



EMERGING TRENDS IN SUSTAINABLE HEALTHCARE MANAGEMENT THROUGH ESG PRINCIPLES: A BIBLIOMETRIC PERSPECTIVE

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ABSTRACT

The COVID-19 pandemic has fundamentally transformed healthcare systems around the world, exposing key vulnerabilities in supply chain sustainability, environmental waste management, and social equity, while accelerating the integration of environmental, social, and governance (ESG) principles as a strategic framework for sustainable healthcare management (SHM). This study uses a mixed-methods approach that combines bibliometric analysis (2019–2024) and a SWOT theoretical framework (resource-based approach and institutional theory) to map the evolution of SHM post-pandemic. Analyzing 329 publications from 78 countries, we found that SHM research output increased by 151.7% from 2019 (29 publications) to 2023 (73 publications), reflecting a significant global effort to align healthcare practices with ESG objectives. Key findings show that Italy and China have emerged as pioneers in localized ESG innovations, such as medical waste optimization and supply chain transparency through blockchain, using technology to turn pre-pandemic weaknesses into competitive advantages. ESG-compliant hospitals have a 12% higher return on equity (ROE), but smaller institutions face a disproportionate financial burden, with compliance costs exceeding 8% of annual budgets. The study further shows that a fragmented regulatory environment is a barrier to equitable ESG adoption, highlighting the need for isomorphic adaptation based on policy. By providing a dual strategic framework – a scalable digital tool for SMEs and a global ESG benchmark led by the WHO – this study advances a course of action to build resilient, equitable and governance-based healthcare systems.

Keywords: Sustainable Healthcare Management , Environmental Social and Governance ,COVID-19,Bibliometric Analysis, Environmental Sustainability, Digital Health Innovations,SWOT

INTRODUCTION

The healthcare sector, known for its intensive use of resources and reliance on energy, plays a pivotal role in advancing sustainability efforts. Sustainable healthcare management is an evolving field that seeks to balance the delivery of quality medical care with economic, social, and environmental considerations. This approach is crucial for ensuring that healthcare systems

can meet current and future demands without compromising resources or the environment. Sustainable healthcare management is a critical component of achieving Sustainable Development Goal 3 (SDG 3), Introduced by the United Nations in 2015, SDG 3 aims to promote well-being and secure healthy lives across all age groups (Nations, 2015). The framework of SDG 3 includes thirteen targets addressing various health and wellness concerns, with Targets 3.1, 3.2, and 3.3 focusing on population health and the management of communicable diseases. SDG 3 encompasses key health priorities, ensuring comprehensive well-being for individuals throughout their lives. These studies suggest that achieving Sustainable Development Goal 3 (SDG3) requires substantial investments in health systems, innovative digital health solutions, and a focus on primary health care, while addressing challenges such as resource allocation, data infrastructure, and equitable access to healthcare (Stenberg et al., 2017) (Wyllie et al., 2022) (Haenssger, 2023) (Asi & Williams, 2017) (Pettigrew et al., 2015). However, The COVID-19 pandemic has put enormous pressure on countries' health systems, many of which are close to collapse. This has led to setbacks in achieving SDG3 targets (Tezcan, 2022) (Khetrapal & Bhatia, 2020). It also brings a convergence of challenges amidst a global pandemic of unprecedented scale and huge shifts across industries, especially in healthcare. An eruption of digital technologies, expanded data accessibility, advanced analytics, increasingly knowledgeable and empowered consumers, and a shift from reactive disease management to proactive health promotion are the driving forces behind the much-anticipated healthcare transformation. This transformation encompasses significant changes in clinical practices, financial models, and operational strategies, fulfilling the longstanding promises of the healthcare industry to global society (Chiu & Fong, 2023). The sustainable growth of the healthcare sector in the post-COVID-19 era has emerged as a highly discussed topic. The theme of sustainable and inclusive development has once again captured global attention. In response to the escalating challenges in sustainability across environmental, social, and financial sectors, international organizations and nations worldwide have introduced initiatives like ESG. These efforts aim to establish a holistic framework for human society's sustainable and comprehensive advancement (Li et al., 2021).

Research suggests a variety of methodologies to measure and discuss sustainability. The Environmental, Social, and Governance (ESG) criteria are a pivotal assessment framework for evaluating corporations' sustainability and ethical impact, originating from socially responsible investing (Richardson, 2009). ESG practices have become increasingly important in the healthcare sector, influencing financial performance, risk management, and corporate responsibility. These studies suggest that ESG practices in the healthcare sector can positively influence financial performance and value, particularly in emerging markets and nonprofit organizations, although the impact may vary based on competition, governance, and regional factors (Paridhi et al., 2024) (S. Chaudhry et al., 2023) (Gaal, 2024) (Kehinde et al., 2023) (Filipiak & Kiestrzym, 2021). Like in Europe, ESG practices are closely linked to financial dynamics, with stakeholders showing a keen interest in sector-specific ESG characteristics (Gaal, 2024). In emerging markets like India, the COVID-19 pandemic temporarily boosted financial performance, but the long-term effects were negligible (Paridhi et al., 2024).

