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Developing a Conceptual Framework for Green Healthcare Initiatives: A Systematic Literature Review and Future Research Agenda

Abstract

In the face of rising global issues, the surge of devotion to green and sustainable healthcare highlights how health systems heal individuals while nurturing the planet and society. This study aims to comprehensively analyze the current literature on green healthcare initiatives (GHI) in healthcare organizations. Additionally, it aims to identify any deficiencies in the available research and provide potential areas for future investigation. A systematic review of 85 research publications obtained through Scopus and Web of Science (WoS) databases was conducted using a well-defined research process known as SPAR-4 SLR protocol. The study employed descriptive analysis and the TCCM (Theory, Context, Characteristics, and Methods) approach to classify and evaluate the research and provide fundamental insights into the literature. This study also conducted a thematic analysis to construct a conceptual framework for GHI. The study identified that incorporating theories like the resource-based view, natural-resource-based view (NRBV), knowledge-based view, and the impact of leadership commitment to sustainability on the execution of green initiatives within healthcare systems and the methods to embed sustainability within healthcare culture, establishing it as a fundamental value rather than a peripheral initiative into GHI is critical for advancing and expanding the healthcare industry. The present research has substantial significance for healthcare stakeholders by providing them with a comprehensive understanding of the green healthcare concept and the role of GHI in the healthcare setting. Furthermore, this will offer readers and scholars a basis for further study on GHI.

Keywords: sustainable healthcare, green healthcare initiatives, technological advancements, SPAR-4 protocol, thematic and content analysis, green healthcare.

1. Introduction

Access to and affordability of healthcare services continue to be contemporary global issues since the number of individuals requiring healthcare services is growing despite the scarcity of resources in each country; the growth has been continuous over time (Akinwale et al., 2023). As medical and healthcare facilities provide healthcare at a considerable energy cost and carbon emission, the medical industry becomes a high-density carbon emission source, indirectly harming the environment and public health (Lee et al., 2023). Furthermore, the healthcare sector significantly influences the environment by consuming resources, producing waste, and contributing to pollution (Sijm-Eeken et al., 2023). The third objective among 17 sustainable development goals (SDG), i.e., "ensuring healthy living and promoting well-being for all ages," specifically pertains to the healthcare industry. However, other SDGs indicators encompass a range of areas, including mitigation of gender inequality and hunger, availability of hygiene water and sanitation, availability of inexpensive energy, development of eco-friendly communities, efforts towards climate change action, establishment of justice, promotion of peace, and creation of higher institutions are indirectly applied to the healthcare sector (Berniak-Wozny et al., 2023). Paradoxically, the industry that seeks to safeguard public health is also the primary source of environmental contaminants that harm human health. Consequently, organizations in the healthcare industry now prioritize sustainability as an essential objective.

Healthcare sectors act as functionality in the ecosystem, exhibit a notable lack of economic efficiency, and are simultaneously intertwined with ethical considerations about society and nature (Engelseth et al., 2021). Given today's growing ecological issues and energy difficulties,

becoming green is crucial at all levels to meet sustainable development (Zhan et al., 2022). Scientific research is crucial in this context as it elucidates the relationships between the impacts of climate change and environmental sustainability. Additionally, it is beneficial to highlight the required steps and promote optimal methods that can expedite the implementation of measures to achieve a more environmentally friendly and carbon-neutral healthcare sector (Berniak-Wozny et al., 2023).

