

ANALYSIS OF STUDIES IN THE FIELD OF SUSTAINABLE LOGISTICS WITH VISUAL MAPPING*

Suzan OĞUZ², Deniz YALÇINTAŞ³

Abstract

Today, the concept of sustainability is becoming increasingly important in the face of increasing environmental challenges such as global warming, drought and unregulated industrialisation. In parallel with this situation, the implementation of environmentally friendly practices in the logistics sector is becoming increasingly widespread. These sustainable approaches and practices enable businesses to increase customer loyalty by developing an environmentally friendly image and gain competitive advantage by reducing operational costs. This research aims to analyse the existing literature on sustainable logistics between 2007 and 2023 by using VOSviewer visual mapping method. In this context, search terms were determined by examining the latest publications in the relevant field and a search was conducted in the Web of Science databWase with the concepts of "green logistics", "sustainable logistics", "environmental logistics" and "ecological logistics". As a result of the search, a total of 1232 publications on the subject were reached. The findings of the analysis show that the most publications (153 publications) were made in 2022. It was determined that the most frequently used keyword was "green logistics" used 437 times, and the author with the most publications and citations was Syed Abdul Rehman Khan (15 publications, 1579 citations). On the basis of countries, it is seen that China ranks first with 384 publications. The review conducted within the scope of the study was not limited to a single concept related to the field, but a comprehensive review covering a series of sustainability concepts was carried out. This review is expected to provide a comprehensive perspective for future research. On the other hand, considering that the studies in this field have increased significantly especially in recent years, it is hoped that this study will contribute to the field by providing up-to-date data.

Keywords: Sustainability, Logistics, Sustainable Logistics, Visual Mapping, Bibliometric Analysis.

JEL Codes: Q56, L91, N50, N70.

SÜRDÜRÜLEBİLİR LOJİSTİK ALANINDAKİ ÇALIŞMALARIN GÖRSEL HARİTALAMA İLE ANALİZİ

Öz

Günümüzde sürdürülebilirlik kavramı, küresel ısınma, kuraklık ve düzensiz sanayileşme gibi artan çevresel zorluklar karşısında giderek daha önemli hale gelmektedir. Bu duruma paralel olarak lojistik sektöründe, çevre dostu uygulamaların hayata geçirilmesi yaygınlaşmaktadır. Bu sürdürülebilir yaklaşım ve uygulamalar, işletmelerin çevreye duyarlı bir imaj geliştirerek müşteri sadakatini artırmalarını ve operasyonel maliyetleri azaltarak rekabet avantajı elde etmelerini sağlamaktadır. Bu araştırma, VOSviewer görsel haritalama yöntemini kullanarak 2007-2023 yılları arasında sürdürülebilir lojistik üzerine mevcut literatürü analiz etmeyi amaçlamaktadır. Bu kapsamda, ilgili alandaki son yayınlar incelenerek arama terimleri belirlenmiş ve Web of Science veri tabanında "yeşil lojistik", "sürdürülebilir lojistik", "çevresel lojistik" ve "ekolojik lojistik" kavramları ile bir tarama gerçekleştirilmiştir. Yapılan tarama sonucunda konu ile ilgili yapılmış toplam 1232 yayına ulaşılmıştır. Analiz bulguları en fazla yayının (153 yayın) 2022 yılında yapıldığını göstermektedir. En sık kullanılan anahtar kelimenin 437 kere kullanılan "yeşil lojistik" olduğu, en fazla yayın ve atıf alan yazarın Syed Abdul Rehman Khan (15 yayın, 1579 atıf) olduğu belirlenmiştir. Ükelere bazında ise Çin'in 384 yayınıla ilk sırada yer aldığı görülmektedir. Çalışma kapsamında yapılan taramada alanla ilgili tek bir kavramla sınırlandırma yapılmamış, bir dizi sürdürülebilirlik kavramını kapsayan kapsamlı bir inceleme gerçekleştirilmiştir. Bu incelemenin gelecekteki araştırmalar için kapsamlı bir bakış açısı sağlaması beklenmektedir. Diğer taraftan bu alandaki çalışmaların özellikle son yıllarda önemli ölçüde arttığı göz önünde bulundurulduğunda, bu çalışmanın güncel veriler sağlayarak alana katkıda bulunacağı umulmaktadır.

Anahtar Kelimeler: Sürdürülebilirlik, Lojistik, Sürdürülebilir Lojistik, Görsel Haritalama, Bibliyometrik Analiz.

JEL Kodları: Q56, L91, N50, N70.

* This study was partially presented at the 2rd International Symposium on Sustainable Logistics "Circular Economy" on June 23-24, 2022 and published online as a short abstract.

² Assist. Prof. Dr., Çağ University, Vocational School, suzanoguz@gmail.com, <https://orcid.org/0000-0003-4876-3173>

³ Independent Researcher, denizyalcintas91@gmail.com, <https://orcid.org/0000-0001-6436-7221>



INTRODUCTION

Developed as a business concept in the 1950s, logistics encompasses activities such as freight transportation, material handling, warehousing and inventory management, and is critical to the performance of both supply chains and organisations due to the increasing complexity of coordinating material replenishment and product shipments across global supply chain networks (Sutton, Smedley and Arnold, 2008). A commonly used definition of sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, 1987). In line with this perspective, academics have been studying sustainability and sustainable development in many fields as well as logistics. Many sustainable logistics projects have been launched in response to the idea of sustainable development, with the aim of reducing the negative impacts of freight transport and promoting positive environmental and social outcomes. Road-based freight transportation systems produce significant negative externalities, such as emissions, overcrowding, traffic accidents, noise pollution, infrastructure degradation, and resource inefficiency in daily operations, whether it be for long-distance heavy-duty logistics or urban distribution (United Nations, 2011). These negative externalities lead to a further decline in supply chain performance at both the organizational and local levels. With the rapid increase in logistics demand, the damages are compounding, potentially causing permanent effects on the economy and the whole ecosystem (Chen, Dong and Ren, 2017). On the other hand, the deterioration of biodiversity due to global warming, unplanned industrialization, government regulations, and irresponsible behaviour of firms has been a frequently discussed issue, along with the increasing water, air, and soil pollution. It is difficult to figure out exactly when researchers began talking about environmental concerns in relation to logistics, but the discussion gained traction around 1990 when environmental difficulties turned into global challenges as a result of globalization (Gills, 2010; Islam, Moeinzadeh, Tseng and Tan, 2021). In this context, various negotiations aiming to mitigate negative transportation externalities and improve supply chain performance have been organized worldwide through green and sustainable logistics initiatives (Qaiser, Ahmed, Sykora, Choudhary and Simpson, 2017).

Numerous logistics firms have adopted an "environmentally friendly" approach, driven by motives such as improving their corporate image, gaining a competitive edge, reducing costs, and complying with governmental regulations (McKinnon, 2012). The importance of sustainability in company operations has increased due to the growing concern over climate change brought on by the environmental effects of industrial manufacturing and trade. Consequently, companies have recognized the potential to leverage environmental sustainability as a means of gaining a competitive advantage (Bask and Rajahonka, 2017). Furthermore, establishing sustainable industries has become necessary for companies to survive and sustain their operations (Islam et al., 2021). As a result, awareness has been raised among scientific researchers and



businesspeople regarding the consideration and adoption of "green" strategies in the field of logistics (Murphy and Poist, 2000; Zhang, Lee, Chan, Choy and Wu, 2015).

