes implemented by Logistics Service Providers (LSPs) to improve services, satisfy stakeholders, and establish strong relationships, all while aligning with sustainability goals [75]. Core elements of SLSQ include sustainable transportation, collaboration, sustainable packaging, training, and information dissemination, aiming to balance logistics efficiency and sustainability.

The term SLSQ addresses a gap in research, where LSQ has been extensively studied but sustainability aspects have received less focus [75]. With the increasing importance of environmental, economic, and social sustainability in the logistics sector, providers must now align traditional service quality with broader sustainability goals [123]. Both LSQ and Sustainable Service Quality (SSQ) are critical factors in selecting logistics providers [97], [124]. However, while green practices are growing, the evaluation of logistics services post-sustainability implementation remains underexplored [75].

To address this issue, researchers have proposed scales for measuring SLSQ, such as the comprehensive scale developed by [75] in Egypt. This scale evaluates 30 sustainability elements, including sustainable transport, collaboration, and sustainable packaging, providing a framework for integrating sustainability practices into logistics. By focusing on the intersection of LSQ and SSQ, SLSQ highlights how service quality and sustainability can

complement each other to meet customer expectations and environmental goals [1]. Studies confirm that changes in SLSQ directly impact LSQ and SSQ indicators, emphasizing its critical role in sustainable logistics [1], [75].

The intersection of SLSQ and SSQ (Sustainable Service Quality) illustrates the direct impact of sustainability initiatives on service quality in logistics [75]. For example, sustainable logistics services enhance both environmental performance and customer satisfaction, particularly when green practices align with customer expectations [16]. Research in Ukraine by [7] highlighted a logistics firm's integration of community responsibility and environmental safety into its operations. Similarly, Dovbischuk [7] findings revealed that customers expect higher levels of social sustainability in LSQ, especially regarding corporate social responsibility and human safety. These patterns are also observed in developed economies, where adopting green practices drives operational excellence and high service quality [24]. Choosing the right LSP becomes pivotal, as their performance in sustainable service quality impacts supply chain success and competitiveness [125].

Despite its benefits, achieving SLSQ poses significant challenges. Logistics providers must transition to green logistics practices, often requiring substantial modifications across supply chain processes to reduce environmental impacts while maintaining service quality [111]. High implementation costs, regulatory compliance, and technological gaps are major hurdles [17], [114]. For example, green practices such as sustainable transportation and waste reduction are hindered by costs and complex legislative requirements [115]. Adopting technologies like alternative fuel vehicles or advanced operational mechanisms requires significant investment, adding to the difficulties faced by many LSPs [126].

Resource limitations further exacerbate these challenges, with many logistics providers prioritizing immediate service quality over long-term sustainability goals [75]. Immature sustainability frameworks and a lack of standardized metrics complicate efforts to integrate sustainability into logistics operations [75], [127]. Communication barriers, such as information asymmetry and poorly structured contracts, also hinder collaborative sustainability efforts [128]. As a result, many logistics providers face slow progress in green transformations, inefficient resource allocation, and high energy consumption, particularly in transportation and distribution [17]. To overcome these obstacles, logistics firms must explore low-carbon development paths, optimize transportation networks, and reduce emissions through efficient resource use and integrated logistics processes [17]. Although these efforts require substantial investment and innovation, they are essential for meeting regulatory standards and customer demands while achieving environmental responsibility [75].

Research Problem

Despite the growing emphasis on sustainability, logistics service quality and sustainable logistics, significant gaps exist in the bibliometric/literature reviews studies that comprehensively examine the integration of sustainable practices with logistics service quality. Bibliometric reviews of these topics tend to address them in isolation, without delving into their interconnections. For instance, while substantial bibliometric work has been done on sustainable logistics [24], [129]-[133], green logistics [131], [134], alongside studies on service quality [135]–[138], reverse logistics [90], sustainable reverse logistics service Quality [16], reverse logistics [139] and general logistics service quality [140], however, these studies often focus on isolated dimensions—either sustainable logistics or logistics service quality—without systematically examining the integrated concept of Sustainable Logistics Service Quality (SLSQ). This represents a critical gap in the literature, it limits our understanding of the interconnectedness between sustainability and service quality in logistics, as the existing literature lacks a holistic bibliometric review that integrates sustainable practices into logistics service quality (SLSQ).

This research fills the identified gap by conducting a comprehensive bibliometric analysis using VOSviewer, which systematically examines the integration of sustainable practices into logistics service quality. This analysis is crucial

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for mapping the current state of research, identifying emerging trends, and uncovering critical gaps at the intersection of sustainability, logistics, and service quality. By evaluating the evolution of research on sustainable logistics, this study will highlight areas requiring theoretical development and empirical validation, ultimately contributing to future research directions in SLSQ [90]. Additionally, the study will assess how existing research has addressed the integration of sustainability into LSQ frameworks, offering a roadmap for industries to effectively incorporate sustainable practices into their logistics operations.

Based on the identified gaps in the literature, the following research questions (RQs) will guide this study:

RQ1. What are the publication trends and patterns, emerging trends in sustainable logistics practices, and predominant research themes in Sustainable Logistics Service Quality (SLSQ) literature over the past decade?

RQ2. What are the knowledge gaps, future research directions, and potential areas for further investigation within the SLSQ literature?

This research applies bibliometric techniques such as author analysis, publication analysis, co-citation analysis, keyword co-occurrence analysis, and data network visualization to discern prevailing trends, identify seminal works, and outline emerging themes in SLSQ. By leveraging these techniques, the study aims to contribute to the literature on sustainable logistics service quality, offering insights that can inform strategic decision-making, foster innovation, and promote sustainability-driven transformation within logistics and supply chain management. The primary objective of this research is to conduct a comprehensive bibliometric analysis that explores the integration of sustainability practices into logistics service quality. Specifically, the study seeks to identify emerging trends and key themes in the literature on Sustainable Logistics Service Quality (SLSQ) while uncovering knowledge gaps and areas for further investigation.

METHODS

The primary objective of this study is to evaluate the existing knowledge structure of Sustainable Logistics Service Quality (SLSQ) through a comprehensive bibliometric analysis. Bibliometric analysis is a systematic analytical approach that identifies the most influential publications, scholars, affiliations, and research themes, providing a transparent, static, and systematic representation of research within a specific domain [141]. This method is widely used across fields such as sustainability [142], [143], supply chain management and logistics [32], Green logistics practices [144], [145], sustainable logistics and supply chain [129], [130], [132], [133] Sustainable supply chain management and green technologies [146], reverse logistics [90], [139], [147], making it ideal for investigating an evolving domain like SLSQ.

The bibliometric approach is particularly suited to this study's objectives, as it allows for the quantitative assessment of academic impact through indicators like citation counts, influential authors, key journals, and collaborative networks [148]. Similarly, bibliometric analysis is a well-established form of meta-analytical research [149]. By mapping the intellectual landscape of SLSQ research, this method identifies not only research trends but also existing gaps and emerging areas that warrant further exploration.

Data Collection

For this study, data were collected from the Scopus database, recognized globally for its comprehensive and high-quality peer-reviewed literature. Scopus was selected over other databases, such as Web of Science and Google Scholar, due to its robust indexing capabilities, extensive multidisciplinary content, and inclusion of international journals across logistics, management, and sustainability disciplines [150]. This choice ensures that the data are both reliable and reflective of the global research landscape in SLSQ.

The data collection process involved a keyword search specifically targeting the title, abstract, and keyword fields, with terms such as 'Sustainable Logistics Service Quality (SLSQ)', 'Logistics Service Quality', 'Sustainability', and 'Green Logistics'. This search was limited to English-language publications from 1994 to May 2024, capturing a 30-year period that reflects the evolution of SLSQ. The initial search returned 558 documents, covering journal articles, conference proceedings, reviews, and book chapters. The inclusion of various publication types ensures a holistic view of SLSQ discourse, from foundational studies to recent insights. This comprehensive search strategy ensures that the selected publications directly contribute to the SLSQ domain, rather than peripheral topics within logistics. The selection of Scopus ensures a comprehensive dataset for analyzing SLSQ research trends, aligning with the study's goal of mapping the global research landscape in Sustainable Logistics Service Quality.

To ensure the relevance and focus of this study, a rigorous screening and filtering process was conducted on the initial dataset of publications related to Sustainable Logistics Service Quality (SLSQ). After exporting the dataset in RIS format, a series of criteria were applied to refine the selection. Only publications that explicitly addressed SLSQ in the contexts of logistics, supply chains and sustainability were included, while articles with non-relevant keywords or those focusing primarily on logistics or sustainability without a specific connection to SLSQ were excluded. Furthermore, only English-language publications were retained to maintain consistency and accessibility of the content. This meticulous filtering process reduced the dataset from the initial 558 documents to a more focused 546 articles, allowing for a targeted bibliometric analysis that provides meaningful insights specific to the SLSQ domain. The refined dataset thus serves as a robust foundation for examining research trends and identifying influential studies in SLSQ. This rigorous screening process ensures that the final dataset of 546 articles represents a focused and high-quality foundation for the bibliometric analysis of SLSQ, as illustrated in Figure 2, which outlines the PRISMA data collection and processing procedure.