While much of the research has been conducted on sustainability in the health sector, very few researchers focus on the operational perspective of environmental sustainability in the green healthcare domain. We perform a systematic literature review (from now on SLR) to address the above gap on the role of "green healthcare initiatives" (from now on GHI) in the healthcare industry from an operations management standpoint. This SLR provides an in-depth comprehension of the concept of "green healthcare" (from now on GH) and develops a conceptual framework for GHI in the healthcare sector using thematic analysis of existing literature and applying recent developments in GH practices and trends. In order to achieve the aims above, we have formulated the following study questions:

1. *What is our present understanding of green healthcare?*
2. *What role could green healthcare initiatives play in the growth and development of the healthcare industry?*

Our study presents three significant and innovative contributions to the domain of GH. First, we expand upon existing green and sustainable healthcare research analyses by utilizing Scopus and WoS databases to investigate scholarly work in social science, environmental science, operations management, green sustainable technologies, and supply chain management. By incorporating a more comprehensive range of journals from adjacent disciplines, the outcome is a comprehensive understanding of GHI within healthcare management, derived from a thorough examination of 85 articles published since 2011. Second, we developed a conceptual framework for GHI by conducting a thematic analysis of existing literature and drawing on contemporary trends and developments in the healthcare domain. Specifically, we expand the concept of GH by proposing innovative strategies such as GHI towards an environmentally friendly healthcare setting. Third, our research has led us to identify those technological innovations, like deep learning, artificial intelligence (AI), industry 5.0, and Blockchain, that play a vital role in the growth and advancement of the healthcare industry and are acknowledged as crucial assets. We strongly believe that incorporating the aforementioned technological breakthroughs into the healthcare sector will provide significant chances for trends in the global health arena.

This SLR has the following structure. The theoretical foundations and methodology will be covered in the ensuing parts. Subsequently, a quantitative content analysis centered on specific articles about green healthcare practices will be conducted, followed by a qualitative thematic analysis of literature obtained through study identification, screening, and selection and followed by discussions of research questions of the study while offering directions for further studies in the GH domain. Lastly, conclusions will be drawn by pointing out gaps in the literature and addressing the study's implications.

3. Theoretical Foundation

The current ecological challenges and energy crises require adopting GH practices for sustainable development; the healthcare industry is no exception. Healthcare sectors use much energy, which raises operational costs, reduces competitiveness, and has an adverse environmental effect (De Oliveira et al., 2021). Hence, a green philosophy is essential to meet

this crisis in the healthcare industry. In this context, we introduced a conceptual framework of GHI using the notion of GH and themes deduced from our in-depth literature review, along with recent trends and practices that have evolved in the healthcare domain. GH is a research field that explicitly examines the adoption of sustainable methods in healthcare institutions and organizations (Dion et al., 2023). GHI is a practice that aids in minimizing adverse environmental impacts and reducing waste and operating expenses while raising the value of healthcare facilities and consumer knowledge of sustainability (Lee & Lee, 2022). Regarding theoretical contribution, the objective is to surpass the mere clarification of sustainable practices. Instead, to establish and elaborate a GHI framework that will significantly impact the healthcare industry regarding technological advancement, environmental sustainability, and public health. To effectively address current global challenges such as an aging population, increased demand for healthcare, rapid technological advancements, workforce shortages, and limited budgets, healthcare facilities must prioritize waste reduction, operational efficiency, and market competitiveness. Our research provided sufficient arguments to encourage GHI in the healthcare sector to address the aforementioned global concerns.

