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ORIGINAL ARTICLE

ESG Transformation in Logistics and Supply Chain Management: Bibliometric Evidence from Central Asia

Gulbakhyt Olzhebayeva[1]* | **Elvira Nurekenova**[2]

[1]University of International Business named after K. Sagadiyev, Almaty, Kazakhstan.

[2]D. Serikbayev East Kazakhstan State Technical University, Ust-Kamenogorsk, Kazakhstan.

Correspondence
*Gulbakhyt Olzhebayeva – PhD candidate, University of International Business named after K. Sagadiyev, Almaty, Kazakhstan.
Email: g.olzhebayeva@gmail.com

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Abstract
In the context of digital transformation, climate risks and geo-economic instability, ESG approaches are becoming an important direction for the modernization of logistics, distribution systems and supply chain management. The purpose of the study is to conduct a bibliometric analysis of scientific publications to identify the dynamics, thematic structure, and role of Central Asian countries in the development of ESG-oriented research in logistics and supply chain management. The methodological basis of the study was made up of bibliometric analysis, the PRISMA approach, co-authorship analysis, co-word analysis and network visualization using the VOSviewer program. The initial empirical base was formed from publications indexed in the Web of Science Core Collection for 2021–2025. The results demonstrate a more than threefold increase in publication activity, from 70 publications in 2021 to 226 publications in 2025, reflecting the growing scientific interest in sustainable logistics systems and ESG-oriented supply chain management. The results of the network analysis revealed the key thematic areas of ESG research: digital ESG ecosystems, artificial intelligence, machine learning, blockchain technologies, supply chain sustainability, circular economy, green logistics, and ESG-oriented risk management. Kazakhstan and Uzbekistan are increasingly serving as connecting nodes between European and Asian research clusters, reflecting the growing importance of Central Asia in Eurasian transport corridors and in the transformation of sustainable logistics within an ESG-oriented economy. The results indicate that ESG is increasingly functioning as an integrated governance framework for adaptive, digitally connected, and sustainable supply chain systems amid climate risks, geo-economic instability, and global disruptions.

KEYWORDS
Logistics, Sustainable Logistics, Logistics Economics, Supply Chain Management, Green Economy, Supply Chain Resilience, Central Asia

1 | INTRODUCTION

ESG is becoming a crucial component in transforming supply chain management and logistics amid growing global instability, digital transformation, and demands for sustainable development. Approaches to supply chain management have changed dramatically due to increased regulatory pressure, the growth of sustainable finance, the adoption of net-zero pledges, and the fallout from global disruptions such as the COVID-19 pandemic. Resilience-oriented and sustainability-driven supply chain strategies are increasingly replacing the conventional emphasis on cost efficiency.

Early research on ESG, logistics, and supply chain management primarily focused on green supply chain management, logistics efficiency, and companies' environmental sustainability. At the initial stage, ESG was interpreted mainly through environmental sustainability, reputational benefits, and compliance-oriented practices, while issues of resilience, digitalisation, and strategic adaptability in supply chains were not yet central to the research agenda (Kim et al., 2021; Chouaibi & Chouaibi, 2021).

After the COVID-19 pandemic, the research focus increasingly shifted to supply chain resilience, ESG-oriented risk management, and digital transformation. Song et al. (2022) emphasise the importance of flexibility, collaboration, and adaptive logistics capabilities for the sustainability of supply chains, while Dai and Tang (2022) consider ESG as part of strategic supply chain management in the post-pandemic economy. At the same time, interest in digital ESG ecosystems is growing, including blockchain technologies, IoT, big data analytics and smart logistics systems.

Central Asian regional studies are mainly focused on modernising logistics infrastructure, digitalising supply chains, and enhancing transportation connectivity. Arynova et al. (2024) analyse the role of distribution centres in the development of logistics infrastructure in Kazakhstan, while Tazhibekova et al. (2023) emphasise the importance of digital tools and information systems for the sustainability of supply chains during COVID-19 disruptions. Li et al. (2025) consider reverse supply chains and circular economy approaches in Kazakhstan's mining industry. However, the issues of ESG governance, supply chain resilience and digital sustainability remain insufficiently integrated into the regional research agenda. The existing research gaps highlight the need for further analysis of the interrelationships among ESG integration, digital transformation, logistics efficiency, and supply chain resilience in the context of emerging economies and the sustainable transformation of global supply chains.

The research aims to conduct a comprehensive bibliometric analysis of scientific publications to identify new trends in the development of sustainable logistics systems, key research areas and the structure of international scientific cooperation, as well as to determine the role of Central Asian countries in shaping the modern ESG agenda and developing research on sustainable supply chains in the context of digitalisation and geo-economic transformation.

Based on the aim, the following research questions arise:

RQ1: How has the scientific agenda of ESG research in the field of distribution,

logistics and supply chain management changed in the period 2021–2025?

RQ2: Which thematic, intellectual and interdisciplinary clusters form the modern structure of ESG research in logistics and supply chain management?

RQ3: Which countries, authors and scientific journals are central to the development of ESG research in the field of logistics and supply chain management, and what is the structure of international scientific cooperation?

RQ4: What role do the Central Asian countries play in shaping the modern ESG agenda and developing research on sustainable logistics systems in the global scientific space?

RQ5: What new trends, technological directions and research gaps determine the further development of ESG-oriented logistics and supply chain management?

2 | LITERATURE REVIEW

Early ESG research on logistics and supply chain management was predominantly shaped around green supply chain management, logistics, and the basic integration of environmental criteria into corporate practice. First of all, he focused on environmental sustainability, reputational advantages, and regulatory-compliance-oriented practices such as supply chain sustainability, digitalisation, and strategic adaptability, thereby paying little attention to strategic development. Zhang (2021) showed that the practice of "green" supply chains can significantly improve the effectiveness of legislation and a company's environmental performance. Kim et al. (2021) analysed ESG logistics as a competitor for e-commerce companies, linking it with stable legal operations and respect for readers. Such studies have focused mainly on operational and environmental efficiency, rather than comprehensive supply chain transformation.