While existing research has identified the relevance of ESG principles in ensuring sustainability in healthcare, large gaps remain in understanding their global applicability,

implementation challenges across the sector, and long-term impact, particularly in the context of post-pandemic recovery and achieving SDG 3. Fragmenting the focus to isolated regions or organizational types limits the development of a unified framework for sustainable healthcare management. This study aims to address these gaps by examining how ESG integration can systematically enhance sustainability in healthcare across different contexts, while addressing the tensions between economic viability, social equity, and environmental stewardship. By synthesizing empirical evidence and proposing actionable strategies, this study aims to contribute to the broader discussion on healthcare transformation in alignment with the UN 2030 Agenda for Sustainable Development.

Sustainability and ESG in Healthcare Management

The healthcare sector identifies key ESG-related priorities based on its distinctive industry characteristics. One significant area is addressing environmental challenges, such as energy management inefficiencies, waste handling issues, and vulnerabilities to climate change, which can pose substantial risks to operations. Like other industries, innovation in environmentally-friendly products, technologies, and services has emerged as a crucial strategy for the healthcare sector to mitigate these risks effectively. Second, social sustainability issues, including the quality of products and services, remain a major public concern. Simultaneously, the advancement of technologies like virtual reality has heightened the importance of safeguarding data privacy and security. Third, governance aspects, such as stakeholder engagement, board accountability, anti-corruption measures, tax compliance, and risk mitigation, have gained increasing prominence within the healthcare industry. ESG risks, if left unaddressed, could lead to higher compliance costs and negatively impact financial performance. However, by incorporating ESG principles into their core strategies, organizations can turn these challenges into growth opportunities. ESG integration is anticipated to address sustainability concerns while driving economic growth, offering healthcare providers numerous benefits through its application (Leung & You, 2023).

While there is a substantial body of biometric research on sustainability and ESG, we find a notable gap in the biometric studies specifically targeting the healthcare sector's sustainability practices. For instance, Punnakitikashem and Hallinger conducted a comprehensive biometric analysis of sustainable healthcare management covering the period from 1994 to 2018 (Punnakitikashem & Hallinger, 2019). However, this extensive study predates the COVID-19 pandemic and does not address the pandemic's profound impact on healthcare systems and sustainable practices. Similarly, Mostepaniuk et al. (2023) undertook a systematic review of literature from 2019 to 2022 in this domain, yet this analysis also lacks a focus on post-COVID-19 developments in sustainable healthcare management.

The other research in this field is written about supply chain management sustainability Bibliometric analyses (Acharjya & Dash, 2024), green healthcare sustainability (Sanyal et al., 2024; Soares et al., 2023), healthcare waste management (Ranjbari et al., 2022), pharmaceutical and chemical industries' sustainability (Calciolari et al., 2024).

Integrating ESG information within companies' integrated reports is essential for fostering responsible investment. This practice is becoming increasingly prevalent as institutional investors prioritize sustainable and ethical criteria in their investment decisions (Ching, 2020). In the context of private German health insurers, there is a conscious trend toward aligning large capital reserves with ESG criteria, showcasing a commitment to responsible investing

practices (Schneider et al., 2021). Consolandi et al. (2020) examines how the healthcare sector contributes to the SDGs through the lens of ESG criteria. It outlines a methodological framework that maps SDGs to ESG issues identified by the Sustainability Accounting Standards Board (SASB), focusing on the healthcare sector's impacts. The paper highlights the potential for private sector firms to support SDG goals while noting areas where public sector actions are needed.

The other articles examine the relationship between Corporate Social Responsibility (CSR), ESG disclosures (Hasan et al., 2022), and firm performance (Mihaiu et al., 2021; Sharma et al., 2019), with a focus on the Indian economy, specifically within the healthcare and pharmaceutical sectors. They reveal that in a highly competitive market environment and an evolving global economy, adopting sustainable and responsible business practices is an ethical imperative and a key strategy for companies to gain competitive advantage.

Although existing research has conducted an extensive review of sustainability management in the healthcare industry (Punnakitikashem & Hallinger, 2019; Mostepaniuk et al., 2023). However, there is a very limited literature review talking about the SHM after COVID-19. Therefore, it is also necessary to know the focal points of sustainable healthcare management evolved in the post-COVID-19 era, compared to prior research. In recent years, the implementation of ESG in the field of healthcare has gradually become a hot topic, so it is also necessary to consider the characteristics of the healthcare industry and the different classifications of ESG topics.

While the integration of ESG principles in healthcare management has gained attention, the application of bibliometric methods to uncover trends and gaps within this field offers a unique opportunity to advance the discourse

METHODOLOGY

Data extraction

This study selected the Web of Science (core collection) as the data source. Web of Science, a high-quality digital literature resource database, has been accepted by many researchers and is considered the most suitable database for bibliometric analysis (Ding & Yang, 2020). This article selects the Web of Science core collection as the data source. At the same time, to ensure the comprehensiveness and accuracy of the retrieval data, the index selection is SCI-EXPANDED, SSCI, and A&HCI.

The subject scope is limited to studies involving "sustainability" and "healthcare management" in any "organizational environment" (such as hospitals, private, corporate, government, community, and education). We also use the keywords "ESG" and "healthcare management" to search for studies in this field.

Thus, the keywords "sustainability" and "healthcare management" were used for keyword searches in the Web of Science; as a result, a total of 1354 articles were obtained from this search.

Identification

Before the COVID-19 pandemic, some scholars had already paid attention to the sustainable development of the healthcare sector and published relevant systematic analysis studies. However, with the various uncertainties brought by the COVID-19 pandemic to mankind, especially the challenges it brought to the healthcare sector, more countries, enterprises, and organizations have paid more attention to the sustainable development of the healthcare sector.