3. Methodology

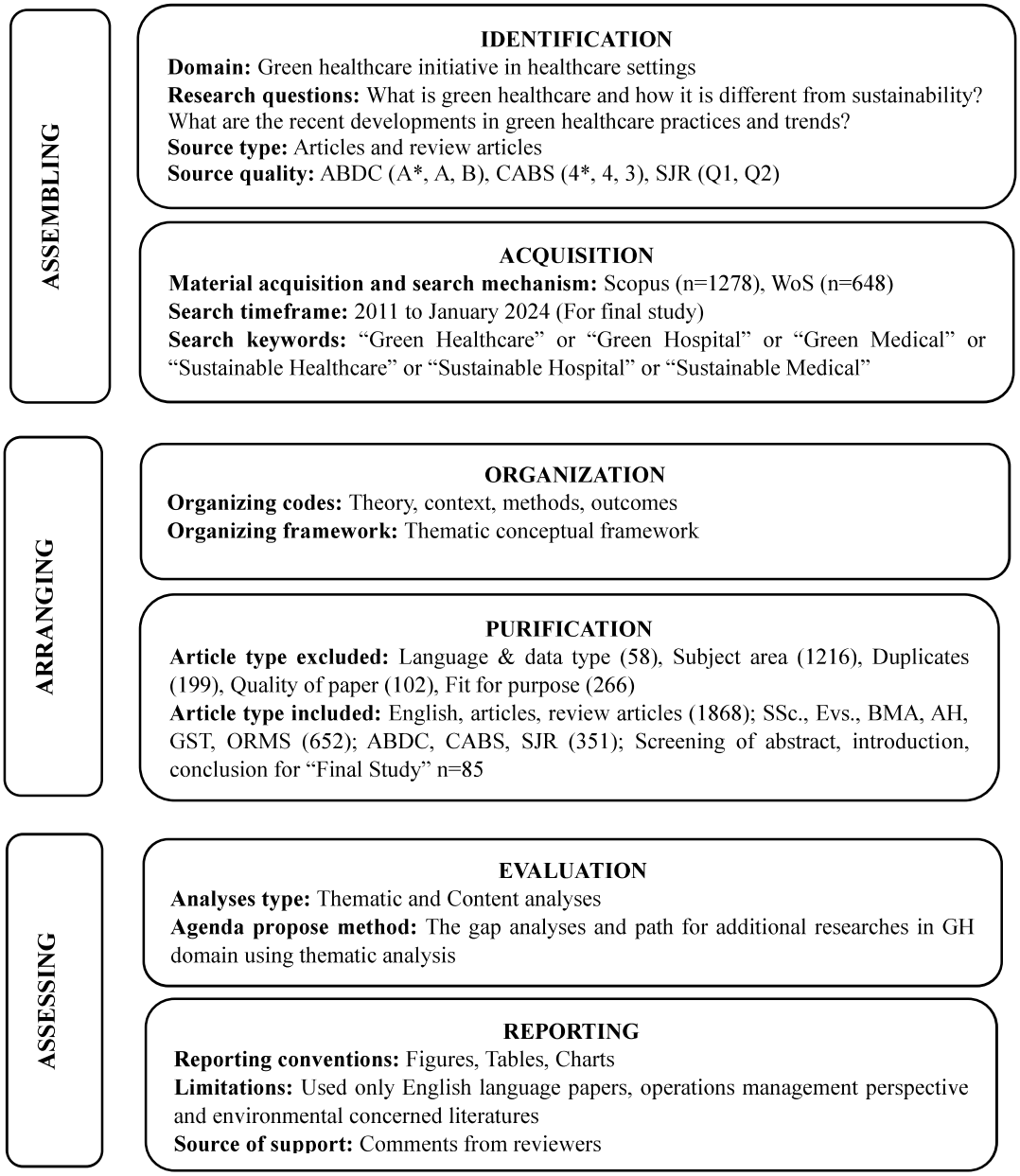
3.1 Systematic literature review

The systematic review is the most valuable and scientific of the many available reviews (such as post-published and critical reviews) as long as they are well-justified and thoroughly carried out (Paul et al., 2021). Building upon Paul's groundbreaking SPAR-4-SLR technique, we conducted a thorough and transparent systematic review. This review consisted of three distinct stages: firstly, the process of assembling, which involved identifying and obtaining relevant literature to be reviewed; secondly, the process of arranging, which entailed organizing and refining the literature; and thirdly, the process of assessing; which involved analyzing and writing a report. The method of SPAR-4 in SLR (Figure 1) promotes the sharing of cutting-edge knowledge and encourages the development of research agendas to contribute to review analyses (Rahat et al., 2023). The approach follows logical and practical reasoning and provides clarity through analyses conducted at various levels and sub-levels.