ESG management and corporate value creation developed in parallel. Chouaibi and Chouaibi (2021) identified a link between social and ethical practices and firm value, while Signori et al. (2021) examined value creation for stakeholders, showing that ESG indicators increasingly complement traditional metrics. The literature of this period remained somewhat fragmented: ESG was considered either as a tool to increase the company's value or as an element of environmental responsibility, but rarely as an integrated mechanism for strategic supply chain management.

Researchers have concentrated on resilience building, risk management, local environmental activities, and the transformation of the ESG-focused supply chain since the COVID-19 pandemic. Amidst global upheavals, the shortcomings of early systems that prioritised environmental efficiency have become especially apparent. In this regard, Song et al. (2022) conceptualised supply chain sustainability through flexibility, redundancy, collaboration, and adaptive logistics capabilities. Dai and Tang (2022) also highlighted the shift from traditional cost-effectiveness to sustainable, ESG-driven supply chains, indicating a more dynamic approach to strategic sustainability.

Buallay (2022) showed a link between sustainability reporting and retail sector performance, while Garsaa and Paulet (2022) showed that ESG disclosure can help reduce staff turnover. Consideration of issues related to the assessment of

consumer demand, long-term profitability, mechanisms of causation, and industry heterogeneity, which, of course, are significant mainly in emerging markets.

ESG is increasingly focused on digital transformation, intelligent management and innovative capabilities. Barykin et al. (2023) analyse smart city logistics as a tool for achieving ESG goals, while Qian et al. (2023) propose a platform based on blockchain and the Internet of Things to support a closed-loop economy and green supply chains. Long et al. (2023) show that the effectiveness of ESG is related to "green" innovations, as it can be implemented under conditions of increased competition and innovation.

The methodological evolution of research is also becoming more pronounced. Early research was based on conceptual analysis, case studies, and ESG correlational approaches. Regression, behavioural measurement models, digital management systems, blockchain/IoT modelling, and data-driven ESG analytics are used widely. Galletta et al. (2022), for example, use a bibliometric approach to analyse the effectiveness of ESG in the banking industry, Long et al. (2023) use quantile regression, and Barbosa et al. (2024) analyse the integration of ESG with the perception of workers and the theory of responding to them. De la Fuente and Velasco (2024) analyse inequality in the field of sustainable development as a possible symptom of symbolic practices of sustainable development, and Zhao et al. (2024) indicate that inconsistencies in executive power can lead to the "greening" of the economy. Such a transformation of research logic indicates a shift in attention from studying the information disclosure to analysing reliability, managerial depth, and behavioural integration in the field of ESG principles.

Research conducted in Central Asia and Kazakhstan focuses on the modernisation of logistics infrastructure, digital transformation of supply chains, and closed-loop economics approaches. While Tazhibekova et al. (2023) examine digital tools and information systems to support supply chains during COVID-19 interruptions, Arynova et al. (2024) examine the function of distribution centres in the growth of Kazakhstan's logistics connectivity. Azimov et al. (2024) analyse the application of blockchain technologies in business, and Li et al. (2025) introduce reverse supply chains, approaches to a closed-loop economy, and the mining industry in Kazakhstan.

Despite a significant increase in ESG studies in logistics and supply chain management, several important gaps remain in the literature. Most early research focused on environmental aspects of sustainability and green logistics, while the strategic integration of ESG into supply chain management was considered fragmentary. Modern works increasingly analyse the relationship between ESG and digital transformation, supply chain sustainability, and risk management, but these areas are developing mainly in isolation from one another.

In addition, existing ESG bibliometric studies are primarily focused on corporate finance, sustainable investment, and non-financial reporting, while the development of the ESG agenda in distribution, logistics, and supply chain management remains poorly understood. Central Asia, which is becoming increasingly important in international transport corridors and global supply chains, requires

special attention, but its contribution to shaping the scientific ESG agenda has been studied to a limited extent. Thus, the scientific gap lies in the absence of a comprehensive bibliometric analysis that simultaneously assesses the dynamics of research, the structure of international cooperation, the thematic evolution and new directions of ESG development in the field of distribution, logistics and supply chain management, taking into account the increasing role of Central Asian countries.

3 | RESEARCH METHODS

This article uses a bibliometric analysis of scientific publications indexed in the Web of Science Core Collection database for the period 2021–2025. The empirical research base is based on a search query on ESG, distribution systems, logistics, and supply chain management. The study used the PRISMA (PRISMA flow diagram) approach adapted for bibliometric analysis to systematise and select scientific publications. The PRISMA approach enabled transparency and reproducibility of the sampling procedure in scientific publications (Figure 1).

At the first stage (identification), publications were searched in the Web of Science Core Collection database on the topics of ESG, distribution, logistics and supply chain management using the search query: TS=('ESG' AND ('distribution' OR 'logistics' OR 'supply chain')). At the second stage (Screening), sequential filters for the selection of publications were applied: restrictions on the publication period (2021–2025), the type of document (articles), as well as the affiliation of the country of the authors (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan). At the final stage (included), the final sample included publications that met all the selection criteria and were used for subsequent bibliometric analysis. The use of PRISMA ensured a logical sequence of data selection and minimised the inclusion of irrelevant publications in the study dataset.

The study used quantitative bibliometric methods, including analyses of publication activity, the dynamics of scientific publications, the structure of international cooperation, the most-cited works, and the frequency of keyword use. The methods of co-word analysis and network visualisation were used to identify the main thematic clusters and research areas.

Bibliometric data were processed and visualised using VOSviewer, a software tool that enables the analysis of collaborations, thematic clusters, and bibliographic coupling. The results obtained were used to identify the main trends in the development of ESG research in logistics, distribution systems, and supply chain management.