Sustainability in logistics aims to minimize environmental impacts and provide social benefits while promoting the effective and efficient use of resources. Therefore, sustainable logistics research can contribute to the achievement of long-term sustainability goals of businesses and society. This study aims to analyse the existing literature on sustainable logistics through visual mapping. This method provides researchers with several advantages, including the ability to identify key topics, understand connections and relationships, identify gaps, reduce complexity and explore different perspectives. In this context, a search was conducted with relevant search terms in the related field. Given the significant increase in studies in this field in recent years, it is hoped that this study will contribute to the field by providing up-to-date data. Conversely, the findings of this study are anticipated to facilitate the advancement of sustainability initiatives within the field of logistics, thereby encouraging the sector to operate in a more effective and environmentally conscious manner.

CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

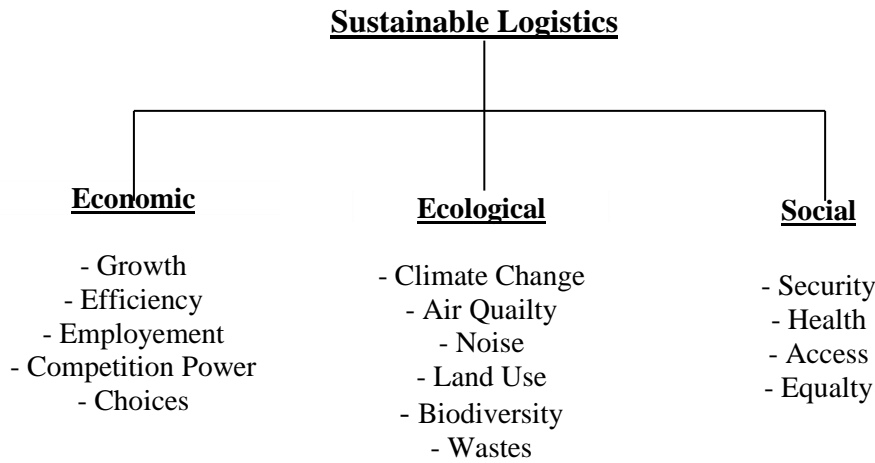
Logistics plays a vital role in the management of supply chains and exerts a substantial environmental impact, encompassing emissions, pollution, and societal health hazards (Tseng, Islam, Karia, Fauzi and Afrin, 2019). With the growing interdependence of economies and the liberalization of global trade, there is a continuous rise in the worldwide movement of materials and goods. In this highly globalized context, logistics activities such as transportation, storage, and packaging are witnessing significant expansion. Consequently, the adverse environmental effects associated with logistics are likely to escalate as well (Deckert, 2020). Adopting cutting-edge logistics technologies that restrict damage, reduce pollution, improve the logistics environment, and maximize the use of logistical resources is essential to reducing the environmental impact caused by logistics (Du, Zhou, Wang and Rong, 2019). Murphy and Poist (2000) provide a sustainable logistics strategy that emphasizes material recycling and reducing consumption.

Sustainable logistics is the implementation of sustainable principles in logistics, including transportation, storage, and packaging functions, deriving from the concept of sustainability (Deckert, 2020). In order to achieve broader sustainability goals, companies need to engage with the external environment, frequently mentioned to as the 'mission to go green' (Bansal and Roth, 2000). The term 'green' in this context is used to denote taking action while integrating environmental or ecological concerns (Tseng et al., 2019). The phrases "green logistics" and "sustainable logistics," although have been used synonymously in the literature, are still not harmonized by scholars. Additionally, compared to the concept

of "green logistics," the official definition of "sustainable logistics" in the literature is less common (Qaiser et al., 2017).

Green logistics is a concept aimed at reducing the environmental impacts of logistics, whereas sustainable logistics is a broader concept that seeks to simultaneously improve environmental, economic, and social impacts (Macharis, Melo, Woxenius and Van Lier, 2014). Elkington (2004) proposed the evaluation of sustainability through three interconnected dimensions: economic, ecological (environmental), and social, known as the "triple bottom line." Building upon these concepts, the Sustainable Logistics Framework, developed by Macharis et al. (2014), is depicted in Figure 1.

Figure 1: Sustainable logistics framework

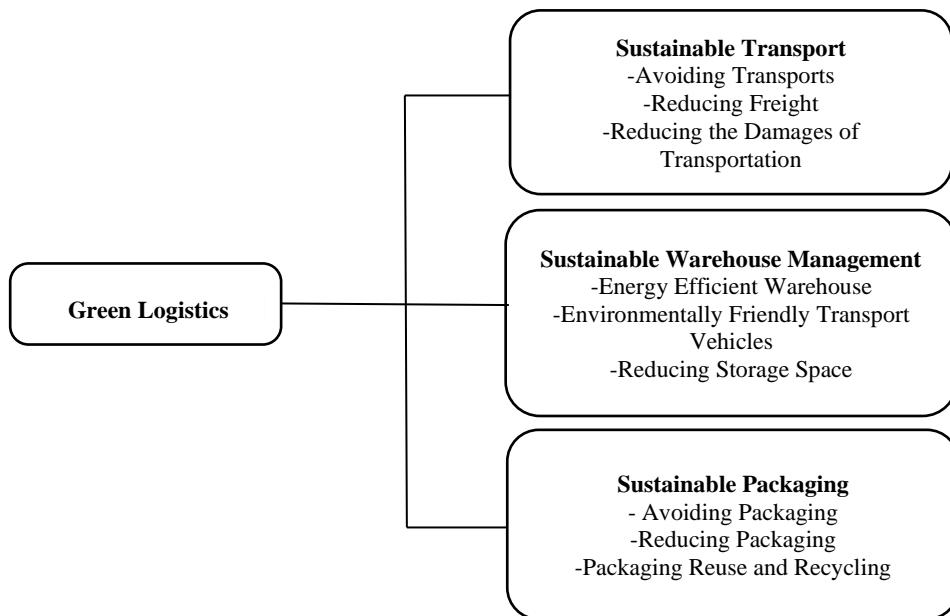


Source: Macharis et al., 2014.