Bibliometric Analysis

Bibliometric analysis provides a systematic and quantitative assessment of SLSQ research, mapping relationships between authors, keywords, and institutions. By using bibliometric methods, researchers can examine publication impact, research collaboration, and academic influence within a field [141]. This approach has been widely utilized to identify both qualitative and quantitative shifts in research topics and provides a meta-analytical perspective on

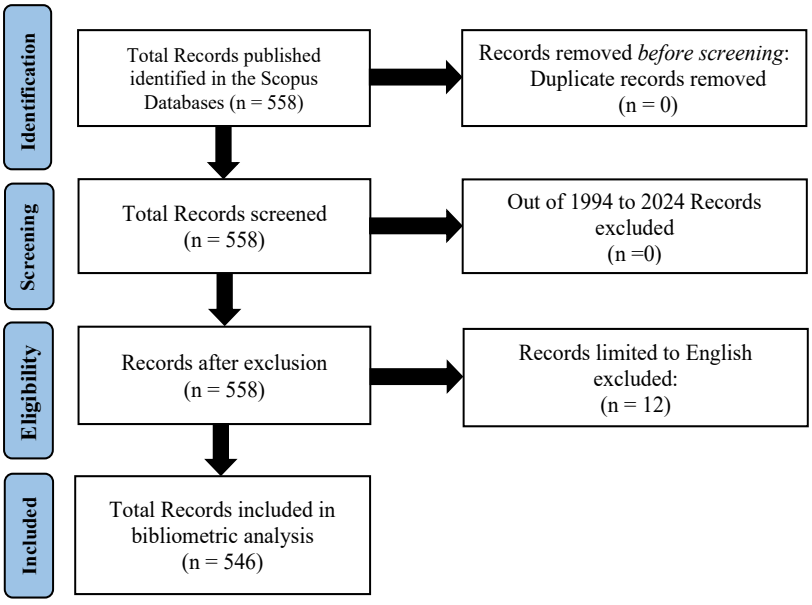

Figure 2. Steps in Identification and Screening of Scopus Sources, PRISMA 2020 flow diagram

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the evolution of specific academic domains, making it particularly ideal approach for examining the knowledge structure and thematic evolution within SLSQ.

The bibliometric analysis in this study focuses on identifying keyword occurrence and co-occurrence, citation patterns, and clustering of related research themes. These indicators allow for the mapping of research clusters and visualization of scholarly networks, which reveal the intellectual structure of SLSQ research. Through this structured approach, the analysis provides a comprehensive view of SLSQ's research landscape, highlighting collaborative networks, influential works, and emerging areas that warrant further investigation.

Analysis Tools and VOSviewer

The VOSviewer software was chosen for the bibliometric analysis in this study due to its robust capabilities in visualizing and analyzing bibliometric networks. Renowned for its intuitive interface and ability to handle large datasets, VOSviewer enables the construction of co-authorship, citation, and keyword co-occurrence maps, making it ideal for mapping the intellectual landscape of Sustainable Logistics Service Quality (SLSQ) research. When compared to other analytical tools like CiteSpace and Gephi, VOSviewer offers a more user-friendly experience, particularly valuable for producing clear visualizations that facilitate the understanding of complex bibliometric networks [151].

In this study, VOSviewer was utilized to generate network visualizations of research clusters within the SLSQ domain. By conducting a co-occurrence keyword analysis, the data was examined to identify terms that frequently appeared together within the SLSQ research. Out of 4,484 keywords, a threshold was set to include only those with at least 2 instances of co-occurrence with other keywords. This resulted in 1,061 keywords meeting the initial threshold. To ensure focus on the most relevant terms, non-relevant keywords were subsequently deselected from this set, refining the analysis to capture the most pertinent and impactful keywords associated with SLSQ research. Furthermore, clustering algorithms were employed to organize related terms into distinct, color-coded clusters, each representing a different research theme. This approach helped in identifying thematic clusters and revealed the structure of the research landscape. By clustering co-occurring keywords, VOSviewer enables an in-depth exploration of research themes, directly contributing to the study's objective of identifying emerging areas and research gaps within SLSQ. The insights gained from the VOSviewer analysis underscore the collaborative networks among scholars, highlight high-impact keywords, and provide a comprehensive view of SLSQ's development trajectory. Through this analysis, potential areas for future research were identified, pointing to gaps and emerging trends within the field that could guide further scholarly inquiry into SLSQ.

RESULTS AND DISCUSSION

The results provide a comprehensive analysis of Sustainable Logistics Service Quality (SLSQ) research trends based on bibliometric data from the Scopus database. The findings detail publication trends, major contributing institutions, and influential researchers, shedding light on the scope and growth of SLSQ as a research field. With an increasing focus on sustainability across global industries, understanding the development of SLSQ research holds significance for both academia and industry. For instance, the recent surge in publications on SLSQ reflects its growing importance in logistics, aligning with broader trends in sustainability and green supply chain management.

Scopus Search Results Analysis

Scopus was chosen for this bibliometric study due to its extensive, high-quality collection of peer-reviewed publications, which spans numerous academic disciplines relevant to SLSQ. Scopus provides comprehensive indexing and citation tracking, essential for identifying influential research, authors, and institutions. Compared to

other databases, such as Web of Science or Google Scholar, Scopus offers a more specialized focus on global research trends in areas like logistics, sustainability, and management, which are critical to this study.

This analysis considers all publications on SLSQ within the Scopus database, using the targeted keywords "Sustainable Logistics Service Quality" across titles, abstracts, and keywords. The selection criteria limit publications to English-language entries from 1994 to May 2024, resulting in 558 documents. This timeframe reflects the evolution of SLSQ research, showing a modest beginning in the 1990s with a noticeable growth phase post-2013, which underscores the increasing emphasis on integrating sustainability in logistics and supply chain practices.

Published Documents by Type

This study examined the distribution of Sustainable Logistics Service Quality (SLSQ) publications across different document types within the Scopus database, with a refined dataset of 546 documents post-screening. As shown in Figure 3, the majority are research articles (355; 65.0%), followed by conference papers (115; 21.0%), conference reviews (26; 4.8%), review papers (24; 4.4%), book chapters (23; 4.2%), and books (3; 0.55%). The prominence of research articles reflects a strong foundation of peer-reviewed work within SLSQ, highlighting this area as a mature field of inquiry with an emphasis on rigorous empirical and theoretical studies. The substantial proportion of conference papers (21.1%) also indicates an active engagement in ongoing research discussions and emerging ideas within both academic and industry contexts. The diverse document types underscore SLSQ's multidisciplinary approach, integrating empirical studies, theoretical frameworks, and industry discussions. This distribution suggests a growing recognition of SLSQ's importance within broader sustainability and logistics research, aligning with global industry trends focused on sustainability in supply chains. Together, these findings provide a comprehensive basis for future research, emphasizing SLSQ's role in bridging academic and industry advancements in sustainable logistics.

Documents by Subject Area

The interdisciplinary scope of Sustainable Logistics Service Quality (SLSQ) is evident from the distribution of research across various subject areas within the Scopus database, as shown in Figure 4. Core fields such as

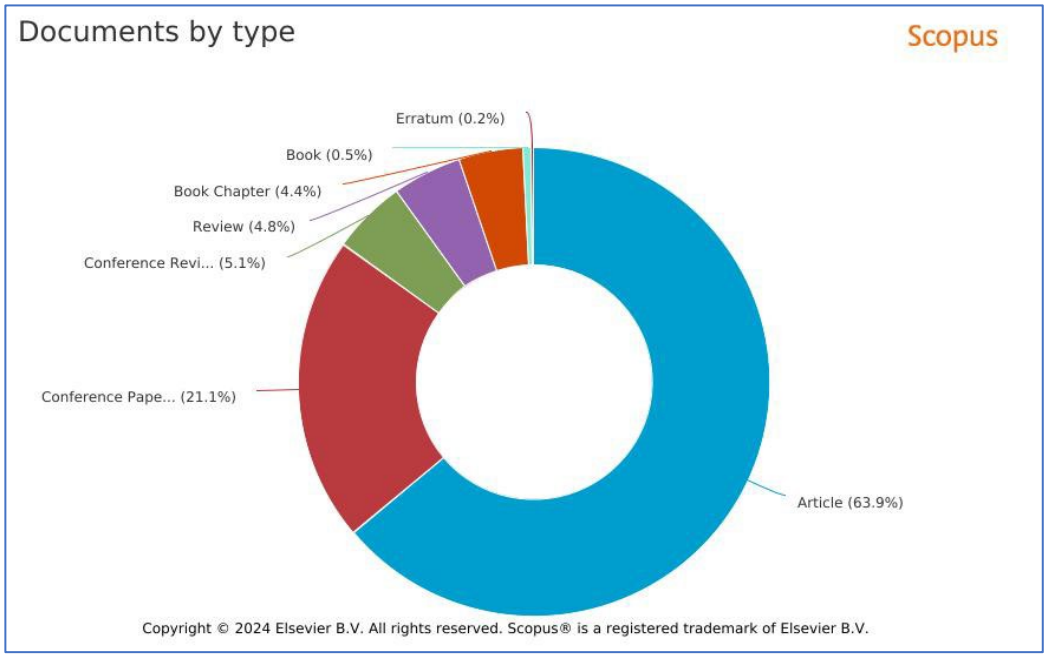

Figure 3. Published Documents by Type for Scopus Database

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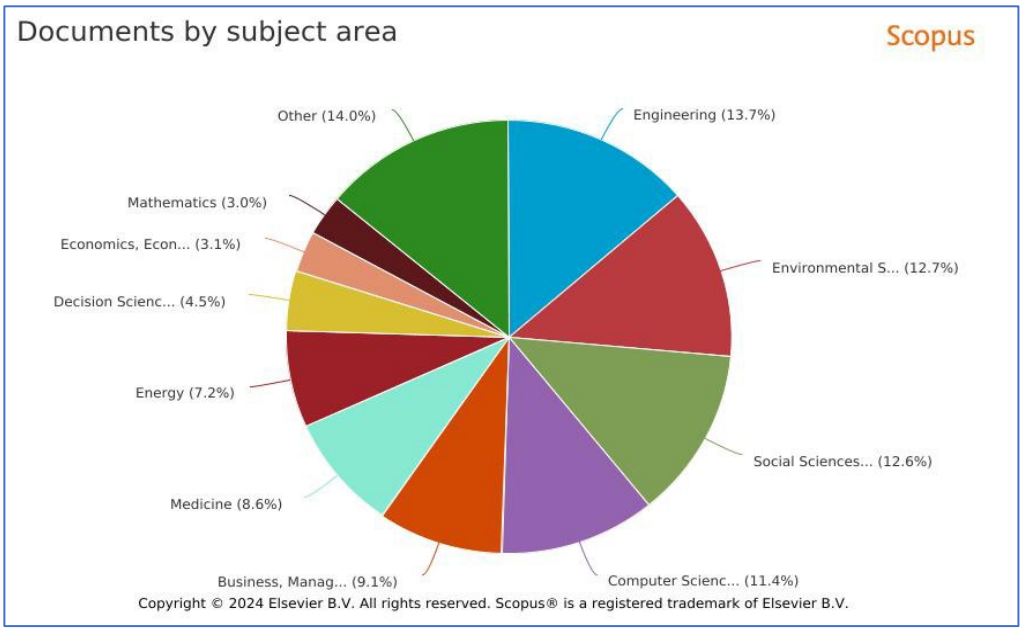

Figure 4. Documents Distributed by Subject Area from Scopus Database

Engineering (151 publications) and Environmental Science (140 publications) dominate, reflecting a strong emphasis on optimizing logistics processes and mitigating environmental impacts, which are central goals in SLSQ. Significant contributions from Social Sciences (139 publications) underscore the social dimension of SLSQ, which includes labor practices, community engagement, and well-being considerations within sustainable logistics. This social emphasis aligns with growing recognition in the logistics industry of the importance of social responsibility alongside environmental performance.