To assess trends in scientific research development, an analysis of the dynamics of publication activity on ESG topics in distribution, logistics, and supply chain management was conducted. The study's results demonstrate a significant increase in publication activity on ESG topics across distribution, logistics, and supply chain management during 2021–2025. The number of publications increased from 70 in 2021 to 226 in 2025, indicating a more than threefold increase in research interest during the analysed period (Figure 2).

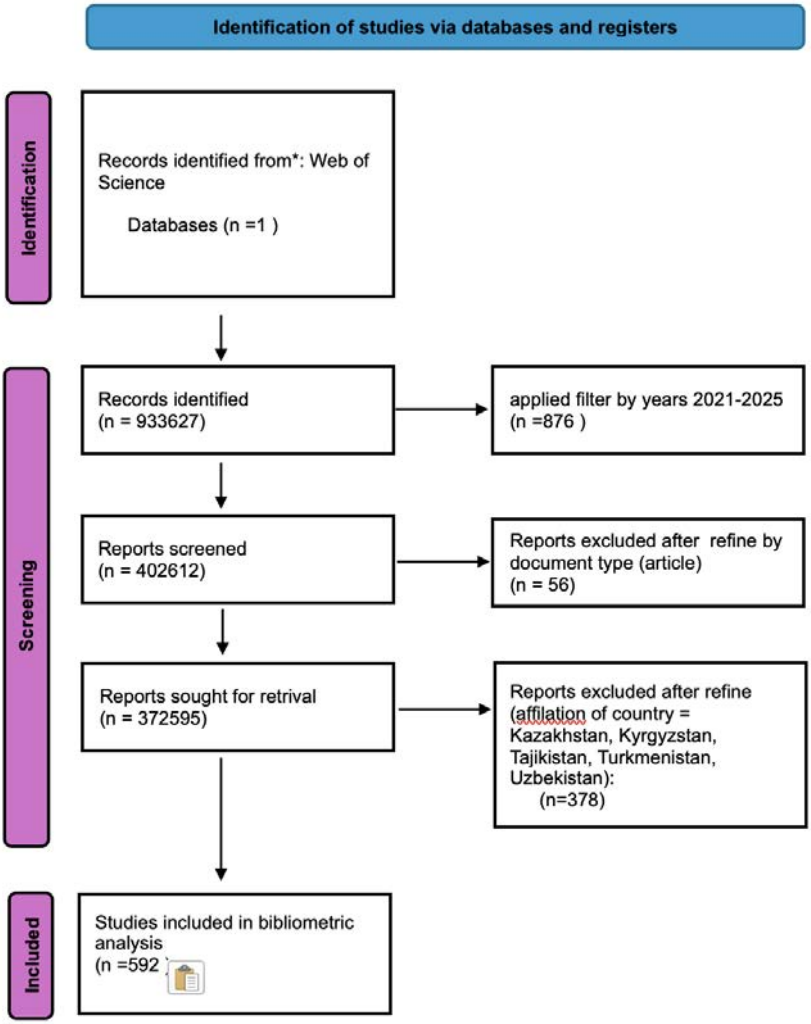

Figure 1. PRISMA-based flow diagram of publication selection for bibliometric analysis

4 | RESULTS

The dynamics of publications are characterised by steady growth, which intensified after 2023. The results obtained reflect the growing attention of the scientific community to integrating ESG principles into logistics systems, sustainable supply chain management, and distribution management processes. A significant increase in publications in 2024–2025 also indicates the growing importance of sustainable development, green logistics, and responsible supply chain management in the modern scientific agenda.

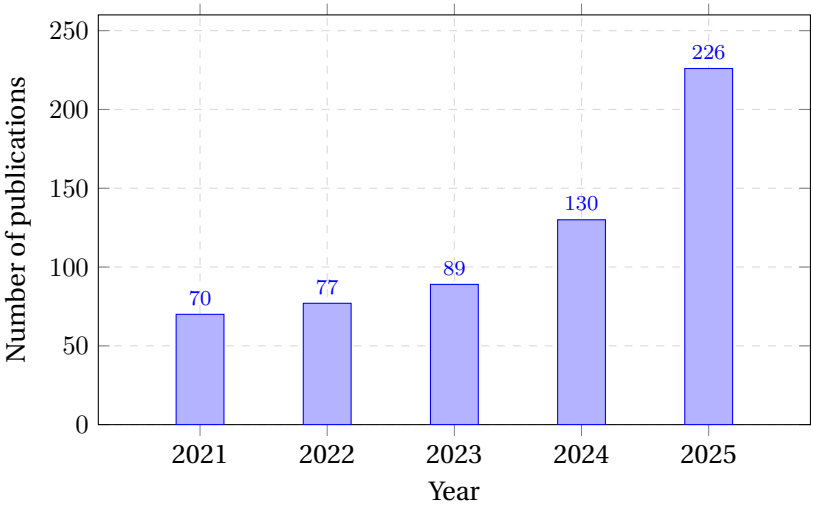

Figure 2. Dynamics of publication activity for 2021–2025

Note: compiled by the authors based on Web of Science database

To identify the structure of international scientific cooperation, an analysis of countries' co-authorship networks was conducted, revealing the most active countries, the intensity of international cooperation, and key research clusters. The results of the analysis are shown in Figure 3.