The transition to sustainable logistics aims to digitally and flexibly manage the increasing volumes of imports and exports and the resulting congestion (D'Amico, Szopik-Depczyńska, Dembińska and Ioppolo, 2021). By redefining logistics processes in a sustainable manner, companies aim to achieve a paradigm shift in their social, environmental, economic, and technological relationships (Duran, Cordova and Palominos 2019). In order to reduce pollution emissions and increase logistical efficiency, green and sustainable logistics refers to the comprehensive planning, control, management, and execution of the logistics system employing cutting-edge logistics technologies and environmental management techniques. (Ren et al., 2020). It spans the full lifetime of the logistics process, concentrating on environmental friendliness and sustainability, and goes beyond simply providing green products or services to clients (Zhang et al., 2015). Green Logistics essentially combines the "six R's" of logistics with goals for environmental sustainability relating to resource utilization and eco-friendliness. As a result, Green

Logistics aims to deliver the right product in the right quantity, at the right time, in the right condition, and at the right price, all while consuming the fewest resources possible and emitting the fewest emissions (Deckert, 2020). By establishing coordinated arrangements that satisfy customer requirements at the lowest possible cost, Green Logistics—which includes all activities involved in product movement across the supply chain seeks to attain a more sustainable balance between economic, ecological, and social goals (Teixeira, Assumpção, Correa, Savi and Prates 2018). The goal of increased resource use, decreased resource consumption and waste, and minimized ecological contamination are similar terms used by Zhao, Liu and He (2009) to describe green logistics. They highlight resource allocation optimization and the use of environmental technologies as essential elements of green logistics. According to Deckert (2018), "green logistics" refers to a logistics approach that tackles the triple bottom line's environmental component and attempts to align logistical purposes with the aims of increasing resource efficiency, cutting emissions, and limiting environmental harm. Figure 2 outlines the main problems with various logistical functions within the context of green logistics and offers illustrations of potential solutions.

Figure 2: Green logistics framework



Source: Deckert, 2020.

In logistics, sustainability efforts generally focus on environmental sustainability (Deckert, 2018). Within this scope, environmental logistics and ecological logistics concepts are also included alongside sustainable logistics and green logistics concepts in various studies (Kim and Han, 2012; Du et al., 2019; Aksentsyeva and Shunevich, 2021). Environmental logistics develops an environmental symbiotic logistics

management system by improving the logistics system from an environmental perspective (Du et al., 2019). Environmental logistics activities aim to minimize negative environmental impacts and maximize logistic efficiency (Kim and Han, 2012). Ecological logistics, on the other hand, encompasses green and environmental logistics. It involves the movement of materials until they become commodities and production waste, followed by their disposal or safe storage in the environment. It also includes measures such as the collection, sorting, transportation, and safe storage of consumption waste (Aksentsyeva and Shunevich, 2021). Ecological logistics can reduce logistic costs, enhance the sustainable development capability of logistic enterprises, and address issues such as environmental degradation and resource waste (Du et al., 2019).

When the relevant literature is examined, there are various studies in the literature that concentrate on environmental concerns in the field of logistics and explore closely related concepts such as sustainable logistics, green logistics, eco-logistics, and environmental logistics (Table 1). However, the number of studies that examine these topics through bibliometric analysis is limited.

Table 1: Summary of related literature

Author(s)	Method	Results of the Study
Abbasi & Nilsson (2016)	Case Study	Four categories of challenges in the development of sustainable logistics activities were identified: customer priorities, managerial complexity, network instability and technological and legal uncertainties.
Alam (2023)	Survey	The findings showed that social economics, environmental economics, and financial economics are important for green logistics in Pakistan. However, transportation and information exchange, as well as logistics networking, were turned down. The study's findings support the company's ongoing use of green logistics.
Ali et al. (2021)	Semi-Structured Interviews & Q-Sorting Technique	The major components that SMEs in the logistics sector should take into account in the Egyptian market are sustainable packaging, sustainable transportation, sustainable information, training, and collaboration. By putting these ideas into practice, we can encourage the next generation to think environmentally and socially responsible.
Ali et al. (2022)	Survey	The findings demonstrate that the second-order aspects of single relationship quality are positively impacted by customer satisfaction with Sustainable Logistics Service Quality (SLSQ). In order to confirm the significant mediating roles that trust and dependency play in the development of high-quality relationships, we also examined the indirect links between customer happiness, dependence, trust, and commitment.
Baah et al. (2021)	Partial Least Square Structural Equation Modelling Technique	The study's conclusions demonstrated the significant impact that environmentally friendly logistics techniques had on both financial performance and environmental reputation. Environmental reputation did not have any mediation effect between waste management and financial performance; however, it did have a partial mediation effect between financial performance and sustainable transportation and information sharing, and a full mediation effect between financial performance and

		reverse logistics, sustainable packaging and distribution, and green monitoring and evaluation.
Björklund & Forslund (2018)	Case Study	The positive relationship between formalisation and the success of sustainable logistics innovations (SLI) is supported. Some critical activities and challenges were found. These are: speed, developing simple concepts, using a sustainability business case template and choosing where to test SLIs.
Cano et al. (2022)	Bibliometric Analysis	The results show that authors from Italy and India stand out with the highest number of publications, with journals such as Sustainability, International Journal of Logistics Research and Applications and Sustainable Cities and Society leading both in the number of articles published and in the number of most cited articles. Key topics include sustainability of e-commerce logistics, environmental impact, impacts of the COVID-19 pandemic, decision-making techniques in operations for cost and energy efficiency.
D'Amico et al. (2021)	Systematic Literature Review	The results show that smart and sustainable logistics initiatives in port cities: have the potential to increase the efficiency of economic, environmental, social and technological flows; provide a detailed overview of the enabling factors, areas and objectives that need to be enabled by port cities to promote a hairy and sustainable logistics transition.
Ferraro et al. (2023)	Comprehensive Literature Review & Analytic Hierarchy Process	The findings demonstrated that exoskeletons, collaborative robots, and additive manufacturing are the best solutions for fulfilling sustainable development objectives in Logistics 4.0.
Görçün et al. (2023)	Step-Wise Weight Assessment Ratio Analysis (SWARA) And Complex Proportional Assessment (COPRAS) Techniques	'Storage Conditions' was the most important criterion for a large-scale international hospital chain in Turkey to select the best Medical Waste Disposal and Logistics (MWDL) company. And 'Republic Services, Inc. was the most successful company and supplier.
Islam et al. (2021)	Metadata Analysis	The Journal of Cleaner Production is found to be the most popular and influencing journal, Kannan Govindan is found to be the most influential authors China produces the highest number of publications. Also, reverse logistics outnumbered other streams significantly.
Jayarathna et al. (2023)	Interview	They categorized 47 sustainable logistics strategies into nine groups based on three main themes: social well-being, firm's dynamic capabilities, and environmental preservation.
Lee et al. (2010)	Case Study	A case study involving a large-scale sustainable logistics network in the Asia Pacific region has shown that product returns have a major impact on the forward network design and that the optimal solution obtained by the integrated solution method provides a more cost-effective network as well as better customer accessibility with the help of decentralised configuration.
Neto et al. (2018)	Data Envelopment Analysis	They found that mandatory legislation favouring recycling would not prevent poor environmental solutions and would reduce the environmental and business efficiency of the sector.
Parhi et al. (2022)	Fuzzy-Analytical Hierarchy Process (F-Ahp)	The findings indicate that senior management commitment, "technology infrastructure and digital solutions," and "governmental norms" are the main influencing variables of the implementation of sustainable logistics 4.0.
Kaiser et al. (2017)	Systematic Literature Review	The key themes were decision models and frameworks to address sustainable logistics issues covering transport, distribution and third party logistics. The