3.1.1 Assembling

This is the first step of the SPAR-4 SLR process. This defines the research problem, source quality and type, and gathering the research method, such as the acquisition of materials, the duration of the search, the search terms, and the first collection of articles found through the search articles for evaluation. This review's primary focus in terms of identification was the recent developments and trends in GH practices from an operations management point of view. We limited our choice of papers and peer-reviewed articles to those published in English-language journals and those utilized keywords identified throughout the literature scoping phase. We used WoS and Scopus databases to assess the importance of the various keywords. Both databases have relevant papers about the literature on GH and are regarded as trustworthy databases for SLRs and can help identify various articles (Strand et al., 2024). We also addressed some research questions to justify the objectives of this literature review, which will be discussed later. We did not restrict the time frame of search articles to get clarity on the number of articles published in our research domain, i.e., GH. However, we restricted our selected literature to the quality of journals: Academic Journal Guide (AJG), Australian Business Deans Council (ABDC), and Scientific Journal Rankings (SJR) (Paul et al., 2021).

Figure 1: SPAR-4 protocol

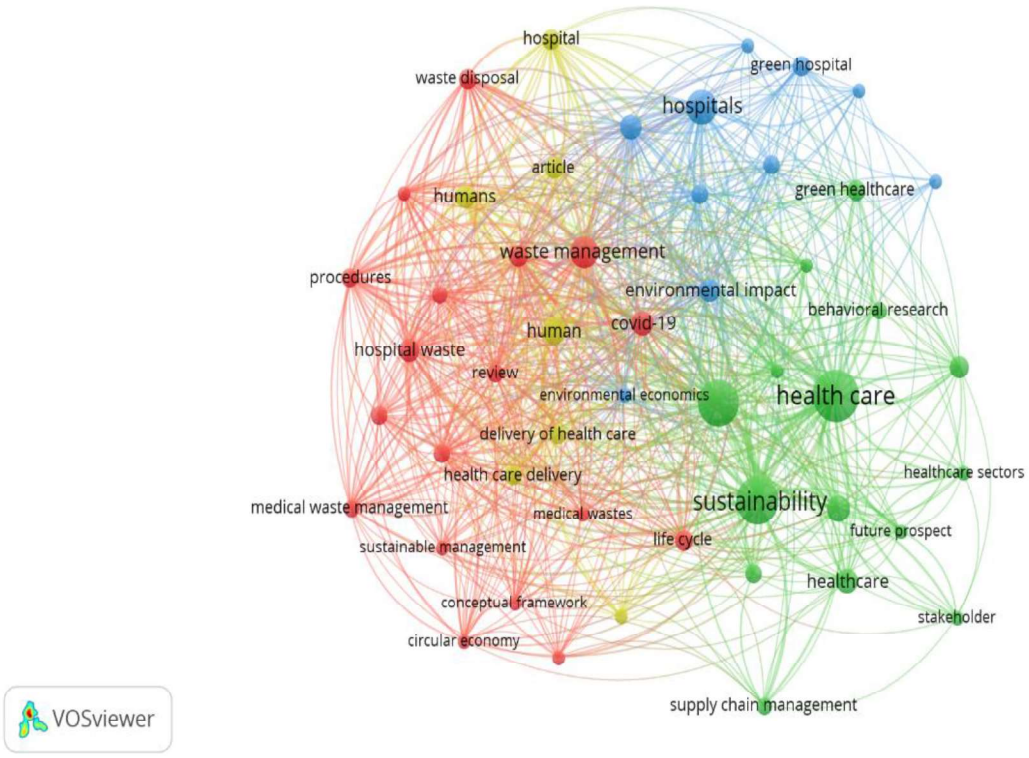


Source: adapted from Paul et al. (2021).