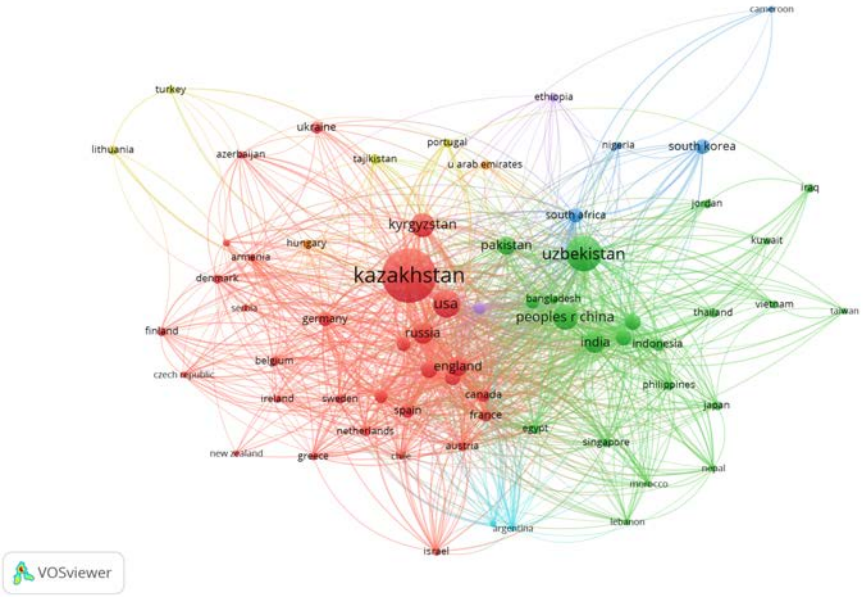

Figure 3. Map of international scientific cooperation between the countries

The network card demonstrates a high level of international cooperation between countries in ESG research and sustainable supply chains. However, the identified central positions of Kazakhstan, Uzbekistan, the People's Republic of China, the USA and England are determined not only by quantitative indicators of publication activity, but also by the specifics of modern global logistics development and ESG transformations. The dominant positions of China, the USA and England are explained by their leading roles in shaping the global ESG agenda, developing sustainable supply chain systems, and concentrating large international research centres in logistics, sustainability and digital transformation. For China, the key factors are the large-scale integration of ESG principles into the Belt and Road Initiative and the development of green logistics and digital supply chain management platforms. The United States and Great Britain retain their central positions due to the high concentration of publications in highly rated journals, the developed research infrastructure and active international scientific cooperation.

Strengthening the positions of Kazakhstan and Uzbekistan as new regional ESG research centres in Central Asia is associated with the active integration of countries into international transport and logistics corridors, including the Middle Corridor and Belt and Road Initiative, the increasing role of the region in ensuring the sustainability of Eurasian supply chains, and increased attention to ESG transformation of raw materials and transit economies. An additional factor is the expansion of international research projects, academic mobility and publication cooperation with universities in Europe and Asia, which contributes to increasing the international scientific visibility of Central Asian countries in the field of sustainable logistics and supply chain management.

The study shows that Kazakhstan and Uzbekistan are emerging as connecting nodes between European and Asian research clusters, forming a new Eurasian segment of scientific cooperation in sustainable supply chain management. Additionally, the results demonstrate a shift in research focus from traditional ESG analysis in corporate and financial contexts to the use of ESG as a tool to enhance the sustainability of international logistics systems, transport corridors, and supply chain resilience amid geo-economic transformation and global crises.

Further analysis aims to identify the quantitative characteristics of publication activity and the structure of international scientific cooperation. For a more detailed presentation of the results of the bibliometric analysis, the main indicators of publication activity, citations and international interaction of researchers were systematised. The corresponding results are presented in Table 1.

The results indicate a high degree of internationalisation of ESG research in Central Asia, particularly in logistics and supply chain management. The greatest publication activity is observed among countries that actively integrate ESG principles into national strategies for sustainable development and digital transformation of logistics systems. The analysis also shows that international co-authorship is a key factor in increasing scientific visibility and publication citations. The most active research networks are formed across Asia, Europe, and North America, reflecting the global nature of the ESG agenda in supply chain management. In

addition, the results demonstrate a gradual increase in Central Asian countries' participation in international ESG research, indicating their expanding integration into the global scientific community and growing interest in sustainable logistics and responsible supply chain management.

Table 1. Distribution of publication activity, citation and strength of international scientific relations by country

No.	Country	Document	Citation	Total link strength
1	Kazakhstan	354	2192	613
2	Uzbekistan	154	1498	494
3	USA	92	910	350
4	China	74	929	352
5	Kyrgyzstan	72	606	200
6	India	55	1091	345
7	Russian Federation	53	519	323
8	England	45	578	370
9	Pakistan	42	481	210
10	Italy	33	450	333

Note: compiled by the authors based on VOSviewer

To determine the most widespread scientific research areas, an analysis of publication subject categories was conducted. The results of the distribution of publications by scientific categories are presented in Table 2.

Table 2. Top 10 scientific journals by number of publications and citation rate

No.	Source title	Quantity of articles	Quantity of citations	H-index
1	Sustainability	21	202	7
2	PLOS ONE	13	88	5
3	Economic annals XXI	11	4	1
4	Scientific reports	9	46	4
5	Industrial engineering and management systems	8	14	3
6	Frontiers in public health	7	12	2
7	Sensors	7	52	3
8	Applied Sciences Basel	6	30	3
9	BMC Public Health	6	127	4
10	Diagnostics	6	19	3

Note: compiled by the authors based on Web of Science database

The analysis shows that ESG research in logistics and supply chain management has a pronounced interdisciplinary character. High publication activity is

observed across journals in various scientific fields, including Sustainability, PLOS ONE, Economic Annals XXI, Scientific Reports, Industrial Engineering and Management Systems, Frontiers in Public Health, Sensors, Applied Sciences Basel, BMC Public Health, and Diagnostics. The dominant position of Sustainability magazine stems from the modern ESG agenda in logistics and supply chain management, which is increasingly focused on sustainable development, green logistics, carbon neutrality, and ESG governance. A significant part of the publications is devoted to decarbonising transport systems, the sustainability of supply chain networks, and integrating sustainability principles into corporate governance.