		most prominent sustainable logistics topic was carbon footprint. Social impact was given less importance compared to economic and environmental aspects.
Raut & Gardas (2018)	The Interpretive Structural Modeling (ISM) Methodology	The analysis's conclusions demonstrated that the two biggest obstacles to environmentally friendly transportation are overloaded cars and the lack of chilled vehicles, which are determined to have the greatest driving force. 12 key barriers to the sustainable transport of fruit and vegetables have been identified.
Ren et al. (2020)	Systematic Literature Review & Bibliometric Analysis	The results show that the chronological publications of Green & Sustainable Logistics (G&SL) show a rapid increasing trend, the current research is mostly related to environmental science and transport science, and China, the United States, the United Kingdom, Sweden and India are the main regions of G&SL research.
Soysal & Bloemhof-Ruwaard (2017)	Systematic Literature Review	The industry's dedication to sustainable development and its constant search for methods to improve organizational efficiency while also being socially and environmentally conscious. Legislative changes, social attitudes, corporate commitment, brand value, and competitive advantage are the key drivers of the urge to pay attention to sustainability.
Sun et al. (2022)	Systematic Literature Review & Bibliometric Analysis	The logistics industry has the potential to enhance its economic efficiency, environmental performance, and social impact through the implementation of Industry 4.0 technology.
Wang et al. (2022)	Bibliometric Analysis	The findings of the research indicate that case studies, green performance, green practices, optimization, and carbon footprint are the primary topics of interest in mainstream studies. Furthermore, the thematic evolution of keywords indicates that, in the field of SL&SCM research, supply chain concerns and sustainability have recently emerged as major subjects.
Werner-Lewandowska, & Golinska-Dawson (2021)	Focus Group & Bayesian Statistics	It was determined that the majority of the logistics service providers of the surveyed enterprises reached the first level of sustainable logistics management maturity, but none of them reached the highest level of sustainable logistics management maturity.
Wichaisri & Sopadang (2013)	Case Study	A company's inputs and outputs are assessed in a sustainable logistics system using the following five sustainability-impacting categories: financial resources, material resources, information resources, human resources, and energy resources.

Among these studies, Qaiser et al. (2017) examined a total of 40 articles related to green and sustainable logistics, retrieved from the Scopus database covering the period from 1994 to 2015. They examined to the authors, citation counts, countries, universities, keywords, geographical distribution, collaboration, and the most influential journals. Ren et al. (2020) employed a mapping methodology to investigate a total of 306 articles published from 1999 to 2019. Their study encompassed bibliographic analysis, offering visual representations of publication trends over time, journals of publication, co-citation patterns, collaborative efforts between countries and institutions, influential articles, co-occurring keywords, and temporal clusters of research themes. In a separate study, Islam et al. (2021) gathered data from Scopus and Web of Science for the period of 2009 to 2018. The collected studies were subjected to analysis based on descriptive factors, including co-authors, journals of publication, subject areas, and countries with the highest publication volume, commonly used keywords in article titles, and other pertinent details.



Additionally, Wang, Lim, Wang and Tseng (2022) conducted a bibliometric analysis on articles published in Scopus and Web of Science between 1994 and 2019, focusing on the topics of sustainable logistics and sustainable supply chains. The findings of the research indicate that case studies, green performance, green practices, optimization, and carbon footprint are the primary topics of interest in mainstream studies.

METHODOLOGY

Literature review articles serve two main purposes: (a) summarizing current literature on a particular subject by recognizing key themes and issues, and providing a rationale for future research endeavors (Seuring, Müller, Westhaus and Morana, 2005), and (b) comparing scientific literature with established knowledge and theories (Saunders, Gray, Tosey and Sadler-Smith 2009). Literature reviews can take various forms, such as systematic literature reviews, content analyses, meta-analyses, bibliometric analyses, and more. In this particular study, a bibliometric analysis approach was employed for examination. Bibliometric analysis involves using mathematical and statistical methods to investigate the formal characteristics of knowledge domains (Tsai, Bui, Tseng, Lim and Hu 2020). With the bibliometric approach, the most productive study/publication, researchers, countries, etc., in the relevant field can be identified, thereby providing guidance for future studies in the context of relation between these works, researchers, and countries (Gülmez, Oğuz and Yalçıntaş 2020). In recent years, environmental issues have become a topic of increasing interest worldwide. This study aims to examine the existing literature on environmental issues in the field of logistics. Given the considerable increase in studies in this area, particularly in recent years, it is hoped that this study will contribute to the field by providing up-to-date data.

Defining the Search Keywords and Data Collection

In order to decide on the terms to be used for the search in the study, current publications in the relevant field were examined, and various word combinations related to environmental issues in logistics were determined by experts in the field. Within the scope of the concepts of green, sustainable, sustainability, environment, and logistics, the following combinations were created: green logistics, sustainable logistics, environmental logistics, and ecological logistics. Data were collected based on these terms. The Web of Science database was utilized for data collection in the study. The database Web of Science (WoS) is one of the most often used platforms, particularly in the field of social sciences, as it contains current research journals (Abrizah, Zainab, Kiran and Raj, 2013). In this study, the data were collected from the WoS database on March 18, 2024. According to the search terms identified for the period between 2007 and 2023, a total of 1232 publications were found, and their types are presented in Table 2.

Table 2: Initial search results from WoS*

Type	Number
Article	821
Proceeding Paper	325
Book and Book Chapters	49
Other	37

*Research and review articles were combined in a single group as 'Article'. Book chapter, book review and book were combined in a single group as 'Book'.

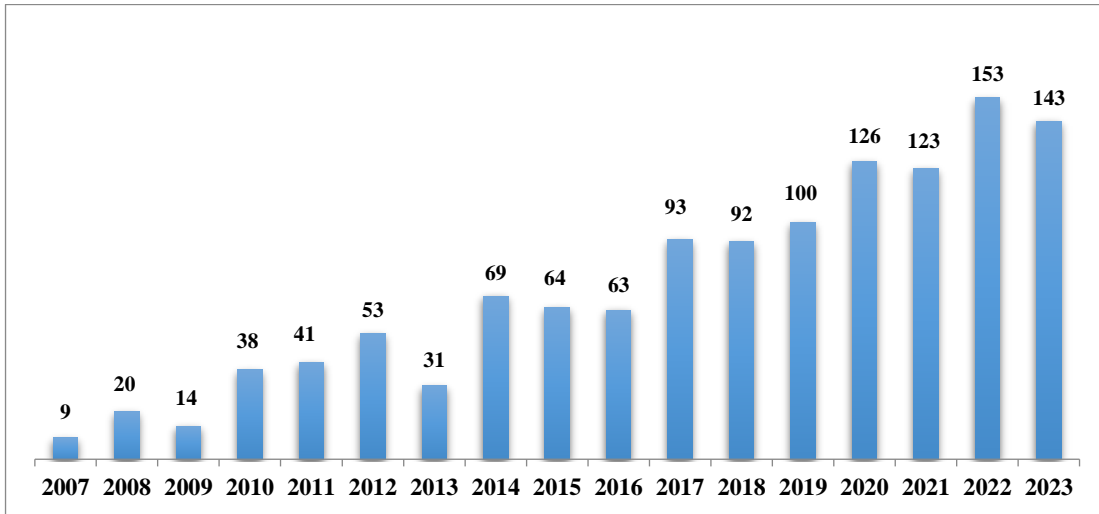
When Table 2 is examined, it can be seen that out of the total of 1232 publications, 821 are articles, 325 are proceeding papers, and 49 are book or book chapters. Therefore, it can be stated that articles constitute the majority of the publications in the field of "sustainable logistics". After analyzing the publication numbers, the types of indexes for these publications were examined and presented in Table 3.