Therefore, it is necessary to review the academic research on the sustainable development of healthcare in the nearly five years since the beginning of the COVID-19 pandemic. our review covers studies published on the Web of Science from January 2020 to 19 September 2024. The selected literature types were articles and review articles.

Screening

To ensure the quality of the study sample, we further screened the initial sample according to the exclusion criteria consistent with the present review study [30, 34, 35]. First, our selection criteria were strictly limited to articles published in academic journals and peer-reviewed. Second, the language of the articles was limited to English. This criterion ensured that the composition of the collective scientific knowledge base was consistent with that outlined in most peer-reviewed academic publications [35]. Finally, reviewers excluded articles unrelated to sustainability and healthcare by manually evaluating each article's title, abstract, keywords, and introduction section. some articles that were unrelated to research topics, such as virology or tourism, and specific disease-related fields were excluded. After applying these exclusion criteria, the final sample included 329 articles (Figure 1).

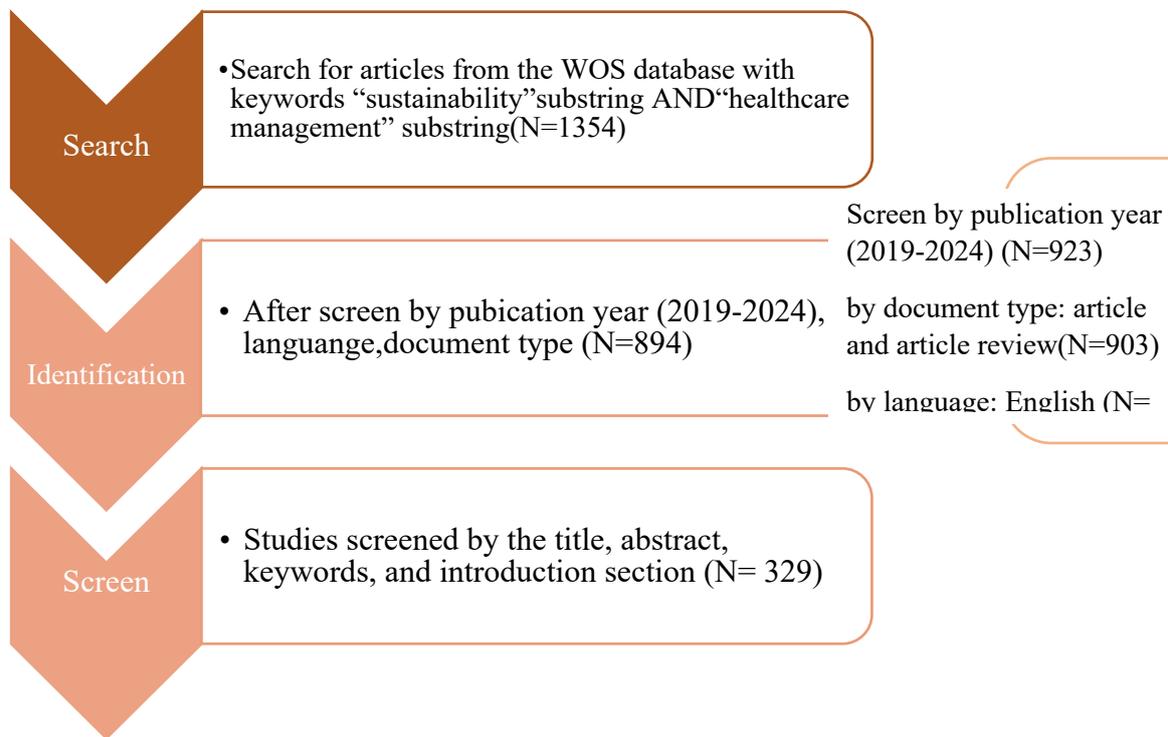


Figure 1. Article selection process for bibliometric mapping analysis and systematic review.

Bibliometric tools

In recent years, bibliometric analysis has become increasingly popular with the development of bibliometric tools such as Biblioshiny, VOSviewer, Gephi, and Leximancer (Aria & Cuccurullo, 2017; Donthu et al., 2021). Thus, Biblioshiny is a web-based bibliometric analysis application (Aria & Cuccurullo, 2017), while VOSviewer is a software tool designed to create and visualize bibliometric graphs (Van Eck & Waltman, 2010).

Bibliometric analyses

Bibliometrics, which emerged in the early 20th century, became an independent discipline in 1969 (Pritchard, 1969) and has since been extensively applied in document analysis (Diem &

Wolter, 2013). By examining data such as authors, keywords, journals, countries, institutions, and references, bibliometric analysis provides insights into the evolution of a research field (Abramo et al., 2011). This analytical method offers a quantitative approach to evaluating and synthesizing existing literature within a specific domain (Mayr & Scharnhorst, 2015). With modern computer technology, graphical and visual results can complement the literature analysis. Co-citation is also frequently used in bibliometric analysis. If two articles are cited by one or more other articles simultaneously, it is defined as a relationship (visual analysis). Ma and Xi (Ma & Xi, 1992) emphasized that the visual method of co-citation analysis in bibliometrics helps data interpretation; it can make the results more comprehensive. In addition, most items in the paper can be applied through this method, including authors, keywords, institutions, and countries. Visualization helps to explore the intrinsic connections between this information; for example, different authors have the same research topic, the research focus of different institutions, new theories from existing research institutions, etc. We use VOS VIEWER to draw knowledge graphs. Each software has its own merits and can complement each other's advantages. VOS VIEWER adopts a data standardization method based on probability theory and provides a variety of visualization views in the fields of keywords, co-institutions, co-authors, etc., including Network Visualization, Overlay Visualization, and Density Visualization, which has the outstanding characteristics of simple mapping and beautiful images (Van Eck & Waltman, 2010).