The high representation of the journals Industrial Engineering and Management Systems and Applied Sciences Basel reflects the strengthening of engineering and technology areas of ESG research. The publications of these journals focus on optimisation of logistics systems, digital transformation, automation, and the use of intelligent technologies in supply chain management. This structure of publication activity indicates the transition of ESG research from primarily normative analysis to the development of applied mechanisms to improve the efficiency and sustainability of logistics systems.

The presence of the journals PLOS ONE, Frontiers in Public Health, BMC Public Health and Diagnostics demonstrates the expansion of the ESG agenda in the field of public health and the sustainability of socio-economic systems. This trend has strengthened since the COVID-19 pandemic, when supply chain sustainability, food security, environmental safety, and public health began to be considered interrelated elements of ESG risk management. The high impact of the journals Economic Annals XXI and Scientific Reports reflect the growing interest in the economic aspects of ESG-oriented logistics systems, including evaluating the effectiveness of ESG practices, reducing transaction costs, assessing the sustainability of international supply chains, and examining the impact of ESG factors on the competitiveness of logistics networks.

The analysis shows that modern ESG research in logistics and supply chain management is developing a new interdisciplinary model that integrates sustainable development, engineering solutions, digital technologies, public health, and the economics of sustainable logistics systems. Accordingly, ESG serves as a comprehensive mechanism for transforming international supply chain systems amid digitalisation, climate risks, and global geo-economic instability.

To assess the scientific impact and quality of publication activity, an analysis of bibliometric indicators for leading scientific journals was conducted and is presented in Table 3.

The results of the analysis show that a significant part of the publications is concentrated in high-quartile journals (Q1–Q2), which indicates a high level of scientific interest in the issues of sustainable supply chain management, green logistics and ESG-oriented business models. Publications in highly rated journals reflect the increasing importance of research on the decarbonization of transport systems, the sustainability of global supply chains, the digitalisation of logistics, and ESG governance. The high values of the Journal Impact Factor and the Journal

Citation Indicator confirm that ESG research is increasingly recognised as a priority in modern interdisciplinary science.

Table 3. Bibliometric indicators of scientific journals

No.	Source	Journal Impact Factor	Journal Citation Indicator	Highest Quartile
1	Sustainability	3.3	0.67	Q2
2	PLOS ONE	2.6	0.85	Q2
3	Economic annals XXI	0.3	0.12	Q4
4	Scientific reports	3.9	1.07	Q1
5	Industrial engineering and management systems	0.5	0.1	Q4
6	Frontiers in public health	3.4	1.06	Q1
7	Sensors	3.5	0.84	Q2
8	Applied Sciences Basel	2.5	0.53	Q2
9	BMC Public Health	3.6	1.18	Q1
10	Diagnostics	3.3	0.92	Q1

Note: compiled by the authors based on Web of Science database

The analysis also shows that the modern ESG agenda is developing at the intersection of management, environmental sciences, engineering, economics and digital technologies. This interdisciplinarity helps expand international scientific cooperation and increase the citation of research in logistics and supply chain management. The conducted analysis allows us to conclude that ESG research in logistics is gradually moving from local applied tasks to the formation of an independent global scientific direction focused on the sustainability of international logistics systems, the digital transformation of supply chains, and business adaptation to climatic and geo-economic challenges.

To identify the structure of scientific cooperation and the most active research groups, an analysis of the authors' co-authorship network was conducted, revealing key researchers, the intensity of scientific interaction, and the research groups formed. The results of the analysis are shown in Figure 4.

The results of the network analysis demonstrate the existence of several stable clusters of scientific cooperation united around the most active researchers. However, the identified structures of co-authorship reflect not only the formal ties between authors, but also the formation of international research centres and thematic scientific schools in the fields of ESG, logistics, and supply chain management. The central positions of the authors Sarria-Santamera Antonio, Issanov Alpamys and Aimagambetova Gulzhanat are due to the high intensity of international publication cooperation, the interdisciplinary nature of research, and the integration of ESG topics with issues of sustainable development, public health, logistics, and the digitalisation of supply chain systems. At the same time, the scientific significance of these nodes is determined not only by the number

of publications but also by their role as connecting elements between various international research groups.

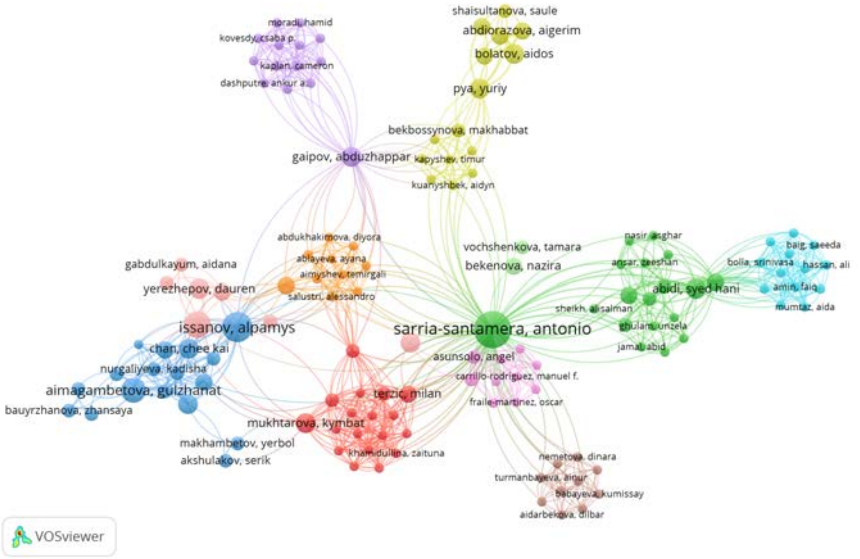

Figure 4. Network visualisation of researchers' co-authorship

The green cluster forming around Sarria-Santamera Antonio reflects the high degree of internationalisation of ESG research and sustainable development. Modern ESG research is increasingly developing at the intersection of public health, sustainability management and risk governance.