Table 3: Number of publications by WoS index types

Index Types	Number
Science Citation Expanded (SCI-EXPANDED)	557
Conference Proceedings Citation Index-Science (CPCI-S)	261
Conference Proceedings Citation Index – Social Science & Humanities (CPI-SSH)	119
Social Sciences Citation Index (SSCI)	411
Emerging Sources Citation Index (ESCI)	192
Book Citation Index – Science (BKCI-S)	28
Book Citation Index - Social Science & Humanities (BKCI – SSH)	27
Arts & Humanities Citation Index (A&HCI)	1

Upon reviewing Table 2, it is observed that in terms of the distribution of studies in the field of "sustainable logistics" according to indexes, SCI-Expanded ranks first with 557 publications. This is followed by SSCI (411 publications), CPI-S (261 publications), and ESCI (192 publications), respectively. The distribution of relevant publications by year is illustrated in Figure 3.

Figure 3: Number of publications by years



When Figure 3 is examined, it is observed that in the analyzed years, the highest number of studies in the field of "sustainable logistics" was conducted in 2022 (153 publications). This is followed by 2023 with 143 publications and 2020 with 126 publications, respectively.

Bibliometric Analysis

The bibliometric analysis method was used to analyze the data collected for this study. The VOSviewer visualization tool was used to conduct the analyses. It makes use of clustering algorithms to put disparate pieces of knowledge from multiple areas into groups based on similarities and relationships. Individual elements, such as people, companies, nations, keywords, or references, are represented in the depicted networks as nodes, with the size of each node representing how frequently that element occurs. On the other side, the connections between nodes show linkages of citation or collaboration (Van Eck and Waltman, 2009).

The goal of bibliometric analysis is to identify the most productive studies, researchers, and nations within a given subject, providing insightful information about the relationships between these parties and supplying direction for future research projects. Researchers can gain a greater grasp of the scholarly environment, identify key publications, identify outstanding scholars, and ascertain the geographic distribution of research contributions by evaluating bibliometric data. Such expertise can guide and influence ongoing research projects, encourage teamwork, and aid in the development of specialized knowledge. In this section, the visual maps and interpretations resulting from the bibliometric analysis of the 881 studies conducted in the field of "sustainable logistics" are presented. To ensure better interpretation

Figure 5: Most publishing countries

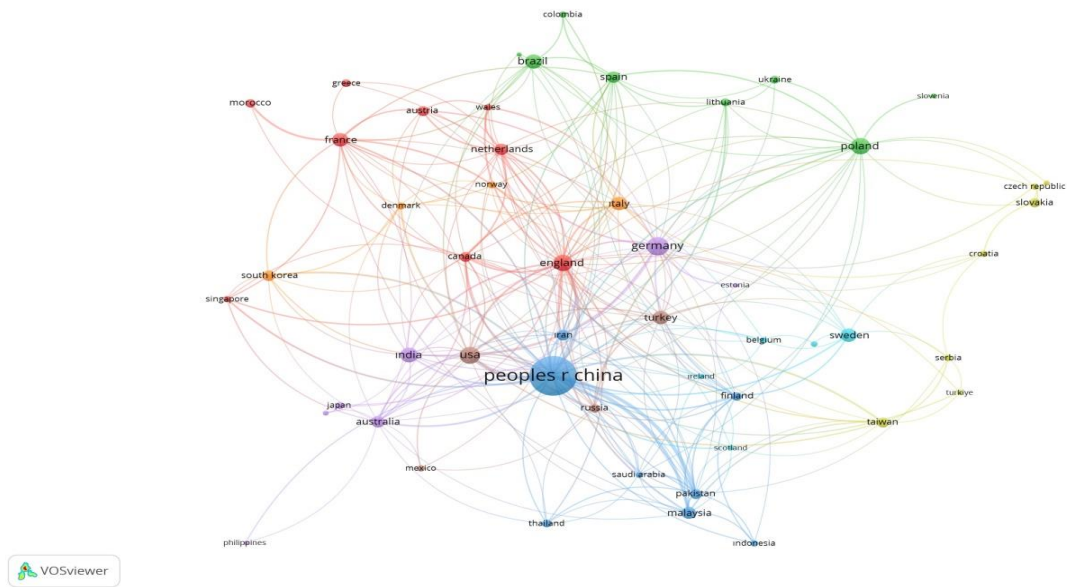


Figure 5 illustrates the countries with the highest number of publications in the field of "sustainable logistics." Among the 52 countries that have published at least 5 publications in this field, China has the highest number of publications (384 publications). China's importance in the world economy and its rapid growth in the logistics sector may be the reason for the increase in interest in research in this area. Germany follows with 85 publications, then USA (72 publications), and the United Kingdom (68 publications). Turkey, on the other hand, has 45 publications.