Computer Science (125 publications) and Business, Management, and Accounting (100 publications) demonstrate the relevance of technological advancements and management practices in driving sustainable logistics. Computer Science research supports innovations in digital solutions, such as data analytics and automation, which enhance logistics efficiency and environmental sustainability. Business and Management publications emphasize the integration of sustainability within logistics operations, aligning with industry trends that prioritize sustainable supply chain management. Further contributions from Energy (79 publications), Decision Sciences (49 publications), and Economics (34 publications) add layers to SLSQ by addressing energy efficiency, strategic decision-making, and economic viability. These insights contribute to industry practices by highlighting areas for improvement, such as cost-effective resource allocation and energy-efficient logistics networks. Although subject areas like Earth and Planetary Sciences, Agricultural and Biological Sciences, and Materials Science may provide insights into environmental challenges, their direct relevance to SLSQ is limited. Additionally, fields such as Arts and Humanities, Chemistry, and Immunology and Microbiology contribute far fewer publications and have peripheral relevance to SLSQ, signaling a broader but less directly applicable interest in sustainability.

This interdisciplinary distribution highlights SLSQ's alignment with broader sustainability and logistics research. Compared to general sustainability fields, SLSQ's growth, especially since 2013, reflects an accelerating pace that underscores its importance within industry and academic discourse. This growth likely stems from increasing environmental regulations, technological developments, and heightened consumer awareness, which collectively influence the logistics sector's move toward sustainable practices. This trend suggests that SLSQ is becoming an integral part of both academic research and practical applications, emphasizing its role in shaping sustainable logistics strategies across industries.

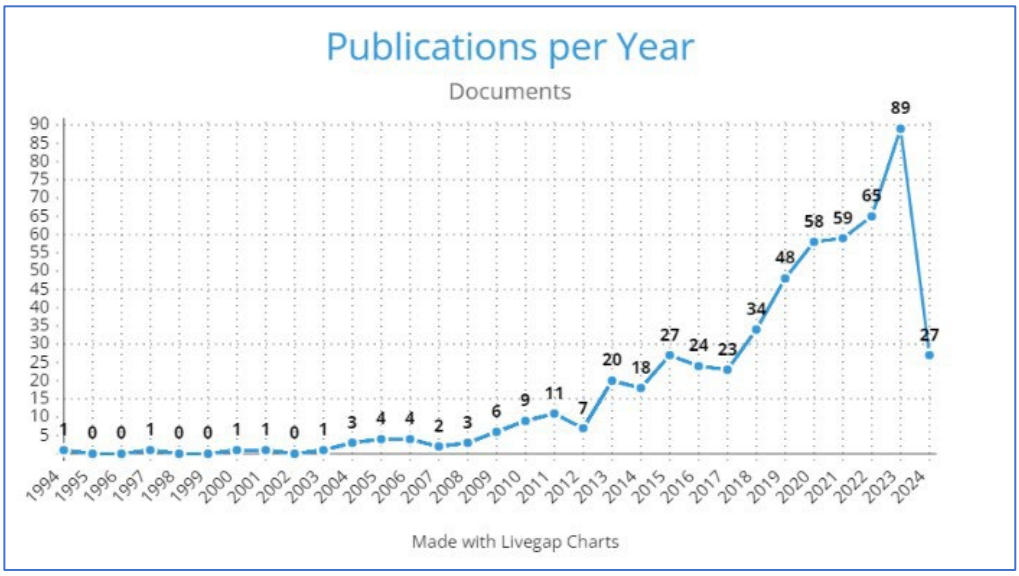

Figure 5 Published Documents per Year from Scopus Database

Publication per Year

The publication trend analysis of Sustainable Logistics Service Quality (SLSQ) over the past 30 years, as depicted in Figure 5, reveals a remarkable increase in research output, with a total of 546 publications identified in the Scopus database. Initial publications appeared sporadically between 1994 and 2004, with only a handful of studies conducted during these early years. However, from 2013 onward, a significant upward trend is evident, with 2023 marking the highest volume of SLSQ publications to date. This trajectory suggests that research interest in SLSQ has intensified and is likely to continue growing through 2024.

The substantial growth in SLSQ research reflects the escalating importance of sustainability in logistics, driven by several interrelated factors. Heightened environmental awareness has increased regulatory and social pressure on businesses to adopt more sustainable practices, with the logistics sector being no exception [152]. Additionally, rising consumer demand for environmentally responsible services has pushed companies to differentiate themselves by prioritizing sustainable logistics strategies [112]. This growing commitment to environmental sustainability has necessitated the development of SLSQ-focused practices and frameworks to balance environmental goals with service quality.

Technological advancements, particularly in electric vehicles, autonomous delivery systems, and data analytics, have further supported the expansion of sustainable logistics operations [101]. These innovations enable logistics providers to reduce carbon emissions, enhance operational efficiency, and optimize resource use, making sustainable practices more feasible and attractive. The increased feasibility of sustainable logistics solutions has opened new research avenues within SLSQ, prompting studies that explore the operationalization of sustainability within logistics service quality frameworks [111]. Such developments have not only broadened the scope of SLSQ research but also amplified its relevance within both academic discourse and industry practices.

Compared to broader fields in logistics and sustainability, the rapid growth in SLSQ-specific research underscores the unique importance of integrating sustainability into service quality metrics. This focus is vital for both academic discourse and industry practices, as it helps organizations navigate the challenges of sustainability without compromising service quality. As SLSQ research continues to expand, it will likely inform best practices, shape policies, and influence industry standards, highlighting its critical role in the evolving landscape of sustainable logistics.

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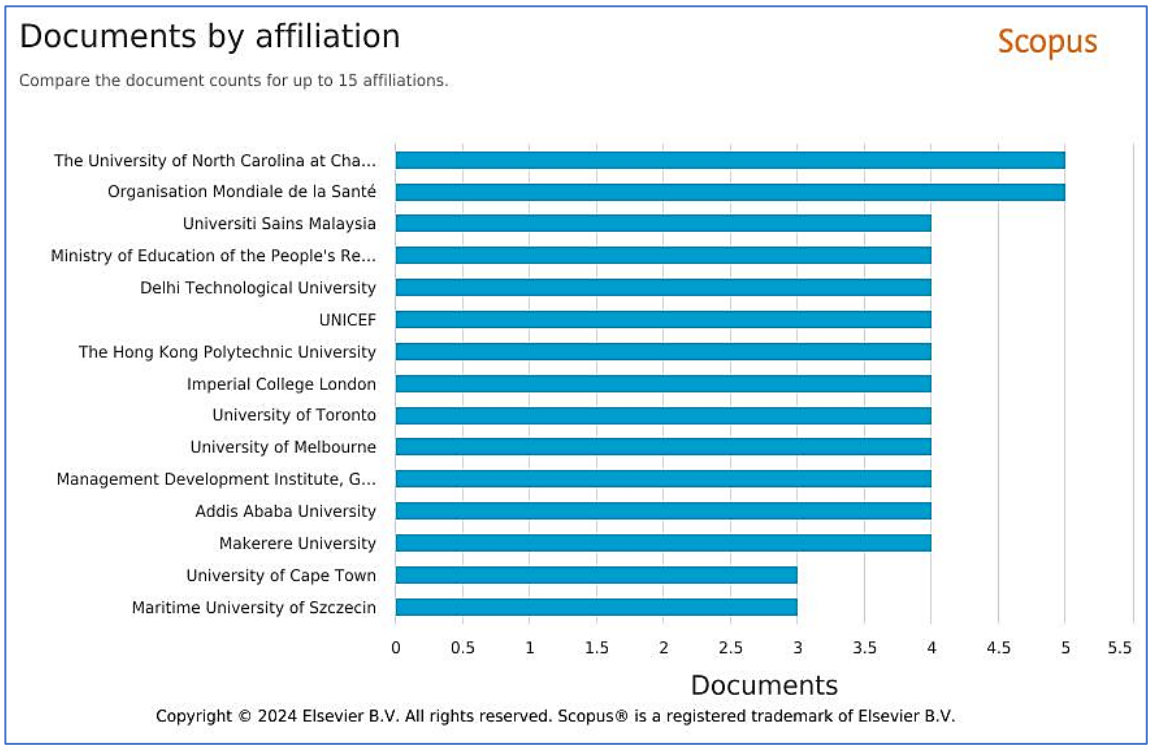

Figure 6 Documents by Affiliation from Scopus Database

Documents by Affiliation

The distribution of publications across institutions provides a valuable perspective on the global and collaborative nature of SLSQ research, as depicted in Figure 6. Among the 546 documents on Sustainable Logistics Service Quality (SLSQ) published between 1994 and May 2024, institutions from around the world demonstrate active engagement, indicating broad international interest in addressing sustainability within logistics. Leading contributors include The University of North Carolina at Chapel Hill (5 publications), Organization Mondiale de la Santé (5 publications), The Hong Kong Polytechnic University (4 publications), Imperial College London (4 publications), and UNICEF (4 publications). This global involvement highlights the shared responsibility and collaborative efforts of institutions worldwide to advance research in sustainable logistics and service quality practices.