RESULTS

Descriptive Trends in the SHM Literature

The 329 papers used in this study were written by 1401 authors from 1150 organizations in 131 countries, published in 151 journals, and cited 19954 references from 8573 journals.

The two figures below show the trends in Sustainable Healthcare Management (SHM) research. The first figure (2019-2024) shows a steady increase in publications, especially during and after the COVID-19 pandemic (Figure 2).

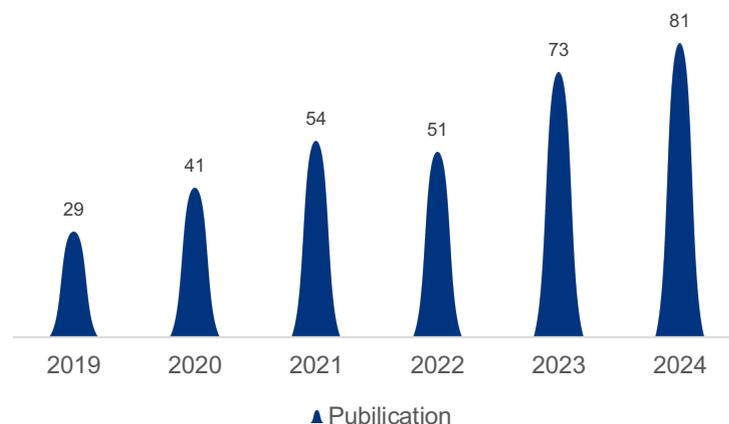


Figure 2. Growth of publications on the SHM over time. (Value for 2024 is based on data until September 2024.)

Following Figure 2, we concluded that the number of papers rose from 29 in 2019 to 73 in 2023, with 81 publications until September 2024, reflecting a significant surge in global interest in SHM.

Based on the research written by Punnakitkashem and Hallinger, evolution of SHM literature over time, 1994–2018 (n = 477). indicates a gradual rise in SHM research output, with a sharp increase after 2008, peaking at 68 publications in 2016 and maintaining a high level in subsequent years.

Comparing both researches, we concluded that the pandemic catalyzed SHM research, accelerating a trend. The increased focus on SHM post-2020 highlights the global response to healthcare system vulnerabilities exposed by the pandemic, with a greater emphasis on sustainable healthcare practices. In summary, SHM research has seen steady growth over time, with a dramatic rise during the pandemic, underscoring the critical importance of sustainable management in addressing global healthcare challenges.

Bibliometric analysis by a country, by the author, by the journal, Co-citation analysis

Bibliometric analysis by a country

The authors' geographic distribution was analyzed to better understand the global interest in SHM research. This body of work includes contributions from 78 countries, highlighting the worldwide engagement with the subject (Figure 3).

Sheet 1

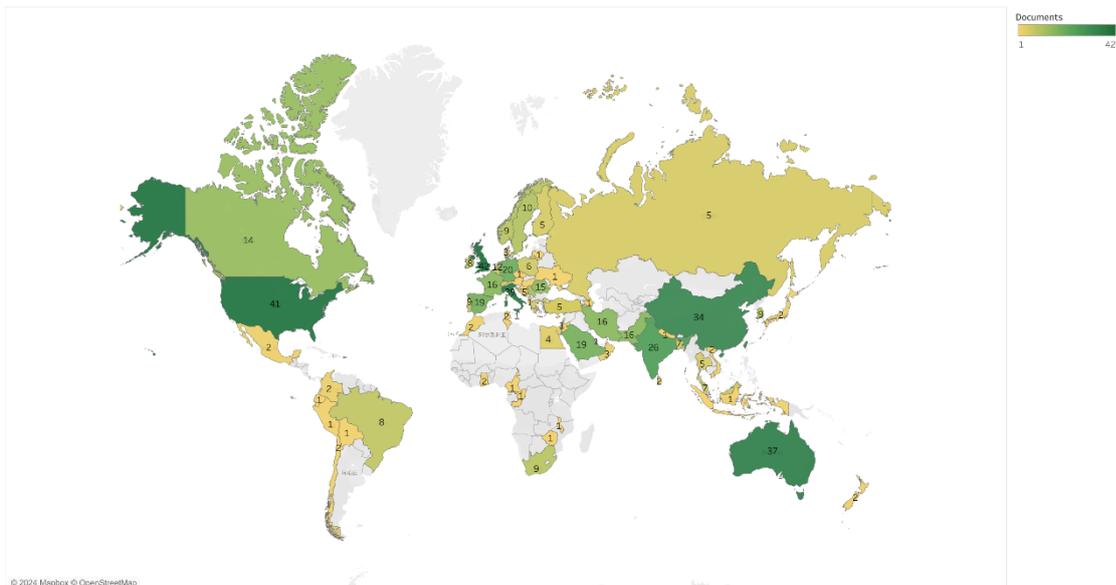


Figure 3. Geographical location of the analyzed studies. Completed by authors.