Figure 6: Co-Authorship network based on authors

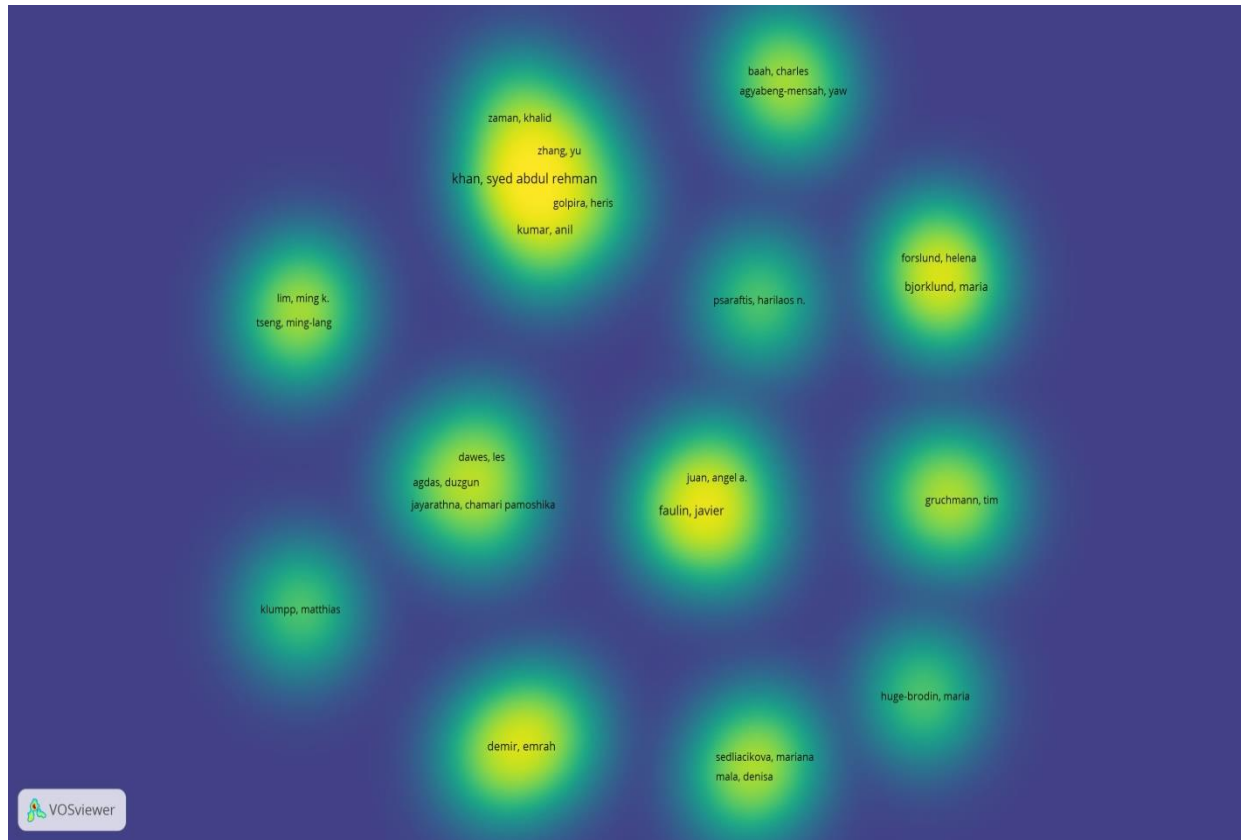


Figure 6 presents the researchers with the highest number of co-authorships in the field of "sustainable logistics." In the analysis, a minimum requirement of at least 5 publications and citations was set for the researchers. This led to a total of 27 authors. The color of the area where the researcher names are located varies based on the number of co-authorships, with a dominance of yellow indicating a higher number of co-authorships. Upon examining Figure 6, it can be observed that Syed Abdul Rehman Khan has the highest number of co-authorships (15 publications). Javier Faulin ranks second with 10 publications, followed by Maria Björklund with 9 publications.

Figure 7: Researchers with the highest number of publications

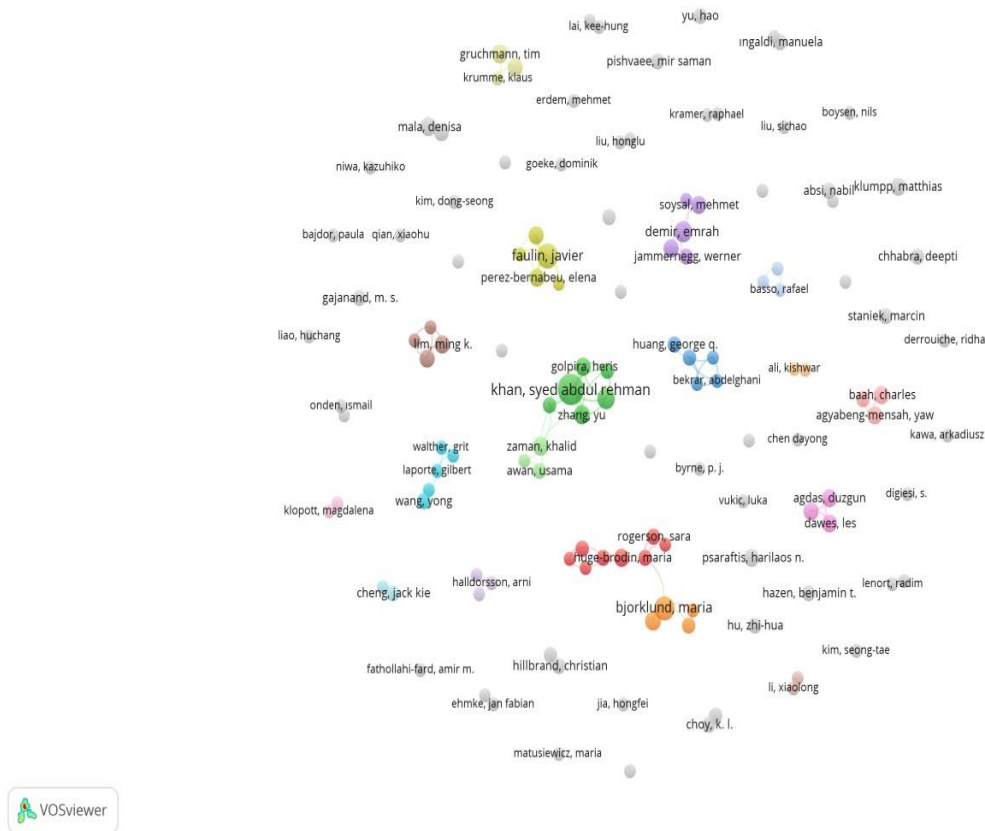


Figure 7 displays the researchers with the highest number of publications in the field of "sustainable logistics." Among these researchers, a total of 128 researchers who have published at least three publications were identified. Accordingly, the researchers with the highest number of publications are Syed Abdul Rehman Khan (15 publications), Javier Faulin (10 publications), and Maria Björklund (9 publications). These findings indicate that these researchers have collaborated with other researchers in conducting these studies, as the number of co-authorships matches the number of publications for these researchers.

**Table 4:** Number of publications and citations of researchers

Author Name	Number of Publications	Number of Citations
Syed Abdul Rehman Khan	15	1579
Javier Faulin	10	202
Maria Björklund	9	276
Anil Kumar	7	758
Emrah Demir	7	153
Yu Zhang	6	852
Khalid Zaman	6	452

The names of the researchers with the highest number of publications, along with their publication and citation counts, are presented in Table 4. Upon examining the citation counts, Syed Abdul Rehman Khan ranks first with 1579 citations, followed by Yu Zhang (852 citations) in second place and Anil Kumar (758 citations) in third place.

Table 5: Most published journals

Journal Name	Number of Publications
Sustainability	108
Journal of Cleaner Production	42
International Journal of Logistics Management	23
Environmental Science and Pollution Research	22
International Journal of Production Research	18
European Journal of Operational Research	15

The journals with the highest number of publications are shown in Table 5 in the field of "sustainable logistics." The journal with the highest number of publications in this field is Sustainability, with 108 publications, followed by the Journal of Cleaner Production with 42 publications in second place, and the International Journal of Logistics Management with 23 publications in third place.

CONCLUSION

The main goal of green and sustainable logistics, which encompasses the integration of all activities related to the movement of products throughout the supply chain, is to achieve a more sustainable balance among economic, environmental, and social objectives by coordinating operations to meet customer



requirements at minimal expense. Within this context, these efforts are crucial for preserving the environment and making it more livable for future generations. Establishing sustainable industries has become imperative for companies to survive and maintain their operations. The logistics sector plays a pivotal role in reducing costs, enhancing services, and mitigating environmental harm. Moreover, the discipline of logistics management has produced a number of management techniques aimed at enhancing a company's environmental performance. As a result, both researchers and professionals in the business community have become aware of the significance of considering and adopting "green" strategies in the realm of logistics.

In recent years, there has been a growing interest in environmental issues and sustainability on a global scale. The aim of this study is to examine the research conducted on sustainability in logistics using the VOSviewer visualization mapping method. In light of the significant increase in studies in this field, particularly in recent years, it is hoped that this study will contribute to the field by providing up-to-date data.