While The University of North Carolina at Chapel Hill leads with the highest number of publications, the distribution of research is notably balanced across various institutions. Universities such as Delhi Technological University, Makerere University, and University of Melbourne, each with at least four publications, demonstrate the multi-institutional approach to advancing SLSQ research. This international diversity enhances the robustness of SLSQ research, facilitating the exchange of insights across regions and academic disciplines, which is essential for developing universally applicable sustainability practices within logistics. This widespread institutional involvement not only reflects a growing commitment to sustainability in logistics sector across academia but also signals the potential for future cross-institutional partnerships to further address pressing global challenges in sustainable logistics service quality.

Author Documents

The author documents present the top five most-cited papers within SLSQ (Table 1), each providing essential insights into major research themes, key trends, and existing gaps in the field. These influential publications reflect the

Table 1. Top 5 Most Cited Papers in Scopus Database

Document Title	Authors	Year	Source	Citations
Developing a theory of reverse logistics	Dowlatshahi, S.	2000	Interfaces, 30(3), pp. 143–155	511
A green ideology in Asian emerging economies: From environmental policy and sustainable development	Khan, S.A.R., Sharif, A., Golpîra, H., Kumar, A.	2019	Sustainable Development, 27(6), pp. 1063–1075	321
Environmental impacts as buying criteria for third party logistical services	Wolf, C., Seuring, S.	2010	International Journal of Physical Distribution and Logistics Management, 40(1-2), pp. 84–102	196
A comparison of fuzzy DEA and fuzzy TOPSIS in sustainable supplier selection: Implications for sourcing strategy	Rashidi, K., Cullinane, K.	2019	Expert Systems with Applications, 121, pp. 266–281	191
Sustainable third-party reverse logistic provider selection with fuzzy SWARA and fuzzy MOORA in plastic industry	Mavi, R.K., Goh, M., Zarbakhshnia, N.	2017	International Journal of Advanced Manufacturing Technology, 91(5-8), pp. 2401–2418	190

evolution of SLSQ, illustrating how sustainability practices intersect with logistics service quality. Notably, the prominence of these studies indicates the importance of sustainability in academic discourse and its impact on logistics practices.

The most-cited paper, "Developing a Theory of Reverse Logistics" by Dowlatshahi (2000), explores the theoretical foundations of reverse logistics, which plays an important role in sustainable supply chains [153]. The focus on optimizing return flows and minimizing waste highlights the growing importance of sustainability within the logistics sector. This paper lays the groundwork for understanding how the management of return processes contributes to overall service quality improvements, aligning with the study's exploration of how sustainability practices are integrated into logistics service quality frameworks. This addresses RQ1, as it highlights key trends in the integration of reverse logistics into service quality.

In contrast, "A Green Ideology in Asian Emerging Economies" by Khan et al. (2019) shifts focus to environmental policy in the context of sustainability [154]. Although this work does not directly discuss logistics service quality, it provides valuable insights into how emerging economies adapt to environmental regulations, shaping sustainable logistics. With 321 citations, this study highlights how policy can drive sustainability practices across regions, thus contributing to RQ2 by revealing knowledge gaps in applying sustainability standards within varied economic and regulatory contexts. This regional adaptation is essential for understanding SLSQ's relevance across global contexts, making the study's findings applicable to both emerging and developed markets.

"Environmental Impacts as Buying Criteria for Third-Party Logistical Services" by Wolf & Seuring (2010) is more closely aligned with logistics service quality, focusing on environmental impacts as a key factor in the selection of third-party logistics providers [126]. The shift towards considering environmental criteria marks a critical point in the evolution of sustainable logistics practices, highlighting the growing influence of sustainability on service quality

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assessments. This work directly addresses RQ1, as it highlights the emerging trend of integrating environmental considerations into logistics service provider evaluations. Its insights reflect the growing recognition of sustainability's role in enhancing logistics service quality, a critical factor for competitive differentiation in the logistics sector.

The fourth and fifth papers, "A Comparison of Fuzzy DEA and Fuzzy TOPSIS in Sustainable Supplier Selection" by Rashidi & Cullinane (2019) and "Sustainable Third-Party Reverse Logistics Provider Selection" by Mavi et al. (2017), introduce fuzzy logic methodologies to deal with the complexity and uncertainty in evaluating sustainability within logistics [155], [156]. While these papers focus on decision-making tools, they provide methodological insights that can be applied to assessing logistics service quality, particularly in contexts where sustainability goals are prioritized. These papers address RQ2, as they highlight gaps in methodological approaches and suggest potential areas for further investigation in in sustainability-driven decision-making within logistics service quality.

These papers collectively highlight critical dimensions within SLSQ, such as reverse logistics, regional adaptations to sustainability policies, environmental criteria for provider selection, and advanced evaluation methodologies. Each paper contributes to filling gaps in the literature by deepening our understanding of how sustainability practices integrate with logistics service quality, while also identifying future areas for research—such as regional differences and methodological innovations. The influence of these studies highlights SLSQ's accelerated growth compared to broader logistics and sustainability research, emphasizing its emerging importance in both academic and industry settings. This trend signals an increasing demand for sustainable practices within logistics, reflecting the rising expectations for environmentally and socially responsible logistics services in contemporary markets.

Documentation by Country

The global contributions to Sustainable Logistics Service Quality (SLSQ) research, emphasizing how different regions recognize and address sustainability challenges in logistics. Figure 7 illustrates that China leads with 83 publications, followed by the United States (61) and the United Kingdom (39), indicating a high level of engagement from these

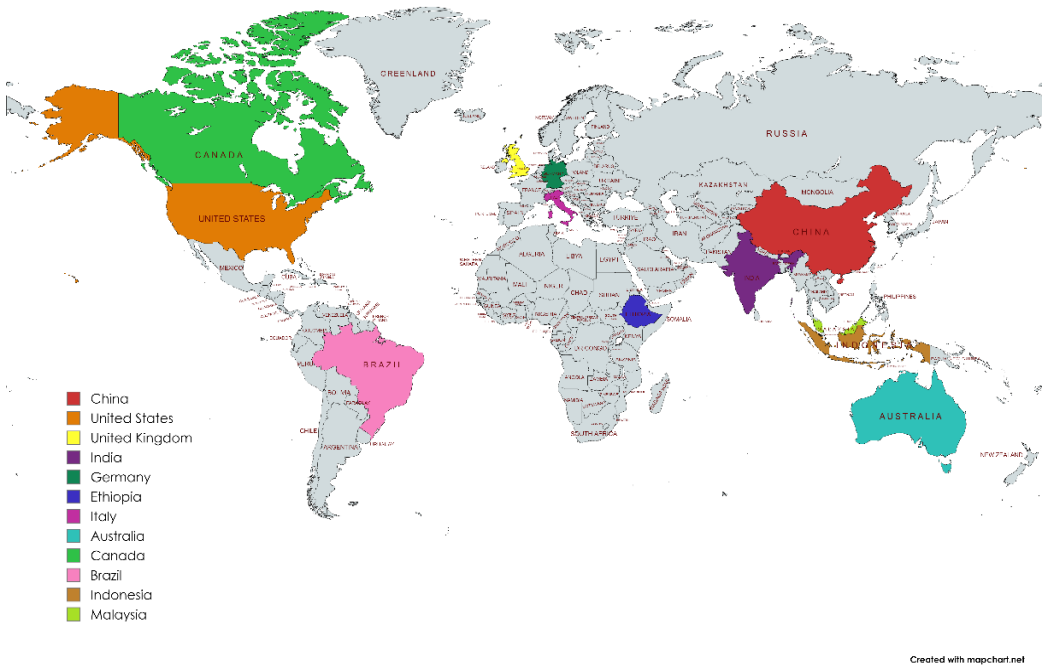

Figure 7. Most Countries that have Publications in Sustainable Logistics Service Quality

regions in advancing SLSQ research. Other contributors, including India, Germany, Ethiopia, Italy, Australia, Canada, Brazil, Indonesia, and Malaysia, further demonstrate the international relevance of SLSQ as these nations work to incorporate sustainable practices into logistics.

The global distribution of SLSQ research highlights the widespread awareness and recognition of sustainability issues within the logistics sector. China and the United States, as major global logistics hubs, contribute significantly to SLSQ research, setting benchmarks that impact both academic and industry practices globally. The broad international representation in SLSQ research underlines the collaborative approach to sustainable logistics, promoting shared solutions to global environmental and operational challenges. Comparing SLSQ to broader sustainability or logistics research, the notable presence of publications from emerging economies like India, Brazil, and Ethiopia indicates an accelerated interest in SLSQ beyond traditionally high-publishing countries. Such expansion into emerging economies could drive more region-specific insights and solutions, potentially enhancing both academic and practical applications of SLSQ across diverse contexts.

VOSviewers Results Analysis

The VOSviewer analysis identified seven thematic clusters that form the core of research SLSQ, as summarized in Table 2. Each cluster is represented by a distinct color—red, green, dark blue, yellow, purple, light blue, and orange—highlighting unique thematic areas within the SLSQ domain. These clusters provide a comprehensive overview of SLSQ's intellectual structure, encompassing critical dimensions such as methodology, business and economic factors, technological advancements, environmental sustainability, and customer-focused considerations. Figures 8 and 9 offer additional visualizations of these clusters: Figure 8 illustrates the network relationships among key terms, while Figure 9 presents a density map emphasizing frequently occurring keywords. Together, these visual tools facilitate the identification of interconnected research areas and emerging trends, offering valuable insights for advancing SLSQ research and its practical applications in academia and industry.