The blue cluster, which unites Issanov Alpamys, Aimagambetova Gulzhanat, and related researchers, reflects the emergence of the Central Asian direction in ESG research. The increase in researchers' publication activity in Kazakhstan is associated with the region's growing role in Eurasian transport corridors, the development of the Middle Corridor, and the integration of ESG principles into transport and logistics infrastructure. A significant part of the publications in this area focuses on regional sustainability, logistics resilience, and digital transformation.

The red cluster focuses on research related to ESG performance, management mechanisms, and sustainability assessment of supply chain systems. This cluster reflects the development of quantitative ESG analysis and managerial approaches to the sustainable management of logistics networks. Its formation is associated with growing interest in ESG metrics, performance assessment, and business sustainability models amid global uncertainty.

The purple cluster reflects the development of specialised research related to quantitative analysis methods, digital management models, and international scientific cooperation. The economic interpretation of this cluster is to strengthen the role of data-driven approaches, econometric modelling, and analytics-based

sustainability assessment in ESG research. This cluster demonstrates the transition from traditional descriptive studies to the use of intelligent analytical tools for assessing the sustainability of supply chains.

The yellow cluster unites researchers working in the field of innovative development and the educational and institutional aspects of ESG. Its formation reflects the growing importance of human capital, knowledge transfer and ESG-oriented institutional modernisation in the development of sustainable logistics systems. The analysis shows the strengthening of Central Asia's role as an emerging research hub in sustainable supply chain research and demonstrates a shift in the global ESG agenda towards integrating logistics sustainability, digitalisation, and regional transport security.

To identify key research areas and the most frequently used thematic concepts, an analysis of the type 1 keyword network was carried out. The results of the analysis are shown in Figure 5.

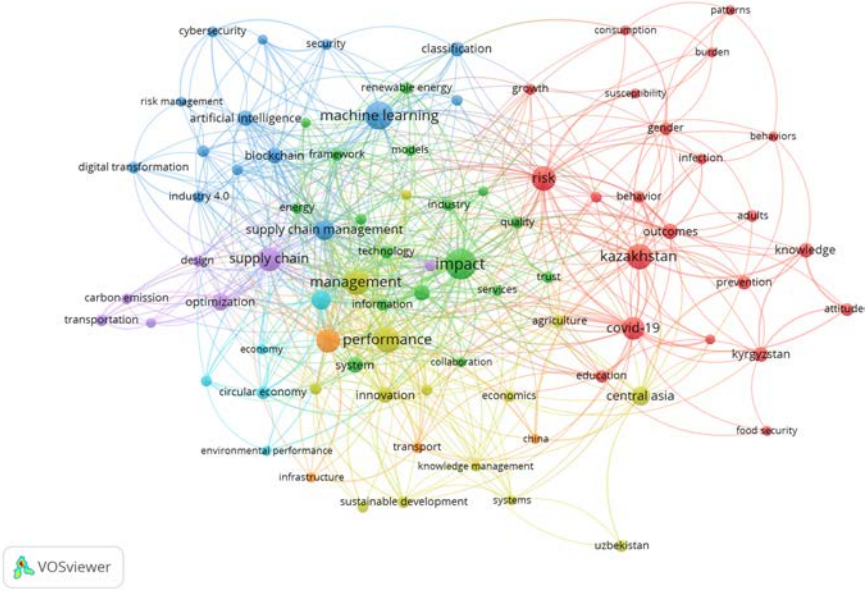

Figure 5. Network visualisation of type 1 keywords

The analysis demonstrates a high level of thematic interconnectedness between ESG research and sustainable supply chain management. However, the allocation of six main clusters reflects the structural transformation of the modern ESG research agenda in the context of digitalisation, geo-economic instability and increasing requirements for the sustainability of global supply chain systems. The centrality of the impact, management, performance, supply chain and risk categories shows that the modern ESG agenda is increasingly focused not only on corporate reporting issues, but also on improving the sustainability and efficiency

of global logistics systems.

The blue cluster, which unites artificial intelligence, machine learning, blockchain, cybersecurity, and Industry 4.0, reflects the emerging digital direction of ESG research. Modern supply chains increasingly depend on intelligent forecasting systems, digital monitoring of ESG risks, and automation of logistics processes. This topic is particularly active in Chinese and South Korean research focused on smart logistics, digital supply chains, and AI-driven sustainability management.

The green cluster, which includes impact, management, industry, quality, and services, reflects the managerial and organisational direction of ESG transformation. This cluster shows that ESG is increasingly seen as a tool for improving operational efficiency, management quality, and long-term business sustainability. The economic essence of the cluster lies in integrating ESG metrics into corporate governance and performance management systems.

The yellow cluster, which unites innovation, sustainable development, knowledge management, systems and economics, demonstrates the innovation and economic research area. Its formation is due to the fact that the sustainability of supply chain systems increasingly depends on innovative adaptability, digital competencies and the ability of companies to integrate ESG principles into strategic development processes. This cluster reflects the transition from traditional logistics to the concept of sustainable innovation ecosystems.

The red cluster, which includes risk, COVID-19, Kazakhstan, Central Asia, food security, and prevention, reflects the regional crisis focus of ESG research. The economic interpretation of this cluster is that the COVID-19 pandemic, geopolitical risks, and disruptions to global supply chains have significantly increased interest in resilience logistics and the sustainability of food systems. The presence of Kazakhstan and Central Asia in the cluster's centre underscores the region's growing importance in research on transport corridors, food security, and the sustainability of Eurasian supply chains.