According to the findings of the study; 2022 had the most articles (153 publications). In fact, the number of publications jumped from 100 publications in 2019 to 126 publications in 2020. In 2020, the Covid-19 pandemic affected the whole world. By 2021, the number of publications was limited to 123 publications. As logistics activities often involve social interactions, there may have been a decrease in the number of publications due to changes in willingness to accept or interact with crowdsourced workers following behavioural changes caused by the pandemic.

The most frequently used keyword (437 times) was green logistics. As a result of the sustainable development goals adopted by many important and large countries in the world and the green policies implemented by countries, sustainability is encountered in many areas. In particular, the concept of 'green' is attracting more and more attention from government sectors, academics, practitioners and international organisations.

Syed Abdul Rehman Khan has highest number of publications and co-authorships (15 publications). He also received the most citations (1579 citations). When the author's studies were examined, it was seen that most of them consisted of topics such as sustainability, renewable energy, green supply chain, green technology, green, finance, green purchasing behaviour, green data analysis eco-friendly packaging. Therefore, it has been a source for many researchers.

A review of the literature reveals that the majority of research in the field of sustainable logistics is conducted in China (384 publications). China's importance in the world economy and its rapid growth in



the logistics sector may explain the increasing interest in research in this field. China's advantages, such as low-cost labour and ease of access to resources, may be a contributing factor to the wider adoption of sustainable logistics practices in this country. This situation encourages academic research to focus on this issue.

And lastly, it has been observed that the "Sustainability" journal has published the most articles on sustainable logistics (108 publications). In recent times, logistics businesses have been taking steps to enhance their corporate image by adopting an environmentally friendly approach. This is not only to improve their public image but also to gain a competitive advantage, reduce operational costs and achieve sustainability goals. Eco-friendly practices have become an important trend in the transport sector, with many of these firms achieving both environmental and economic benefits by improving energy efficiency and reducing their carbon footprint through the adoption of green technologies. Moreover, eco-friendly practices serve as an important motivator for these firms to achieve legal compliance. This is due to the fact that governments are introducing stricter standards for the industry to comply with environmental regulations and reduce environmental impacts. Therefore, the environmentally friendly approach is not only a trend in the logistics industry, but also a strategy that provides sustainability and competitive advantage. Researchers investigating sustainable logistics can acquire valuable knowledge from the existing body of literature as presented in this study. Researchers who will work on this subject in the future can perform analyses using different software and compare the results. This may increase the diversity of analytical methods and provide a more comprehensive analysis.

AUTHOR STATEMENT / YAZAR BEYANI

Researchers have jointly contributed to the article. Researchers have not declared any conflict of interest.

Araştırmacılar makaleye ortak olarak katkıda bulunduğunu bildirmiştir. Araştırmacılar herhangi bir çıkar çatışması bildirmemiştir.

REFERENCES

- Abbasi, M., & Nilsson, F. (2016). Developing environmentally sustainable logistics: Exploring themes and challenges from a logistics service providers' perspective. *Transportation Research Part D: Transport and Environment*, 46, 273-283.
- Abri zah, A., Zainab, A. N., Kiran, K., & Raj, R. G. (2013). LIS journals scientific impact and subject categorization: A comparison between Web of Science and Scopus, *Scientometrics*, 94(2), 721-740.



- Aksentsyeva, D., & Shunevich, V. (2021). *Eco-packaging as the basis for the development of ecological logistics*. Belarus State Economy University Library. Retrieved from: http://edoc.bseu.by:8080/bitstream/edoc/87292/1/Aksenteva_D..pdf
- Alam, S. (2023). Factors influencing sustainable logistics: Sustainability in Logistics. *South Asian Journal of Operations and Logistics*, 2(1), 48-62.
- Ali, A. H., Gruchmann, T., & Melkonyan, A. (2022). Assessing the impact of sustainable logistics service quality on relationship quality: Survey-based evidence in Egypt. *Cleaner Logistics and Supply Chain*, 4, 100036.
- Ali, A. H., Melkonyan, A., Noche, B., & Gruchmann, T. (2021). Developing a sustainable logistics service quality scale for logistics service providers in Egypt. *Logistics*, 5(2), 21.
- Baah, C., Amponsah, K. T., Issau, K., Ofori, D., Acquah, I. S. K., & Agyeman, D. O. (2021). Examining the interconnections between sustainable logistics practices, environmental reputation and financial performance: a mediation approach. *Vision*, 25(1), 47-64.
- Bansal, P., & Roth, K. (2000). Why companies go green: A model of ecological responsiveness, *Academy of Management Journal*, 43(4), 717-736.
- Bask, A., & Rajahonka, M. (2017). The role of environmental sustainability in the freight transport mode choice: A systematic literature review with focus on the EU, *International Journal of Physical Distribution & Logistics Management*, 47, 560-602.
- Björklund, M., & Forslund, H. (2018). Exploring the sustainable logistics innovation process. *Industrial Management & Data Systems*, 118(1), 204-217.
- Cano, J. A., Londoño-Pineda, A., & Rodas, C. (2022). Sustainable logistics for e-commerce: A literature review and bibliometric analysis. *Sustainability*, 14(19), 12247.
- Chang, Q., & Qin, R. (2008). Analysis on development path of Tianjin green logistics, *International Journal of Business and Management*, 3(9), 96-98.
- Chen, Z., Dong, J., & Ren, R. (2017). Urban underground logistics system in China: opportunities or challenges?, *Underground Space*, 2(3), 195-208.
- D'Amico, G., Szopik-Decpczyńska, K., Dembińska, I., & Ioppolo, G. (2021). Smart and sustainable logistics of Port cities: A framework for comprehending enabling factors, domains and goals. *Sustainable Cities and Society*, 69, 102801.
- Deckert, C. (2018). Sustainable logistics: a framework for green logistics and city logistics. H. Lu, R. Schmidpeter, N. Capaldi & L. Zu (Ed.), in *Building new bridges between business and society* (pp. 53-70). Springer, Cham.
- Deckert, C. (2020). Sustainable logistics. S. Idowu, R. Schmidpeter, N. Capaldi, L. Zu, M. Del Baldo & R. Abreu (Ed.). In *Encyclopedia of sustainable management* (pp. 1-5). Retrieved from https://link.springer.com/referenceworkentry/10.1007/978-3-030-02006-4_131-1
- Du, W., Zhou, X., Wang, C., & Rong, D. (2019). Research on ecological logistics evaluation model based on BCPSGA-BP neural network. *Multimedia Tools and Applications*, 78(21), 30271-30295.