Table 2 Sustainable Logistics Service Quality Research Clusters 1994- May 2024

Cluster	Colour	Items	Constructs
Cluster 1 (Methodology & Analysis)	Red	102	"Data analysis", "Statistical methods (regression analysis, cross-sectional studies)", "Cost-effectiveness analysis", "Surveys and questionnaires", "Program evaluation", "Quality improvement", "Reliability", "Outcome assessment", "Total quality management".
Cluster 2 (Business & Economic Factors)	Green	97	"Supply chain management," Logistics services", "Cost reduction", "Customer service", "Economic and social effects", "Sustainability (environmental, economic, social)", "Logistics service provider", "Sustainable supply chain", "Reverse logistics", "Sustainable practices".
Cluster 3 (Transportation & Operations)	Dark Blue	65	"Electric vehicles", "Urban transport", "Freight transportation", "Emission reduction", "Transportation infrastructure", "Public transport", "Fleet operations", "Sustainable transportation".
Cluster 4 (Customer Perception & Satisfaction)	Yellow	52	Customer satisfaction, Service quality, Consumer behaviour, Logistics performance, Customer perception, "Logistics service quality", "Satisfaction", "Survey".
Cluster 5 (Environmental Sustainability)	Purple	38	"Carbon emissions", "Climate change", "Renewable energy", "Ecosystem services", "Sustainable logistics", "Environmental protection", "Conservation", "Environmental policy".
Cluster 6 (Information Technology and Decision Making)	Light Blue	38	"Big data", "Cloud computing", "Internet of things (IoT)", "Artificial intelligence (AI)", "Decision making", "Logistics service, "Machine learning", "Last-mile delivery".
Cluster 7 (General Terms)	Orange	16	"Logistics providers", "Evaluation", "Information technology", "Logistics operations", "Public policy", "Decision making".

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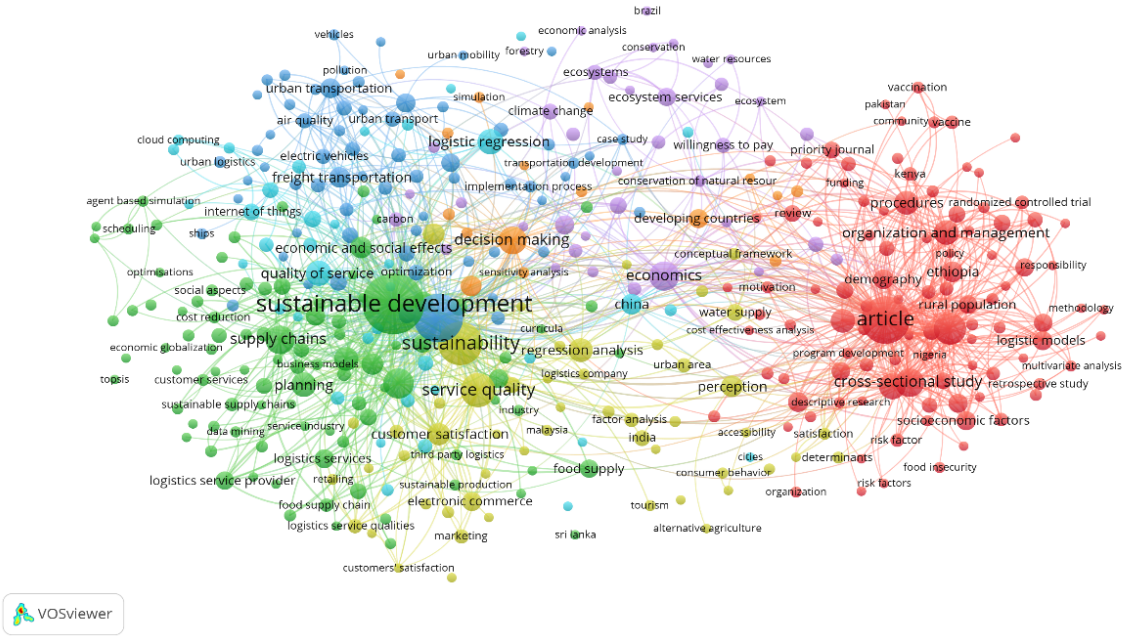

Figure 8. Network Visualization Map of the Keywords using VOSviewer Software (1994-May 2024)

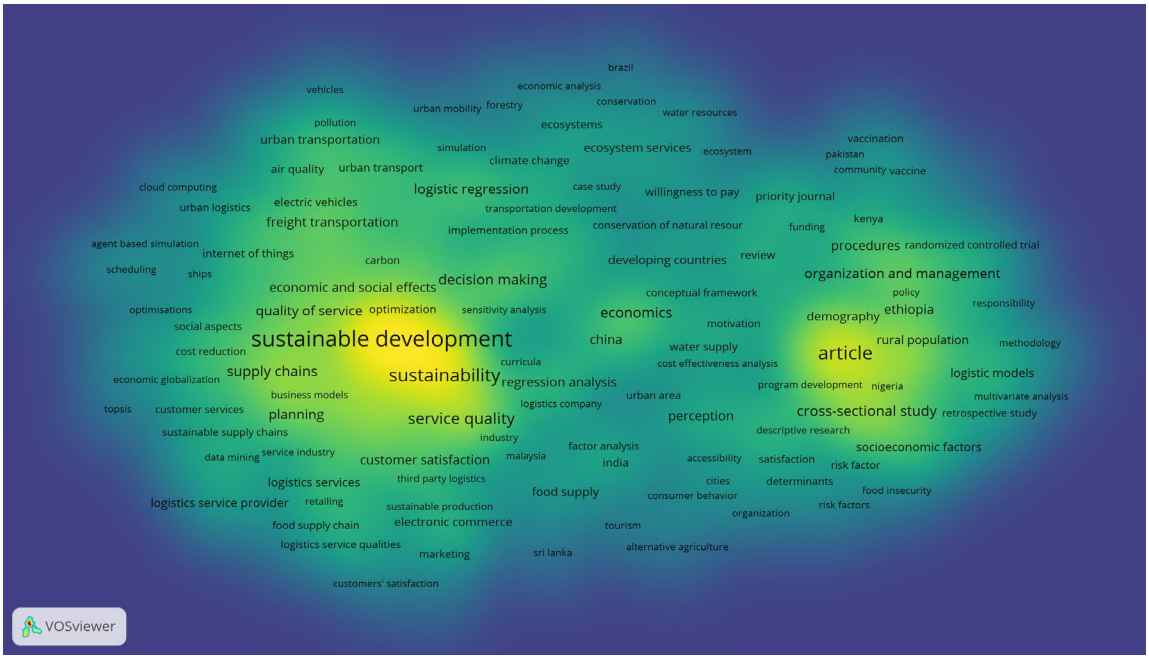

Figure 9 Density Visualization Map using VOSviewer Software (1994-May 2024)

Concurrent Occurrence of Keywords

Since 2013, SLSQ research has witnessed significant growth, reflecting increased academic and industry focus on sustainable practices that align logistics service quality with environmental and social goals. This growth aligns with broader sustainability research but underscores the unique complexities in logistics, emphasizing the need for industry-specific solutions. Each cluster reflects SLSQ's current state and addresses RQ1 and RQ2 by identifying trends, patterns, and gaps that guide future research directions.

Cluster 1 (Methodology and Analysis), represented in red, is defined by keywords such as “data analysis,” “statistical methods,” and “cost-effectiveness analysis,” which underscore the methodological rigor underlying SLSQ evaluations. Terms like "total quality management" and "outcome assessment" emphasize a focus on frameworks that prioritize reliability and continuous quality improvement. For RQ1, this cluster highlights how empirical, quantitative methods have shaped SLSQ's methodological landscape, fostering standardized approaches that enhance accountability and allow for systematic quality assessment. Since 2013, there has been a shift toward more data-driven frameworks in logistics, influenced by broader sustainability research that prioritizes empirical validation. This trend reflects an industry need for credible, repeatable methodologies that support sustainable logistics standards, essential for meeting regulatory and consumer expectations.

In addressing RQ2, gaps persist in integrating dynamic sustainability indicators—such as “program evaluation” and “quality improvement”—within these frameworks. The lack of sustainability-specific metrics in logistics assessment frameworks suggests an area ripe for future exploration. Methodological advancements that incorporate environmental and social sustainability metrics can drive a more nuanced evaluation of logistics service quality, aligning with broader trends in empirical sustainability research. This focus on combining rigorous assessment tools with sustainability indicators underscores the complexity of logistics, distinguishing it from general sustainability frameworks and marking it as a distinctive research area in need of tailored methodologies. Figure 8’s red cluster visually highlights this focus on methodological development, providing a foundation for examining how quantitative rigor supports sustainable logistics quality.

Cluster 2 (Business and Economic Factors), defined by keywords like “supply chain management,” “economic and social effects,” and “cost reduction,” reveals an industry-wide emphasis on balancing economic efficiency with sustainable practices. The inclusion of terms like “reverse logistics” and “sustainable supply chain” illustrates the sector’s strategic shift toward environmentally responsible operations that do not compromise profitability. In response to RQ1, this cluster captures the emerging trend of economically viable sustainable practices in logistics, accelerated post-2013 by regulatory pressures and growing consumer demand for sustainable practices.

In terms of RQ2, further research is needed to fully understand the long-term economic impacts of these sustainable initiatives, as the cost-benefit balance in sustainable logistics is complex and context-dependent. Keywords like “customer service” and “sustainable practices” suggest the need for studies that examine the cost-effectiveness and competitive advantage of sustainable logistics practices. While sustainability in broader fields often centers on economic sustainability, logistics has unique challenges related to balancing immediate operational costs with potential future savings from sustainable practices. This dual focus on economic and environmental goals positions SLSQ at the intersection of sustainability and business performance, shaping a competitive landscape that is increasingly influenced by sustainability credentials. Figure 8 shows this business focus in the green cluster, highlighting keywords that emphasize the interplay between economic factors and sustainability within logistics.

Cluster 3 (Transportation and Operations) revolves around sustainable transportation, reflected in keywords like “electric vehicles,” “urban transport,” and “emission reduction.” These terms signal logistics’ push to innovate transportation solutions that reduce carbon emissions. Infrastructure-related keywords such as “fleet operations” and “transportation infrastructure” indicate the logistical challenges in scaling sustainable practices, as these systems support the shift toward low-emission technologies. For RQ1, this cluster highlights an upward trend in adopting green transportation methods, showcasing the logistics industry’s response to environmental targets and increased interest in sustainable urban logistics post-2013.