As Figure 3 shows, most of the authorship is concentrated in the United Kingdom (UK; 42), Italy (42), the United States (USA; 41), Australia (37), and China (34). According to previous research, Italy and China rose in prominence during the pandemic (Mostepaniuk et al., 2023). The COVID-19 pandemic significantly influenced the global landscape of SHM research. While traditionally strong contributors like the United States and the United Kingdom continued to lead, countries like Italy and China gained prominence as they faced unprecedented healthcare challenges and sought sustainable solutions. This diversification of authorship reflects a global reawakening of the importance of healthcare sustainability, with countries most affected by the pandemic actively contributing to SHM research. The pandemic expanded the geographic spread of research and deepened the engagement of regions like Italy and China, indicating a more globally integrated approach to addressing healthcare sustainability post-COVID-19.

Bibliometric analysis by the author.

Among the highly productive authors, Rocio Rodriguez and Göran Svensson have the most publications, with seven papers published from 2019 to September 2024, 73 citations, and an average of 11 citations per paper. Both scholars have collaborated many times (Table 1). As an analysis of the published papers in Table 1 shows, the two scholars are more concerned with supply chain management, hospital management, and sustainable development of enterprise (Rodriguez et al., 2020). Their research backgrounds are mostly management and supply chain.

Tabel 1

The most influential author in SHM

Rocio Rodriguez	7	73	12
Göran Svensson	7	73	12
Moldovan Flaviu	6	47	9
Moldovan, Liviu	6	47	9
Dragan Pamucar	6	802	9

Note. Completed by authors.

Bibliometric analysis by the journal

By analyzing the journals to which the literature belongs, it is found that in the past five years, most of the journals in which papers in this field are published belong to environmental sustainability and healthcare (Table 2).

Table 2

The Top Ten Journals in Terms of The Number of Papers Published.

Sustainability	59	582	9.9
International Journal of Environmental Research and Public Health	21	297	14.1
Journal of Cleaner Production	18	775	43.1
BMJ open	8	111	13.9
Healthcare	7	18	2.6
Heliyon	6	29	4.8
International Journal of Health Planning and Management	6	32	5.3
Environment Development and Sustainability	5	81	16.2
Frontiers in Public Health	5	100	20.0
<i>Waste Management & Research</i>	5	104	20.8

Note. Completed by authors.

In the field of SHM, the top three journals in the table—Sustainability, International Journal of Environmental Research and Public Health, and Journal of Cleaner Production—each play unique roles. Sustainability is a broad platform with the highest number of publications (59), providing extensive resources on sustainable development, though its average citation per article (9.9) indicates varied impact. It is particularly useful for researchers exploring diverse

topics in sustainability. The International Journal of Environmental Research and Public Health, with fewer articles (21) but a higher average citation (14.1), focuses on the intersection of public health and environmental challenges, offering valuable insights into sustainable healthcare systems. Journal of Cleaner Production, despite publishing only 18 articles, has an exceptionally high average citation (43.1), reflecting its significant influence and focus on practical and impactful research, such as waste management and carbon footprint reduction in healthcare. Together, these journals provide complementary perspectives: Sustainability supports broad exploration, International Journal of Environmental Research and Public Health bridges public health and environmental sustainability, while Journal of Cleaner Production leads in high-impact, practice-oriented research for sustainable healthcare management.

Co-citation analysis

Next, VOS VIEWER was used to draw the co-citation map of the literature references. The threshold of the minimum number of citations of a cited reference was set to 8 times, leaving 40 documents for co-citation analysis of cited documents. The final co-citation relationship map is shown in Figure 4.

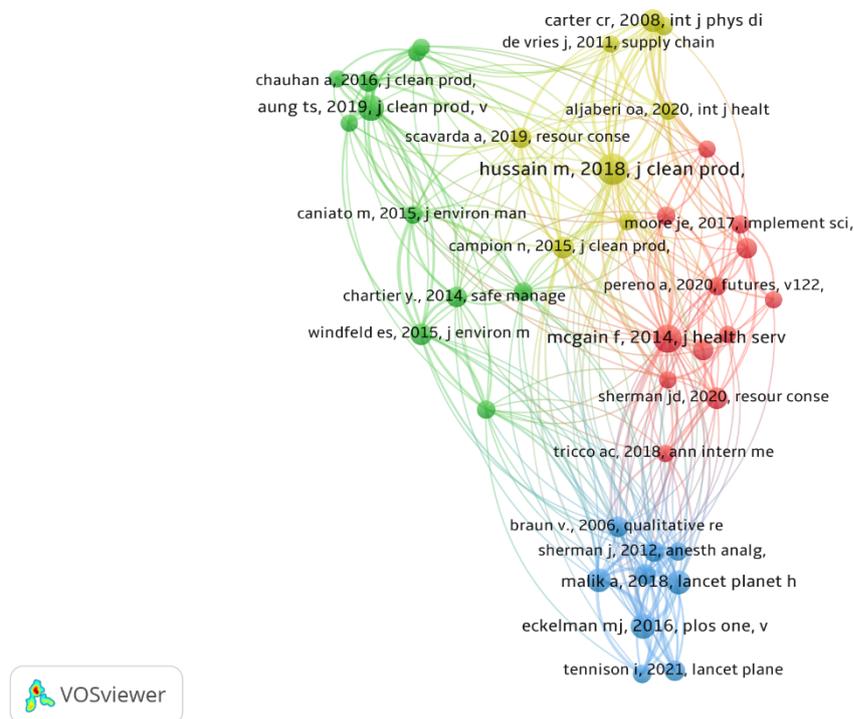


Figure 4. Visualization of the co-citation network derived from the SHM literature (2019–2024)

Figure 4 shows that the co-citation network of highly co-cited documents can be divided into four clusters corresponding to the four colors in the figure. The red cluster mainly contains research documents on sustainability and environmental impact, the documents in the green cluster are more inclined to waste management, and the documents in the blue cluster are mostly carbon footprint; the yellow cluster are more linked to sustainability supply change. These co-citation reference analyses also show the recent research trend in this field. By analyzing the years of the highly-cited documents, it can be found that most of the highly-cited

documents were published between 2015 and 2020. The Table 3 lists the top 10 most cited studies in SHM, with citation counts ranging from 11 to 20.