The purple cluster, associated with transportation, carbon emission, optimisation, and design, reflects the environmental and transportation research area. Its economic essence lies in the search for models to reduce carbon emissions, optimise traffic flows and increase energy efficiency of logistics systems. This cluster is directly related to the development of green transportation policies and carbon-neutral supply chains, which are being actively researched in the European Union.

The blue cluster, which unites circular economy, environmental performance, economy and infrastructure, demonstrates the development of a circular model of sustainable logistics. This cluster reflects the transition from linear supply chain management models to circular supply chains based on resource recycling, reduced waste generation, and ESG-oriented infrastructure development. The analysis shows that the modern ESG agenda is developing into an integration system that combines digitalisation, sustainable development, risk management, transport sustainability, and the innovative transformation of global supply chains.

To deepen understanding of the research agenda's structure, an analysis of the

thematic relationships among type 2 keywords was conducted. The results of the analysis are shown in Figure 6.

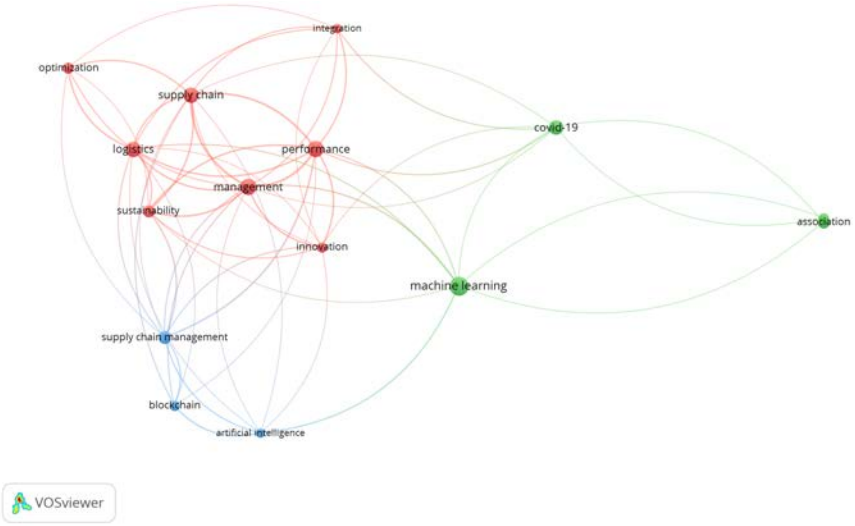

Figure 6. Network visualisation of type 2 keywords

The results of the analysis demonstrate that the central place in the research network is occupied by the categories logistics, supply chain, performance and management, which form the basis of modern research on ESG-oriented supply chain management.

The red cluster, which unites performance, innovation, integration, optimisation, sustainability, logistics and supply chain, reflects the management and operational direction of research. ESG is increasingly seen as a tool for improving the efficiency of supply chain systems, optimising logistics processes, and integrating sustainability metrics into corporate management. The high density of connections between performance and sustainability suggests that modern research is increasingly focused on balancing economic efficiency and environmental sustainability.

The blue cluster, which includes blockchain, artificial intelligence, and supply chain management, reflects the digital transformation of ESG-oriented logistics systems. Digital technologies are increasingly used to increase supply chain transparency, monitor ESG risks, and automate logistics operations. The use of blockchain technologies enables traceability of supply chains and ESG compliance, while artificial intelligence supports predictive analytics, demand forecasting, and the optimisation of logistics networks.

The green cluster associated with machine learning and COVID-19 reflects the crisis-analytical direction of research. The COVID-19 pandemic has demonstrated the high vulnerability of global supply chain systems and increased the need for intelligent forecasting models and risk analytics. The economic interpretation of this

cluster is the transition from traditional supply chain management to resilience-oriented logistics systems based on machine learning algorithms and adaptive risk management. In recent years, ESG has increasingly been seen as a tool for ensuring the sustainability of logistics networks amid global shocks, disruptions, and geopolitical instability.

The results obtained confirm that the modern ESG research agenda in logistics and supply chain management is developing towards the integration of sustainable development, digitalisation, and intelligent logistics system management technologies. ESG acts not only as a non-financial reporting system but also as a tool to enhance the sustainability, adaptability, and technological modernisation of international logistics systems.

5 | DISCUSSION

The results of the study demonstrate a significant transformation of the ESG scientific agenda in the fields of distribution, logistics, and supply chain management during the period 2021–2025. The number of publications increased from 70 in 2021 to 226 in 2025, indicating a more than threefold increase in research interest.

Early research mainly focused on green logistics, environmental sustainability, and compliance-oriented ESG practices. The ESG was mainly interpreted through environmental performance, reputational benefits, and sustainability reporting. Similar findings are reported in studies by Zhang (2021) and Kim et al. (2021), in which ESG was mainly associated with logistics efficiency and competitiveness. After the COVID-19 pandemic, the scientific agenda is increasingly shifting towards supply chain resilience, adaptive logistics systems, ESG-oriented risk management and digital transformation. This transformation is consistent with the findings of Song et al. (2022) and Dai and Tang (2022), who emphasise the growing importance of resilient, flexible, and adaptive supply chains for governance in a post-pandemic economy.

An integrated governance paradigm that integrates sustainability, digitalisation, resilience, and strategic supply chain coordination is gradually replacing fragmented environmental analysis in modern ESG research. Blockchain, AI, machine learning, and digital monitoring systems are becoming increasingly important. This suggests that ESG is seen not just as a non-financial reporting tool but also as a means of modernising technology and managing logistics in an adaptable manner.

The bibliometric analysis revealed several key thematic and intellectual clusters that form the modern structure of ESG research. The most significant areas are green logistics and environmental performance; supply chain resilience and risk management; ESG governance and performance assessment; digital supply chain transformation; circular economy and reverse logistics; and intelligent logistics systems based on blockchain and artificial intelligence technologies.