Addressing RQ2, there is a gap in fully developing infrastructure that supports these innovations, especially concerning sustainable fleet management and urban transportation integration. Further studies could focus on the interplay between technological advancements, infrastructure needs, and sustainable outcomes, providing insights

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into enhancing sustainability in logistics operations. In a broader context, the logistics sector's focus on transportation innovation aligns with global sustainability efforts, although the industry faces unique challenges, such as managing high-volume fleets while reducing emissions. This focus on transportation solutions underscores the importance of tailored logistics practices to meet sustainability targets. In Figure 8, the dark blue cluster visually emphasizes transportation-focused keywords, underscoring its critical role in driving SLSQ advancements.

Cluster 4 (Customer Perception and Satisfaction) highlights the increasing role of consumer expectations in shaping SLSQ practices, as seen in keywords like "customer satisfaction," "logistics performance," and "consumer behavior." The emphasis on "service quality" and "customer perception" signals a recognition within the industry that aligning with customer sustainability expectations is crucial to market success. In addressing RQ1, this cluster reflects an emerging trend where logistics providers are adjusting practices to meet these expectations, directly influencing service quality and customer satisfaction. This consumer-driven shift since 2013 reflects broader trends in retail and services where sustainability is increasingly seen as a key factor in customer loyalty and brand perception.

In terms of RQ2, there is limited research on quantifying the impact of sustainable practices on consumer loyalty and brand perception within logistics. Future research could examine the influence of sustainable logistics on consumer trust and competitive positioning, offering actionable insights for providers aiming to leverage sustainability as a market differentiator. Although the logistics sector faces operational complexities that can challenge customer satisfaction, this focus on consumer engagement through sustainable practices highlights a unique convergence between customer satisfaction and sustainability objectives. In Figure 9, the cluster visually represents customer-focused themes, providing insights into the growing intersection between consumer expectations and sustainable logistics.

Cluster 5 (Environmental Sustainability), environmental sustainability is central to this cluster, with keywords like "carbon emissions," "renewable energy," and "environmental policy" underscoring the logistics sector's commitment to reducing its ecological footprint. Terms such as "ecosystem services" and "conservation" reflect a shift toward understanding logistics' broader environmental impact. In response to RQ1, this cluster represents a trend of embedding environmental objectives into SLSQ, acknowledging logistics' role in global sustainability goals. Since 2013, the increased focus on environmental impact highlights an academic and industry response to regulatory demands and consumer expectations for greener logistics.

For RQ2, a major gap exists in translating these environmental policies into actionable metrics for logistics providers. Standardized environmental benchmarks tailored for logistics could enhance the industry's ability to measure and mitigate its environmental impact. This focus within SLSQ on environmental objectives aligns with broader global sustainability initiatives, although logistics faces distinct challenges due to its dependency on transportation and fossil fuels. Addressing these challenges requires sustainability frameworks specific to logistics, reconciling service quality with environmental responsibility. The purple cluster in Figure 8 visually encapsulates environmental sustainability keywords, illustrating logistics' unique role within the global sustainability framework.

Cluster 6 (Information Technology and Decision Making) emphasizes the transformative role of digital technology in SLSQ, with keywords such as "big data," "cloud computing," and "artificial intelligence (AI)" reflecting logistics' reliance on data-driven optimization. Terms like "last-mile delivery" and "decision making" indicate the practical applications of these technologies in improving efficiency, reducing waste, and streamlining decision processes. For RQ1, this cluster highlights the increasing adoption of technology in SLSQ, demonstrating how digital tools enable sustainable logistics through enhanced service quality and operational efficiency.

However, for RQ2, research is needed to explore fully how these technologies align with sustainability goals, especially in optimizing processes like last-mile delivery for reduced emissions. Future studies could examine how advanced technologies such as AI and IoT can be leveraged to support sustainable logistics, providing solutions that

address real-time challenges in complex supply chains. While digital transformation is a common trend in sustainability research, logistics poses unique challenges due to its scale and real-time requirements, underscoring the need for specialized technological solutions that foster sustainability. The light blue cluster in Figure 8 captures these technology-driven themes, showcasing logistics' shift toward digital sustainability solutions.

Cluster 7 (General Terms), the final cluster, is characterized by key terms such as "logistics operations," "public policy," and "evaluation," underscoring the strategic and regulatory dimensions of SLSQ. The inclusion of "public policy" highlights the pivotal role of government regulations in shaping sustainable logistics practices, while "decision making" underscores the strategic integration of sustainability within logistics operations. In addressing RQ1, this cluster suggests that logistics providers are increasingly navigating intricate regulatory landscapes and embedding sustainability considerations into their strategic planning processes.

Addressing RQ2, a notable research gap exists in understanding how policy frameworks can most effectively support sustainable logistics. Examining the influence of regulatory mechanisms on sustainable logistics could yield valuable insights into policy tools that incentivize sustainability. While regulatory support is a recurring theme in sustainability research, the logistics sector faces distinct challenges due to its vast operational scale and cross-border activities. This underscores the need for logistics-specific policy studies that foster sustainable growth. The orange cluster in Figure 8 visually represents this regulatory focus, highlighting the critical role of public policy and strategic planning within SLSQ.

The VOSviewer analysis identifies seven interconnected clusters, illustrating the core themes driving Sustainable Logistics Service Quality (SLSQ) research. Since 2013, SLSQ research has experienced significant growth, reflecting the logistics industry's strategic shift toward sustainability in response to increasing regulatory pressures, evolving consumer expectations, and heightened environmental accountability. This growth is particularly pronounced in Cluster 2 (Business and Economic Factors) and Cluster 4 (Customer Perception and Satisfaction), which highlight the industry's efforts to balance operational efficiency with sustainable practices and meet consumer demands for eco-friendly logistics. These trends signify a broader transformation in business practices, where sustainable logistics has transitioned from a niche concern to a fundamental operational strategy, fostering greater accountability and quality within logistics services.

Comparatively, SLSQ research is growing at a pace comparable to broader sustainability and logistics studies, reflecting its alignment with global sustainability goals and its increasing prominence within the logistics industry. Unlike general sustainability research, SLSQ uniquely tackles logistical challenges such as optimizing transportation emissions, implementing sustainable last-mile delivery, and managing reverse logistics, all of which have a direct impact on reducing the carbon footprint across supply chains. This focused growth highlights the logistics sector's pivotal role in advancing global sustainability efforts by addressing sector-specific issues through innovative and practical solutions. Moreover, SLSQ research extends its impact beyond logistics, contributing to the sustainability frameworks of industries that depend on efficient supply chains, thereby supporting both environmental stewardship and economic resilience on a global scale.

Moreover, Clusters 5 (Environmental Sustainability) and 7 (General Terms) highlight SLSQ's alignment with broader sustainability initiatives while emphasizing the unique challenges inherent to logistics. Unlike other industries, logistics faces distinct hurdles, such as its reliance on high-emission transportation modes, the complexity of optimizing routes and supply chains in real-time, and the need for substantial infrastructure investments to support sustainable operations. These challenges are compounded by the sector's scale, cross-border activities, and the pressure to meet time-sensitive demands, setting it apart from general sustainability efforts. The clusters underscore the critical need for tailored strategies and innovations within SLSQ to address these complexities, reinforcing the logistics sector's role as both a driver and enabler of global sustainability goals.

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Discussion

Sustainable Logistics Service Quality (SLSQ) is emerging as a critical field that combines sustainability and high service quality standards to meet the evolving demands of consumers, regulatory bodies, and stakeholders. This bibliometric analysis uncovers a significant gap in empirical research on SLSQ, highlighting the need for multidimensional metrics that can accurately assess SLSQ performance across areas like customer satisfaction, operational efficiency, environmental impact, and economic viability.

While sustainable logistics research has gained considerable attention, studies specifically focused on SLSQ remain sparse. This gap reveals a need for standardized, multidimensional frameworks that logistics providers can use to implement and measure SLSQ across complex supply chains. Without these frameworks, both researchers and practitioners face challenges in understanding SLSQ's full potential and in developing effective, scalable models that align service quality with sustainability objectives [1], [75].

This analysis, organized by key clusters, provides insights into the foundational elements and current challenges of SLSQ, addressing RQ1 by mapping publication trends and RQ2 by identifying areas for further empirical study. Each cluster offers a closer look at the interplay between sustainability and service quality, establishing a roadmap for advancing SLSQ in theory and practice.

Growth and Trends in SLSQ

The bibliometric analysis of SLSQ shows a marked increase in publications since 2013, reflecting an industry-wide shift toward integrating sustainability into logistics operations. This upward trajectory addresses RQ1 by indicating a growing awareness of environmental responsibility and regulatory compliance within logistics, resonating with prior studies by [157] and [6], who observed a similar shift in response to rising consumer demand for eco-friendly practices and stricter environmental regulations. This trend is an integral part of the broader sustainability agenda in global supply chains, with SLSQ now playing a central role in both industry practices and academic research. This global interest toward sustainable practices was in response to climate change, resource conservation, and increased regulatory pressures, as well as consumer demand for more responsible corporate practices. Similar trends are noted in recent studies, such as by [1] and [5], underscoring sustainability's central role in logistics strategy.

Co-Word Cluster Analysis in SLSQ Research

The co-word cluster analysis highlights the interconnected themes within SLSQ research, providing insights into how these themes illustrate the evolution and multidimensional nature of SLSQ. In Cluster 1 (Methodology and Analysis), keywords such as "data analysis," "quality improvement," "cost-effectiveness analysis," and "program evaluation" underscore the shift toward data-driven, rigorous evaluation methods within Sustainable Logistics Service Quality (SLSQ). This trend highlights logistics providers' increasing reliance on quantitative tools to transparently assess and enhance both sustainability initiatives and service quality. However, a notable gap emerges in the lack of comprehensive, standardized metrics that can effectively capture SLSQ's multi-dimensional aspects—namely, customer satisfaction, operational efficiency, and environmental impact. Studies by [75] and [1] emphasize the necessity for these multi-dimensional metrics, which would enable logistics providers to benchmark and improve their sustainable practices more effectively. Addressing RQ2, the findings reveal an urgent need for these metrics to evaluate SLSQ's holistic impact on service quality. This aligns with insights from [158], who advocate for comprehensive measurement scales that integrate both quality and environmental indicators, further supporting the development of robust, adaptable SLSQ frameworks.