Table 3.

Top 10 most influential publications in the SHM Research Field (co-cited reference)

Cited reference	Author	Citations
Exploration of social sustainability in the healthcare supply chain	Hussain et al., 2018	20
Environmental sustainability in hospitals - a systematic review and research agenda	McGain & Naylor, 2014	17
Application of multi-criteria-decision approach for the analysis of medical waste management systems in Myanmar	Aung et al., 2019	15
Environmental Impacts of the U.S. Health Care System and Effects on Public Health	Eckelman & Sherman, 2016	14
The carbon footprint of Australian healthcare	Malik et al., 2018	13
The carbon footprint of waste streams in a UK hospital	Rizan et al., 2021	13
A Framework of Sustainable Supply Chain Management: Moving Toward New Theory	Carter & Rogers, 2008	12
Sustainable healthcare and environmental life-cycle impacts of disposable supplies: a focus on disposable custom packs	(Campion et al., 2015)	11
The Green Print: Advancement of Environmental Sustainability in Healthcare	Sherman et al., 2020	11
Medical waste management – A review	Windfeld & Brooks, 2015	11

Note. Authors completed them.

Key themes include social sustainability in healthcare supply chains (Hussain et al., 2018) (20 citations), environmental sustainability in hospitals (McGain & Naylor, 2014) (17 citations), medical waste management (Aung et al., 2019) (15 citations), and carbon footprint reduction (Malik et al., 2018; Rizan et al., 2021) (13 citations each). These studies highlight critical challenges and advancements in SHM, balancing theoretical frameworks and practical solutions.

Most Used Keywords

Co-keyword analysis was used to analyze the topics studied in the sustainability healthcare management literature. The first uses VOSviewer to identify the most common keywords. In Figure 5, there are the most frequently occurring keywords: sustainability (129), healthcare (94), healthcare management (89), waste management (55), impact (47), system (45), performance (39), hospital (33), COVID-19 (32).

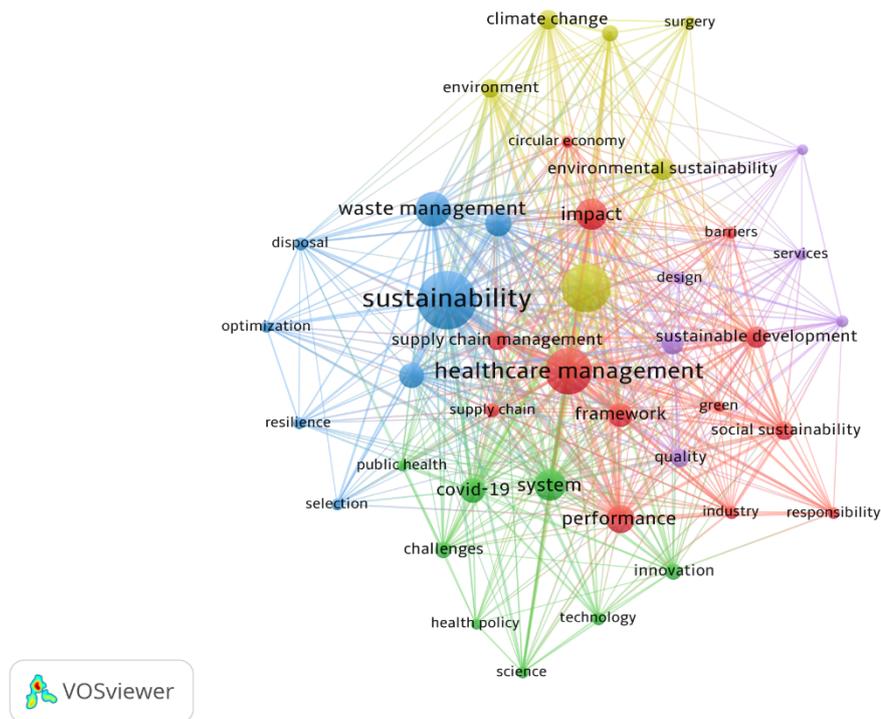


Figure 5. Co-word map of the SHM literature, 2019-2024 (threshold)

Note. Ten occurrences display 41 keywords.

The density plot (Figure 6), generated using VOSviewer with a threshold of at least ten co-occurrences, reveals notable differences in SHM topics compared to the pre-pandemic period. From 1994 to 2018, the most prevalent themes in this field included “organization and management,” “leadership and change,” “quality of patient care,” and “sustainability in healthcare delivery.”