- Duran, C. A., Cordova, F. M., & Palominos, F. (2019). A conceptual model for a cybersocial-technological-cognitive smart medium-size port. *Procedia Computer Science*, 162, 94–101.
- Elkington, J. (2004). Enter the triple bottom line. A. Henriques & J. Richardson (Ed.). In *The triple bottom line does it all add up* (pp. 1-16). London: Earthscan. Retrieved from <https://www.routledge.com/The-Triple-Bottom-Line-Does-It-All-Add-Up/Henriques-Richardson/p/book/9781844070152?srsId=AfmBOopoVc5bY4K5RL94U8IH0Zoz6UTpcZX5sYSj36Ob3ljFqIC-SiOH>
- Ferraro, S., Cantini, A., Leoni, L., & De Carlo, F. (2023). Sustainable logistics 4.0: A study on selecting the best technology for internal material handling. *Sustainability*, 15(9), 7067.
- Gills, B. K. (2010). The return of crisis in the era of globalization: One crisis, or many?. *Globalizations*, 7(1-2), 3–8.
- Görçün, Ö. F., Aytakin, A., Korucuk, S., & Tirkolae, E. B. (2023). Evaluating and selecting sustainable logistics service providers for medical waste disposal treatment in the healthcare industry. *Journal of Cleaner Production*, 408, 137194.
- Gülmez, M., Oğuz, S., & Yalçıntaş, D. (2020). Sosyal inovasyon alanındaki yayınların görsel haritalama yöntemiyle bibliyometrik analizi. *Süleyman Demirel Üniversitesi Vizyoner Dergisi*, 11, 90-101 .
- Islam, M. S., Moeinzadeh, S., Tseng, M. L., & Tan, K. (2021). A literature review on environmental concerns in logistics: trends and future challenges. *International Journal of Logistics Research and Applications*, 24(2), 126-151.
- Jayarathna, C. P., Agdas, D., & Dawes, L. (2023). Exploring sustainable logistics practices toward a circular economy: A value creation perspective. *Business Strategy and the environment*, 32(1), 704-720.
- Kim, S. T., & Han, C. H. (2012). The role of organisational learning in the adoption of environmental logistics practices: Empirical evidence from Korea. *International Journal of Logistics Research and Applications*, 15(3), 147-161.
- Lee, D. H., Dong, M., & Bian, W. (2010). The design of sustainable logistics network under uncertainty. *International Journal of Production Economics*, 128(1), 159-166.
- Macharis, C., Melo, S., Woxenius, J., & Van Lier, T. (Eds.). (2014). *Sustainable logistics*. Emerald Group Publishing.
- Mckinnon, A., Browne, M., & Whiteing, A. (2012). *Green Logistics: Improving the Environmental Sustainability of Logistics*. London: Kogan Page Publishers.
- Murphy, P. R., & Poist, R. F. (2000). Green logistics strategies: an analysis of usage patterns, *Transportation journal*. 40(2), 5-16.
- Neto, J. Q. F., Bloemhof-Ruwaard, J. M., van Nunen, J. A., & van Heck, E. (2008). Designing and evaluating sustainable logistics networks. *International journal of production economics*, 111(2), 195-208.



- Parhi, S., Joshi, K., Gunasekaran, A., & Sethuraman, K. (2022). Reflecting on an empirical study of the digitalization initiatives for sustainability on logistics: The concept of sustainable logistics 4.0. *Cleaner Logistics and Supply Chain*, 4, 100058.
- Qaiser, F. H., Ahmed, K., Sykora, M., Choudhary, A., & Simpson, M. (2017). Decision support systems for sustainable logistics: a review and bibliometric analysis. *Industrial Management & Data Systems*, 117(7), 1376-1388.
- Raut, R., & Gardas, B. B. (2018). Sustainable logistics barriers of fruits and vegetables: An interpretive structural modeling approach. *Benchmarking: An International Journal*, 25(8), 2589-2610.
- Ren, R., Hu, W., Dong, J., Sun, B., Chen, Y., & Chen, Z. (2020). A systematic literature review of green and sustainable logistics: Bibliometric analysis, research trend and knowledge taxonomy. *International Journal of Environmental Research and Public Health*, 17(1), 261.
- Saunders, M. N., Gray, D. E., Tosey, P. & Sadler-Smith, E. (2015). Concepts and theory building. *A Guide to Professional Doctorates in Business and Management*, 35-56.
- Seuring, S., Müller, M., Westhaus, M., & Morana, R. (2005). Conducting a literature review—the example of sustainability in supply chains. H. Kotzab, S. Seuring, M. Müller & G. Reeiner (Ed.), In *research methodologies in supply chain management* (pp. 91-106). Physica-Verlag.
- Soysal, M., & Bloemhof-Ruwaard, J. M. (2017). Toward sustainable logistics. D. Çınar, K. Gakis & P. M. Pardalos (Ed.), In *Sustainable logistics and transportation: Optimization models and algorithms*, (pp. 1-17). Springer.
- Sun, X., Yu, H., Solvang, W. D., Wang, Y., & Wang, K. (2022). The application of Industry 4.0 technologies in sustainable logistics: a systematic literature review (2012–2020) to explore future research opportunities. *Environmental Science and Pollution Research*, 1-32.
- Sutton, S. G., Smedley, G., & Arnold, V. (2008). Accounting for collaborative supply chain relationships: Issues and strategies. *The International Journal of Digital Accounting Research*, 8(14), pp. 1-22.
- Teixeira, C. R. B., Assumpção, A. L., Correa, A. L., Savi, A. F., & Prates, G. A. (2018). The contribution of green logistics and sustainable purchasing for green supply chain management. *Independent Journal of Management & Production*, 9(3), 1002-1026.
- Tsai, F. M., Bui, T. D., Tseng, M. L., Lim, M. K., & Hu, J. (2020). Municipal solid waste management in a circular economy: A data-driven bibliometric analysis. *Journal of Cleaner Production*, 275, 124-132.
- Tseng, M. L., Islam, M. S., Karia, N., Fauzi, F. A., & Afrin, S. (2019). A literature review on green supply chain management: Trends and future challenges. *Resources, Conservation and Recycling*, 141, 145-162.
- United Nations (1987). “Our Common Future”, World Commission on Environment and United Nations (2011). Transport and Communications Bulletin for Asia and the Pacific, No. 80 Sustainable Urban Freight Transport; Economic and Social Commission for Asia and Pacific; United Nations Building: Bangkok, Thailand. Retrieved from: <https://www.unescap.org/publications/transport-and-communicationsbulletin-asia-and-pacific-no-80-sustainable-urban-freight>



- Van Eck, N., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*, 84(2), 523-538.
- Wang, J., Lim, M. K., Wang, C., & Tseng, M. L. (2022). Comprehensive analysis of sustainable logistics and supply chain based on bibliometrics: Overview, trends, challenges, and opportunities. *International Journal of Logistics Research and Applications*, 1-30.
- Werner-Lewandowska, K., & Golinska-Dawson, P. (2021). Sustainable logistics management maturity—the theoretical assessment framework and empirical results from Poland. *Sustainability*, 13(9), 5102.
- Wichaisri, S., & Sopadang, A. (2013, December). Sustainable logistics system: A framework and case study. *2013 IEEE International Conference on Industrial Engineering and Engineering Management [Proceeding]* (pp. 1017-1021). IEEE.
- Zhang, S., Lee, C. K., Chan, H. K., Choy, K. L., & Wu, Z. (2015). Swarm intelligence applied in green logistics: A literature review. *Engineering Applications of Artificial Intelligence*, 37, 154-169.
- Zhao, P., Liu, J., & He, L. (2009). Study on the development of modern green logistics in China. *International Conference on Innovation Management Wuhan China*, IEEE, Los Alamitos, CA, December 8-9, pp. 43-46.