In Cluster 2 (Business and Economic Factors), terms like "supply chain management" and "reverse logistics" reflect the growing balance between economic goals and sustainability, indicating that logistics providers are increasingly

structuring business models around SLSQ principles. Our findings highlight that collaboration among stakeholders—suppliers, logistics providers, and regulatory bodies—plays a crucial role in implementing sustainable practices effectively. These partnerships foster shared standards across supply chain actors, aligning with [79] and supporting RQ2 by emphasizing collaboration as essential for sustainable logistics outcomes. This focus on aligning profitability with environmental responsibility is consistent with [159], while [7] further underscores the economic benefits of collaborative logistics, especially in sectors like agri-food within the Ukrainian logistics industry, where sustainability initiatives support local economies. Addressing RQ2, this cluster points to a gap in understanding how logistics providers might balance profitability with sustainability, particularly in industries highly dependent on competitive pricing. Future research could explore how logistics firms might balance cost-saving measures with eco-friendly practices to optimize both sustainability and profitability.

For Cluster 3 (Transportation and Operations), keywords like "electric vehicles" and "emission reduction" highlight the logistics sector's commitment to sustainable transport solutions by lowering emissions. [112] emphasize environmental criteria as essential for selecting logistics providers, reinforcing that green transportation aligns with SLSQ's sustainability goals. This aligns with recent studies on green logistics practices by [101], which emphasize the logistics sector's contribution to global emissions and the necessity for low-carbon transport solutions. Addressing both RQ1 and RQ2, this cluster suggests that future research should investigate the long-term impact of green transportation technologies on logistics service quality, especially as regulatory pressures around emissions continue to increase. The integration of electric vehicle fleets and optimized route planning is essential for meeting global sustainability goals, as noted by the Global Logistics Emissions Council [18], demonstrating a critical area for SLSQ development.

Cluster 4 (Customer Perception and Satisfaction) includes terms such as "customer satisfaction," "logistics performance," and "service quality," which reveal the critical role sustainability plays in influencing customer loyalty and brand perception. [3] and [16] suggest that logistics providers are increasingly aligning SLSQ practices, such as carbon-neutral shipping and sustainable packaging, with customer expectations to enhance loyalty. This customer-centric focus in SLSQ supports earlier findings by [160] and [79], indicating that service quality reinforces long-term customer relationships in sustainable logistics. Recent studies in the Indian e-commerce sector demonstrate how green service quality practices can drive customer satisfaction, highlighting a need for closer examination of how sustainable logistics practices impact brand loyalty across various market segments [6], [25]. Addressing RQ1, these findings demonstrate how customer-driven demand for sustainability is becoming integral to service quality, especially in high-engagement industries. Addressing RQ2, future research could identify which specific sustainable service attributes drive customer engagement, providing logistics providers insights for optimizing their SLSQ frameworks to enhance customer loyalty and brand perception.

In Cluster 5 (Environmental Sustainability), keywords like "carbon emissions" and "renewable energy" underscore the logistics industry's increasing focus on minimizing environmental impact. This emphasis reflects the need for standardized benchmarks that ensure SLSQ aligns operational goals with environmental responsibilities. The cluster highlights logistics providers' shift to renewable energy and eco-friendly practices, aligning with global efforts to reduce carbon footprints across supply chains. Studies by [67] reinforce the importance of integrating renewable energy solutions to meet sustainability targets within logistics. Addressing RQ1, this cluster suggests that further research could investigate sector-specific green practices to support SLSQ implementation while meeting environmental objectives. Additionally, addressing RQ2, deeper investigation into the scalability and efficiency of renewable logistics solutions is needed to establish models that are both sustainable and operationally viable. Such research would enable logistics providers to adopt renewable resources that meet environmental goals without compromising service quality or efficiency, thus advancing SLSQ as a balanced approach to sustainable logistics.

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In Cluster 6 (Information Technology and Decision Making), keywords such as “big data,” “cloud computing,” and “AI” highlight the transformative role of digital technology within SLSQ. These terms underscore the increasing reliance on data-driven decision-making to optimize logistics processes, reduce emissions, and enhance customer service. Advanced technologies such as AI, IoT, blockchain, and big data are pivotal to modern SLSQ strategies, enabling real-time tracking of sustainability metrics, resource optimization, and enhanced logistical transparency—all essential for balancing quality and sustainability in SLSQ [22], [25]. Supporting this, [32] illustrate that IoT and AI facilitate predictive analytics and route optimization, which directly contribute to customer satisfaction while minimizing environmental impact, effectively reducing carbon emissions [3]. Further, recent studies by [22] and [29] reinforce that advanced technologies enhance SLSQ by enabling real-time monitoring and automated processes. This technological shift is integral to modern SLSQ strategies, as logistics providers increasingly use these tools to balance sustainability with service efficiency [27]. Addressing both RQ1 and RQ2, this cluster highlights the opportunity for future research into how digital tools like IoT and big data can further enhance SLSQ by providing logistics providers with detailed, data-driven insights into environmental performance. Emphasizing digital tools is crucial for understanding SLSQ's trajectory as technology continues to reshape logistics processes.

Lastly, Cluster 7 (General Terms) underscores the strategic importance of regulatory frameworks and policy compliance in shaping Sustainable Logistics Service Quality (SLSQ). Keywords such as "public policy," "logistics operations," and "evaluation" highlight the dual challenge faced by logistics providers: aligning with policy mandates while maintaining high service standards. Research emphasizes the necessity of adaptive public policies that not only promote environmental responsibility but also assist logistics providers in achieving SLSQ requirements [128]. Striking this balance is critical as logistics providers work to comply with sustainability regulations, which are integral to meeting SLSQ standards. Additionally, studies explore the impact of European regulatory frameworks, including the European Union’s Green Deal, which places significant pressure on logistics providers to integrate sustainability into their operations [17], [114]. These challenges are especially pronounced in cost-sensitive markets, where achieving affordability while adhering to stringent sustainability goals remains a challenge.

The financial and operational challenges associated with regulatory compliance underscore a critical gap in the literature, particularly in regions characterized by diverse regulatory landscapes. Foundational studies, such as [161], have examined the broad impacts of regulations on logistics operations; however, evolving regulatory pressures increasingly compel logistics providers to align service quality with sustainability mandates. While these compliance requirements advance sustainability goals, they often introduce additional costs, emphasizing the necessity for SLSQ-specific compliance models. Such models would enable logistics providers to balance service quality with environmental objectives effectively. This aligns with addressing RQ1 by illustrating how regulations influence SLSQ practices and underscores the need for frameworks that facilitate regulatory adherence while maintaining operational viability.

Moreover, this cluster highlights a critical area for future research: the development of regulatory compliance models tailored to emerging markets, where policy frameworks often differ significantly from those in developed economies. The logistical and financial challenges of adhering to diverse regulatory standards reveal a gap in understanding how logistics providers can standardize SLSQ practices across varying regulatory contexts. Addressing RQ2, studies such as [118] recommend policy adaptations that support logistics providers in implementing sustainable practices, particularly in economically diverse regions. Further research into adaptive compliance models could assist providers in navigating regulatory challenges without sacrificing competitiveness. For instance, Lieb and Lieb [13] emphasizes the importance of integrating regulatory requirements with service quality standards to meet sustainability goals effectively.

The emphasis on comprehensive regulatory compliance within SLSQ sets it apart from broader logistics studies, which often overlook the intricate balance between service quality and environmental mandates. As logistics

providers work to align SLSQ practices with evolving policy standards, the challenge of balancing regulatory compliance with operational efficiency grows increasingly complex. This highlights the strategic necessity for logistics providers to embed regulatory compliance into their operational frameworks, enabling them to achieve sustainability objectives while maintaining market competitiveness.

Publication Patterns and Emerging Themes in SLSQ (RQ1)

The growing importance of sustainability within the logistics sector aligns with global shifts in sustainability focus, as highlighted by [4] and further validated by [157], who note that rising environmental concerns and regulatory demands have driven logistics to incorporate sustainability goals. Addressing RQ1, this analysis shows that research on Sustainable Logistics Service Quality (SLSQ) has grown steadily since 2013; however, SLSQ remains an emerging field within the broader context of sustainable logistics, where studies frequently address environmental concerns without integrating service quality as a core performance metric. These findings indicate that SLSQ publications form a relatively small subset of sustainable logistics research, revealing a gap in understanding how logistics providers can merge sustainability principles with high service quality standards. This trend aligns with insights from [16] and [7], who point to limited research on SLSQ's role in enhancing both service quality and sustainability simultaneously. In recent years, there has been a significant rise in studies focusing on SLSQ, particularly in areas involving green logistics and reverse logistics, reflecting a broader industry trend that connects logistics service quality directly with sustainable practices. For example, [16] underscore the role of reverse logistics as a vital component of customer satisfaction and sustainability, integrating environmental responsibility with high service quality to enhance the overall customer experience.

Additionally, the keyword and co-word analyses reveal several emerging themes in SLSQ research, focusing on advanced technological adoption, customer satisfaction, and sustainable transportation practices. Each of these themes connects operational efficiency with eco-friendly practices, highlighting how service quality within sustainable logistics increasingly relies on technological innovation and environmental accountability. The integration of AI, blockchain, and IoT has been identified as essential for optimizing logistics processes, ensuring transparency, and minimizing environmental impact, as seen in recent studies by [22] and [1]. When applied within the SLSQ framework, these technologies enable logistics providers to meet customer expectations and regulatory standards by fostering a unique, dual focus on both sustainability and quality—an aspect that distinguishes SLSQ from more general sustainable logistics practices. For instance, studies demonstrate that real-time data management and predictive analytics allow logistics providers to optimize delivery routes and reduce emissions, aligning operational efficiency with environmental objectives [29]. These tools also address the rising demand for efficient, eco-friendly logistics, meeting customer expectations for sustainable practices and supporting competitive differentiation within the logistics sector [24], [27].

Overall, while SLSQ shares objectives with sustainable logistics, it places a unique and concurrent emphasis on service quality, creating a dual focus on environmental performance and high service delivery standards. This distinctive combination makes SLSQ an emerging and essential field, especially as logistics providers face increasing pressure to integrate environmental accountability with customer satisfaction.