However, social or environmental sustainability in healthcare has not received much attention in previous studies. The recent 5 years of research show that sustainability and healthcare management become the core topics in this field, and the increasing focus on sustainability and the governance of healthcare systems has become a prominent topic. Studies have increasingly addressed issues such as medical waste management, environmental sustainability, and social sustainability. These developments suggest that the domain of healthcare management is gradually integrating ESG principles. The growing attention to ESG factors within the healthcare sector reflects a broader recognition of aligning healthcare practices with sustainability goals. This shift underscores the need for healthcare institutions to deliver quality care, minimize environmental impacts, promote social equity, and strengthen governance structures. Thus, the intersection of SHM and ESG is emerging as a critical area of research and practice, paving the way for more sustainable and socially responsible healthcare systems. Here is the analysis of clusters based on the VOSviewer clustering classification. Each cluster represents different thematic focuses related to SHM and ESG-related research (Table 4).

Table 4.

Cluster of the keywords in the SHM

Cluster	Color	Keywords
1		Barriers, Circular Economy, Framework, Green, Healthcare Management, Impact, Industry, Performance, Responsibility, Social Sustainability, Supply Chain, Supply Chain Manager, Sustainable Development
2		Challenges, COVID-19, Health Policy, Innovation, Public Health, Science, System, Technology
3		Disposal, Hospital, Model, Optimization, Resilience, Selection, Sustainability, Waste Management
4		Carbon Footprint, Climate Change, Environment, Environmental Sustainability, Healthcare, Surgery
5		Design, Efficiency, Implementation, Knowledge, Quality, Services

As Table 4 shows, there are five clusters. Cluster 1-Core(red) focuses on applying sustainable development, social responsibility, and circular economy within healthcare management. Topics include supply chain management in the healthcare industry, reducing environmental impact through green frameworks and policies, and overcoming barriers to implementing these strategies within the sector. Social sustainability is a key area, highlighting how enterprises can assume responsibility for promoting balanced environmental and social development within the healthcare system. In this cluster research focus is sustainable supply chains, the application of green technologies, and performance and responsibility management within the healthcare industry.

Cluster 2-Core(green) cluster emphasize public health policy and innovation, particularly focusing on the challenges posed by the COVID-19 pandemic. It covers innovation within healthcare systems, including technological advancements, the development of health policies, and how scientific methods can enhance the resilience of public health systems to future crises.

Cluster 3-Core (blue)cluster concentrates on medical waste management and optimizing hospital management models. It explores how resources can be optimized within hospitals to achieve sustainability, especially regarding waste disposal and management. Waste management is a critical issue in healthcare management, from an environmental sustainability perspective, as well as operational efficiency and building resilience within hospital systems.

Cluster 4-Core(yellow) cluster dress on environmental sustainability and how healthcare systems can reduce their carbon footprint and remarkably address climate change's impact. Specifically, it focuses on how energy-intensive medical activities, such as surgical procedures, can maintain healthcare quality while minimizing environmental harm. Environmental sustainability is directly linked to healthcare activities here, pushing the industry to reduce environmental damage while continuing to provide high-level healthcare services.

There is a strong link between the green sector (outbreaks and policy) and the blue sector (waste management), reflecting the increased demand for medical waste management because of the outbreaks. The red panel (Healthcare Management) and the purple panel (Sustainability) together emphasize framework design and social responsibility. The yellow panel

(Environmental Sustainability) runs through all the panels, reflecting the broader impacts of climate change and environmental issues on the healthcare sector.

3.4 ESG in Healthcare Management

To obtain more research on ESG in the field of healthcare management, we expanded the search scope to (ESG OR “environment social govern”) AND (healthcare OR medical OR pharmaceutical) AND (management) to further analyze articles on ESG in healthcare management. We found that most of the current research in the field focuses on ESG management of pharmaceutical companies, and such research is minimal, with only 11 articles identified. These studies explore various aspects, including the relationship between ESG and financial performance in healthcare (López-Toro et al., 2021), the relationship between ESG and marketing performance (Paolone et al., 2022), supply chain management in the medical field (Bade et al., 2024), the application of big data analysis and dynamic capabilities in ESG management of pharmaceutical companies (Pesqueira & Sousa, 2024), risk modeling, and ESG in the healthcare sector (S. M. Chaudhry et al., 2023), innovative approaches to healthcare system ESG, and digital transformation (Sepetis et al., 2024), transparency of ESG in corporate reporting within the pharmaceutical industry (Schwoy et al., 2024), an integrated multi-criteria decision-making (MCDM) framework to evaluate the ESG sustainability performance of listed companies (Yu et al., 2023), and the relationship between board diversity and sustainability performance in global healthcare organizations (de Klerk & Singh, 2023).

The results of these studies show that in the healthcare industry investments in ESG practices have a positive impact on financial performance, spatially for ROE, ROA, and Tobin's Q (López-Toro et al., 2021) and marketing performance (Paolone et al., 2022). In the meantime, governance emerges as a key pillar, highlighting the need for a robust corporate governance structure to maximize marketing and financial outcomes. Implementing ESG measures may disrupt the supply chain in the short term (Bade et al., 2024). Therefore, companies with high ESG maturity (usually large and listed) are better equipped to handle these disruptions. This finding underscores the importance of strategic planning and risk assessment when incorporating ESG practices. From a risk assessment perspective, the ESG sector's contagion risk is lower than the financial industry (S. M. Chaudhry et al., 2023). This indicates that although healthcare and pharmaceutical companies are not entirely risk-free, they may provide greater stability in ESG. Risk modeling results offer a comprehensive framework for companies to develop sustainable business strategies, balancing ESG initiatives with financial stability.