The analysis of keyword networks demonstrates the high level of interdisciplinarity of ESG research. Dedicated clusters combine logistics management, sustainability science, digital governance, public health, engineering systems, in-

novation studies, and economics. This interdisciplinarity reflects the formation of an integrated framework for sustainable and adaptive management of logistics systems.

The study demonstrates the high level of internationalisation of ESG research in logistics and supply chain management. Kazakhstan and Uzbekistan increasingly act as connecting nodes between European and Asian research clusters. The region's increased publication activity is related to the growing strategic importance of Eurasian transport corridors, including the Middle Corridor, as well as the digitalisation of logistics systems and ESG transformation of transit economies.

The analysis of co-authorship networks shows the formation of stable international research clusters. The identified author networks reflect not only formal ties among researchers but also the emergence of new interdisciplinary scientific schools in ESG governance, sustainable logistics, digital supply chains, and resilience management. Analysis of scientific journals confirms the pronounced interdisciplinary nature of ESG research. The concentration of publications in Q1–Q2 journals indicates the growing scientific significance of ESG-oriented logistics and supply chain management research.

The Central Asian countries are gradually strengthening their presence in the global ESG research landscape. Regional research is mainly focused on logistics infrastructure modernisation, digital transformation of supply chains, transportation connectivity, blockchain technologies and reverse logistics systems. However, compared to global ESG literature, regional research largely remains operationally oriented and focuses primarily on infrastructure efficiency and digitalisation rather than integrated ESG governance frameworks, stakeholder accountability, and sustainability-oriented institutional coordination.

At the same time, a new Eurasian segment of international scientific cooperation on ESG is emerging. Central Asia is increasingly serving as a regional research hub, connecting European and Asian scientific networks in sustainable logistics and supply chain resilience. Further development of ESG-oriented logistics research will increasingly involve digital ESG ecosystems, artificial intelligence, blockchain-based traceability systems, machine learning, circular supply chains, and adaptive resilience-oriented governance models. The identified keyword clusters show that the modern ESG agenda is increasingly associated with intelligent logistics systems, predictive analytics, cybersecurity, digital monitoring of ESG risks and automated supply chain management. The strengthening of blockchain and AI technologies reflects the transition from traditional logistics management to data-driven, fully traceable supply chain ecosystems.

Most existing studies continue to analyse ESG, digitalisation, resilience, and logistics performance in isolation from each other, rather than within integrated analytical frameworks. Limited attention has been paid to the interrelationships among ESG governance, digital transformation, the circular economy, and adaptive supply chain resilience, especially in emerging and transit-oriented economies.

The modern ESG agenda increasingly functions not only as a non-financial reporting system, but also as a strategic governance architecture for sustainable lo-

gistics systems in the context of climate risks, geo-economic instability and global disruptions. In this regard, future research should shift from descriptive sustainability analysis to integrated models that combine resilience, digital governance, intelligent logistics systems, and ESG-oriented strategic coordination.

6 | CONCLUSION

The study showed that over the period 2021–2025, there has been a steady increase in scientific interest in ESG issues across distribution, logistics, and supply chain management. The results of the bibliometric analysis indicate a shift in the research agenda from traditional issues of environmental efficiency and green logistics to more complex topics related to supply chain sustainability, digital transformation, risk management, and the introduction of artificial intelligence and blockchain technologies.

The analysis of international scientific cooperation revealed a high level of internationalisation of research and the strengthening of Central Asian countries' role in shaping the modern ESG agenda. Kazakhstan and Uzbekistan are becoming important participants in global research networks, reflecting the region's growing importance in the development of Eurasian transport corridors and sustainable logistics systems. The identified thematic clusters confirm the interdisciplinary nature of ESG research, combining approaches from sustainable development, management, economics, digital technologies, and logistics. The results obtained allow us to conclude that further research will involve integrating ESG principles, digitalisation, and supply chain resilience, as well as expanding research on the role of developing regions in the transformation of global supply chains.

Promising areas of future research include assessing the impact of ESG practices on the efficiency and sustainability of logistics systems, exploring the role of artificial intelligence, blockchain, and big data technologies in ESG-oriented supply chain management, and conducting comparative studies between developed and developing countries. It is advisable to pay special attention to the countries of Central Asia, including the analysis of the ESG transformation of transport and logistics infrastructure, the sustainability of international transport corridors and the region's integration into global supply chains in the context of digitalisation and geo-economic changes.

AUTHOR CONTRIBUTIONS

Writing – Original Draft: Gulbakhyt Olzhebayeva, Elvira Nurekenova.
Conceptualization: Gulbakhyt Olzhebayeva, Elvira Nurekenova.
Formal Analysis and Investigation: Gulbakhyt Olzhebayeva, Elvira Nurekenova.
Funding Acquisition and Research Administration: Gulbakhyt Olzhebayeva, Elvira Nurekenova.
Development of Research Methodology: Gulbakhyt Olzhebayeva.
Resources: Gulbakhyt Olzhebayeva.
Software and Supervision: Gulbakhyt Olzhebayeva, Elvira Nurekenova.
Data Collection, Analysis, and Interpretation: Gulbakhyt Olzhebayeva, Elvira Nurekenova.
Visualization: Gulbakhyt Olzhebayeva, Elvira Nurekenova.
Writing – Review and Editing: Gulbakhyt Olzhebayeva, Elvira Nurekenova.

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AUTHOR BIOGRAPHIES

Gulbakhyt Olzhebayeva – PhD candidate, University of International Business named after K.Sagadiyev, Almaty, Kazakhstan. Email: g.olzhebayeva@gmail.com, ORCID ID: https://orcid.org/0000-0002-4964-2747

Elvira Nurekenova – Cand. Sc. (Econ.), Professor, D. Serikbayev East Kazakhstan State Technical University, Ust-Kamenogorsk, Kazakhstan. Email: emadiyarova@mail.ru, ORCID ID: https://orcid.org/0000-0002-2944-6968

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