Knowledge Gaps and Future Directions in SLSQ (RQ2)

The analysis reveals several critical knowledge gaps in the SLSQ literature that future research should address, including the development of comprehensive, multidimensional SLSQ metrics, the exploration of regional variations in SLSQ practices, and empirical studies on the role of emerging technologies in advancing SLSQ. First, there is a clear need for dynamic, multidimensional metrics that can assess SLSQ holistically, encompassing environmental, social, and economic impacts. Existing logistics service quality frameworks, such as the SERVQUAL model [105],

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focus primarily on service delivery without integrating sustainability as a core evaluative factor, as noted by [1]. This gap aligns with the insights of [162] and [81], who emphasize the need for adaptable metrics that incorporate sustainability measures within service quality assessments. Addressing this gap would enable logistics providers to measure, assess, and improve their sustainability initiatives more comprehensively, supporting balanced sustainability goals [1].

Another critical gap lies in understanding how regulatory and contextual factors influence SLSQ implementation across different regions. While general sustainable logistics research often examines how regulations impact environmental strategies [80], [112], few studies specifically explore how these regulations affect service quality within the SLSQ framework. [8] suggest that stringent environmental policies shape logistics providers' approaches to sustainability; however, empirical evidence is still lacking on how these standards impact service quality outcomes and customer satisfaction across varying regional and economic contexts. Studies such as [7] and [11] highlight the need for compliance with regulatory standards in sustainable logistics, yet the practical implications for SLSQ in diverse regions remain underexplored. Addressing these regional and regulatory gaps could significantly deepen the understanding of SLSQ, offering actionable insights on integrating compliance with sustainable service quality across different markets.

The potential of emerging technologies such as AI, blockchain, and IoT to advance Sustainable Logistics Service Quality (SLSQ) warrants deeper empirical investigation. While innovations like big data analytics and predictive algorithms have demonstrated promise in optimizing logistics operations and achieving sustainability goals, limited research explores their direct impact on improving service quality and customer satisfaction in logistics [22], [24]. Future studies could focus on the specific applications of these technologies, such as AI-driven demand forecasting, blockchain for transparent supply chain management, and IoT for real-time tracking, to determine how they contribute to environmental and operational improvements while aligning with customer expectations. Addressing these gaps in SLSQ research will empower logistics providers to develop integrated frameworks that balance sustainability and service quality, enhance operational efficiency, and meet the evolving demands of both regulatory standards and eco-conscious customers.

Practical Applications of Advanced Technologies in SLSQ

Emerging technologies identified in the analysis play a significant role in advancing SLSQ by enabling real-time data management, predictive analytics, and optimization of logistics operations. Big data analytics, for instance, provides insights into optimizing routes, while AI supports real-time adjustments in logistics planning to minimize fuel consumption and emissions, as emphasized by [30] and [29]. Blockchain technologies foster transparency and accountability in logistics transactions, ensuring that sustainability metrics are traceable and verifiable throughout the supply chain [1], [27]. Furthermore, AI and IoT technologies on Logistics 4.0 facilitate real-time tracking, smart sensors, and automation, which are essential for reducing waste and improving operational transparency [21], [28]. These advancements align with recent findings by [22] and [29], which suggest that technology-driven sustainability practices not only support operational efficiency but also enhance customer satisfaction by meeting the growing demand for eco-friendly logistics services.

Furthermore, these technologies enhance logistics providers' capabilities to track and analyze their environmental impacts, ensuring compliance with sustainability goals and facilitating continuous improvements in logistics service quality by supporting the automation of logistics tasks, enhancing customer service through faster, more reliable deliveries. For example, IoT-enabled sensors provide real-time data on emissions, fuel use, and operational efficiency, which provide valuable data for sustainability reporting and continuous improvement, creating opportunities for logistics providers to adjust strategies dynamically and maintain service quality even as they pursue sustainable practices [28]. This dual impact on efficiency and sustainability positions SLSQ as a vital approach for companies

seeking competitive advantage through technology-enabled, customer-centered logistics solutions [32], [103]. By increasingly leveraging these tools, logistics providers are positioned to offer competitive, sustainable services that align with both regulatory expectations and consumer demands for greener practices.

Synthesis with Current Literature

The analysis provides a nuanced view of Sustainable Logistics Service Quality (SLSQ), bridging traditionally separate studies on logistics service quality and sustainable logistics into a dual-focus framework that integrates both service quality and sustainability. While foundational studies by [74] and [157] have examined green logistics and LSQ as independent concerns—focusing on efficiency and environmental responsibility separately—our study extends this by demonstrating the integrated value of SLSQ within a comprehensive approach that aligns with the complexities of today's logistics sector. Unlike general sustainable logistics research, which often emphasizes environmental outcomes alone, SLSQ emphasizes service quality as a concurrent priority. This dual emphasis reflects precious research like [153] on reverse logistics, which underscores the strategic advantage of merging quality service with sustainable practices to meet diverse customer needs effectively. The findings also align with the work of [24], which explores Logistics 4.0 service quality and its role as a sustainability enabler in emerging economies. This study supports the notion that advanced technologies such as IoT, AI, and big data are instrumental in achieving sustainable goals by enhancing service quality within logistics. It aligns with SLSQ by illustrating how technological advancements are being harnessed to balance environmental responsibility and service expectations—thereby reinforcing the dual focus of SLSQ on sustainability and quality.

Further supporting this perspective are findings from [7], which highlight how sustainability initiatives in Ukraine reflect both social and environmental responsibilities that directly influence customer satisfaction and brand loyalty. This supports the idea that SLSQ goes beyond a simple measure of service quality; it also strengthens logistics providers' reputations and consumer loyalty by prioritizing sustainable practices like community involvement and employee safety, in line with consumer expectations. Such findings are consistent with [8], who emphasize the role of sustainability in enhancing customer loyalty and competitive advantage.

Key Research Gaps and Future Directions

This study identifies specific research gaps and future directions for advancing the understanding of Sustainable Logistics Service Quality (SLSQ). First, there is a pressing need for Comprehensive SLSQ Metrics that can adaptively integrate the environmental, economic, and social dimensions of SLSQ. Currently, most metrics prioritize operational efficiency, limiting their scope in fully assessing sustainability within logistics. Developing these multidimensional metrics, as suggested by [1], [75] and [129], would allow logistics providers to evaluate and improve their sustainability impacts alongside service quality. Such metrics would help providers meet the increasing demands of regulatory frameworks and align with consumer expectations for sustainable practices.

Second, Regional and Context-Specific Studies on SLSQ are crucial, as differences in regulatory frameworks, economic resources, and consumer expectations across regions significantly impact SLSQ implementation. [11] highlight the need for tailored logistics solutions suited to specific regions. Understanding these regional variations could assist logistics providers in optimizing sustainable practices in alignment with local demands, market dynamics, and regulatory policies. Future studies should thus examine how strategies tailored to emerging economies influence SLSQ practices, offering actionable insights for providers operating in diverse markets.

Finally, there is a need for Empirical Studies on Technology's Role in SLSQ Implementation. Although technologies like AI, blockchain, and IoT hold promise for advancing SLSQ, more empirical research is necessary to assess their practical effectiveness. [22] and [24] discuss the potential of these technologies to streamline logistics operations and

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enhance service quality, yet few studies have measured their real-world impact on both service quality and sustainability. Research in this area could explore specific applications of these technologies across various logistics settings to determine how they support sustainability goals, cost savings, environmental benefits, and customer satisfaction, providing logistics providers with a clearer framework for technology integration in SLSQ.

The findings of this study highlight that Sustainable Logistics Service Quality (SLSQ) remains an emerging and distinct area within sustainable logistics research. This underexplored field addresses complex, interconnected challenges specific to logistics, such as high-emission transportation and the demand for robust infrastructure, through a dual-focus framework that integrates both service quality and sustainability. The co-word cluster analysis identifies key themes—technological innovation, customer satisfaction, and regulatory impact—that each play a unique role in shaping the SLSQ framework. Unlike broader sustainable logistics research, SLSQ emphasizes achieving both environmental objectives and high service quality standards simultaneously, reflecting a holistic approach that meets contemporary logistics demands.

In summary, this research contributes to a deeper understanding of SLSQ as an essential focus in logistics and sustainability. As industries face mounting environmental pressures, SLSQ offers logistics providers a strategic framework to balance sustainability goals with superior service standards, ultimately positioning SLSQ as a vital tool for securing long-term competitiveness in a rapidly evolving global market.

CONCLUSION

This bibliometric analysis of Sustainable Logistics Service Quality (SLSQ) highlights the field's rapid development and its critical alignment with global sustainability goals, emphasizing the transformative role of advanced technologies, environmental accountability, and customer-centric approaches. Key findings reveal that SLSQ not only enhances operational efficiency and reduces environmental footprints but also addresses strategic industry needs, such as integrating sustainable practices into service quality frameworks. The study underscores the importance of balancing sustainability with service quality through strategies like regulatory compliance, strategic partnerships, and technology-driven innovations, which are essential for building resilient, competitive supply chains. Despite its contributions, this analysis identifies notable gaps, including the limited scope of bibliometric data and the narrow research focus of SLSQ compared to broader sustainable logistics topics. To address these, future studies should expand bibliometric analyses to include diverse databases like Web of Science and Google Scholar and incorporate less cited and emerging research to uncover underexplored areas. Empirical research is needed to examine social dimensions of SLSQ, such as labor practices and community impacts, and to assess the influence of regional regulatory frameworks on adoption. Further exploration of technologies like AI, blockchain, IoT, and machine learning can reveal their potential to advance SLSQ practices, offering logistics providers tools to achieve both environmental and operational goals. Additionally, longitudinal studies and comprehensive sustainability metrics encompassing social, environmental, and economic dimensions would provide a more integrated understanding of SLSQ's long-term impacts on business performance and customer satisfaction. By addressing these recommendations, future research can strengthen the theoretical foundations and practical applications of SLSQ, fostering a more sustainable, efficient, and socially responsible logistics ecosystem.

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CONFLICT OF INTEREST

A The authors declare that there is no conflict of interest regarding the authorship and publication of this manuscript.

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