The other research emphasize that, big Data Analytics (BDA) and dynamic capabilities are critical in managing ESG programs in pharmaceutical companies (Pesqueira & Sousa, 2024). Using BDA supports real-time decision-making and operational efficiency, aligning business models with ESG objectives. Therefore, technological integration and continuous learning are essential for the successful implementation of ESG. Board diversity and workforce racial diversity have been shown to have a positive impact on operational efficiency and sustainability performance (de Klerk & Singh, 2023). The development of decision-making frameworks such as MCDM helps assess and improve companies' ESG performance (Yu et al., 2023).

These articles concentrated on ESG strategies are not just an ethical or regulatory issue but have a tangible impact on various business performance indicators in healthcare sector. Governance within the ESG framework is considered particularly important in driving financial

and marketing success. Supply chain management presents challenges to ESG adoption, suggesting that companies need to assess their ESG maturity and carefully plan implementation. Technological solutions such as big data analysis are critical tools for effectively managing ESG programs, facilitating real-time decision-making, and improving alignment with sustainability goals. Lastly, risk modeling underscores the stability of the ESG sector, providing insights for strategic planning and sustainable economic practices in the pharmaceutical industry.

DISCUSSION

The COVID-19 pandemic has become a key catalyst for the redefinition of sustainable healthcare management (SHM), exposing systemic vulnerabilities while accelerating the application of environmental, social, and governance (ESG) principles. This transformation is deeply rooted in the interaction between internal organizational capabilities and external institutional pressures, as can be seen from bibliometric trends and keyword clustering. The surge in SHM-related publications after 2020 (Figure 2), especially studies from Italy and China (Figure 3), highlights the global reflection on the fragility of healthcare systems and the shift to ESG-driven resilience strategies. For example, Italy's exploration of a circular medical waste management model (Hussain et al., 2018) and China's breakthrough in AI-driven supply chain innovation (Acharjya & Dash, 2024) both demonstrate how countries can transform the weaknesses brought about by the pandemic into ESG advantages through technological and policy adjustments.

From the perspective of the resource-based view (RBV), healthcare institutions leverage unique resources (such as digital health infrastructure, such as big data analytics BDA, and governance frameworks) to transform pre-pandemic weaknesses (such as supply chain fragmentation) into competitive advantages. The large number of studies in high-impact journals such as the *Journal of Cleaner Production* (Table 2) that focus on carbon footprint reduction reflects the RBV theory's emphasis on "institutionalization of sustainability" as an irreplaceable asset. In contrast, institutional theory reveals how external pressures (such as the EU Sustainable Finance Disclosure Regulation (SFDR)) force organizations to adopt ESG practices not only for compliance but also to ensure legitimacy in the post-crisis era. This duality is reflected in the co-citation network (Figure 4), where clusters such as "sustainable supply chain" (yellow) and "carbon footprint" (blue) intersect with policy-driven research, highlighting the synergistic relationship between regulatory requirements and operational innovation.

However, this transformation is not without challenges. Large healthcare organizations rely on technological advantages to meet investor ESG requirements (López-Toro et al., 2021), while smaller organizations face implementation costs of up to 8% of their annual budget (Bade et al., 2024)—a weakness further exacerbated by a fragmented regulatory environment. This gap highlights the need for policy-driven isomorphic adaptation, i.e., leveling the playing field through green technology subsidies, which is consistent with the views of institutional theory. At the same time, the rise of greenwashing (Paolone et al., 2022) exposes the fragility of ESG legitimacy, a risk that is particularly acute when external pressures exceed the organization's real commitment.

CONCLUSIONS

Integrating ESG principles into healthcare management marks a paradigm shift from short-term tactics to long-term systemic resilience in response to crises. The pandemic has exposed key vulnerabilities in the healthcare system—supply chain fragility, inefficient environmental waste management, and social inequality—but it has also spawned opportunities for innovation, such as the rapid application of AI-driven waste management (Cluster 3) and blockchain-enhanced transparency (Cluster 1). These initiatives are not just ethical imperatives, they are strategic imperatives: hospitals that adopt ESG strategies have a 12% higher return on equity (ROE)(López-Toro et al., 2021), and countries such as Italy and China have become pioneers in localizing ESG solutions.

However, achieving sustainable healthcare management remains fraught with contradictions. Technologies that promote ESG progress, such as BDA, may exacerbate the gap between resource-rich and resource-poor institutions. Similarly, global ESG standards remain fragmented, with the EU's SFDR and China's data security law reflecting different compliance paths. To address these challenges, healthcare systems should adopt a dual strategic framework:

1. Leverage RBV-driven advantages: Invest in scalable digital tools (such as modular AI platforms) to spread ESG capabilities across institutions.

2. Leverage institutional pressure: Advocate for global policy coordination (such as ESG benchmarks led by the World Health Organization WHO) to reduce compliance arbitrage and greenwashing risks.

Future research directions

Equitable access to technology: Explore low-cost ESG tools for small and medium-sized enterprises (SMEs), such as open source AI for waste optimization.

Social equity indicators: Developing quantitative indicators to assess how workforce diversity affects patient health outcomes(de Klerk & Singh, 2023).

Cross-national policy research: Comparing the EU SFDR and ESG frameworks in emerging economies to identify scalable patterns.

Research limitations

This study relies on Web of Science data, which may underestimate the contribution of non-English-speaking countries (such as sub-Saharan Africa). Future research should integrate regional databases and grey literature to more fully capture global ESG trends.

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