In the section on acquisition, we mentioned the period taken in this research, i.e., from January 2011 to January 2024, for the final study after considering study identification, screening, and selection process (Zahoor et al., 2020). Figure 2 illustrates the keyword co-occurrence analysis conducted using VOS viewer software. Keyword co-occurrence analysis identifies nascent research themes within a specific domain and encompasses additional areas for keyword exploration (Kevork et al., 2009). In Figure 2, the bolded keywords represent the primary keyword, encompassing various significant keywords utilized in previous studies. The study obtained 4 clusters containing 50 keywords. The study was organized to satisfy search demands using phrases, synonyms, related terms, acronyms, and spelling variations. The search terms that might be utilized were determined by reviewing the paper abstracts and keywords. Review papers on related subjects were also consulted to verify the terminology employed in green healthcare and sustainability in healthcare. We used iterated keyword formulation, created

through refining and enriching with search phrases to create the final keywords. Whenever a different term related to green and sustainable healthcare was found, it was combined with the original search string. Hence, the query strings were "Green Healthcare*" OR "Green Hospital*" OR "Green Medical*" OR "Sustainable Healthcare*" OR "Sustainable Hospital*" OR "Sustainable Medical*" in order to assemble the related articles fully. In the first search, we got 1926 articles, including 1278 from Scopus and 648 from WoS databases. The search was conducted without any temporal constraints to obtain a comprehensive chronological perspective (Rahat et al., 2023).

Figure 2: Keyword co-occurrence analysis conducted using VOS viewer software



Source: Authors' own

3.1.2 Arranging

This is the next step of SPAR-4 technology, in which articles are coded and subsequently sorted according to relevance as part of the organization. The data collected through peer-reviewed articles were coded by the publication patterns, theories undertaken, methods they used, themes, and contexts of the articles. We proposed a thematic conceptual framework to organize all the themes, contexts, and theories and briefly explain GH taking (Li, Y. et al., 2021) as a base framework.

Purification is the second sub-stage of the arranging step of the SPAR-4 protocol in which the reason for an article's inclusion or exclusion criteria is justified. After acquiring articles through the combined search string of six keywords applied in two databases, 1926 articles were collected. After that, using limitations like language (i.e., English) and data type (i.e., articles and review articles), the articles decrease to 1868 (Zahoor et al., 2020). We are then using the subject area restrictions viz. Social Science (SSc), Environmental Science (Evs), Business Management Accounting (BMA), Arts & Humanities (AH), Green technology et al., and Operations Research Management Science, which are in line with our research domain GH,

the articles reduce to 652. After removing duplicates (199 articles) using the Zotero application, we narrowed the articles to 351 by screening the articles against quality criteria. We took the quality of journals like ABDC (A*, A, B), AJG (4*, 4, 3), and SJR (Q1, Q2) papers in our SLR for their pertinence, applicability, and attributive publications. Our final study sample is then reduced to 85 by screening against fit-for-purpose criteria, which entails a careful examination of the abstract, introduction, and conclusion on the GH domain.

3.1.3 Assessing

This is the last step of the SPAR-4 method, which involves evaluating and writing a report on analyzed data. The evaluation section entails the collection of articles that are evaluated using some analysis method. In contrast, all the analyzed data is reported using figures, tables, facts, and themes in the reporting section. This study first conducted a descriptive analysis and then a qualitative thematic analysis to evaluate the collected literature. The study also introduced a conceptual framework of GHI in the healthcare context using an inductive approach, i.e., themes derived from the study to give an in-depth idea about the concept of GH. Using thematic analysis and the TCCM (Theory, Characteristics, Context, Methodology) approach, this study also addresses future research areas in the GH domain. We utilized the TCCM framework proposed by Paul and Rosado-Serrano (2019) to organize the research response, as the framework guarantees the integrity of SLR and provides a credible, transparent assessment (Billore et al., 2021).

4. Results and Findings

To determine the present status of existing literature on the GH domain, it is essential to conduct a thematic analysis using the themes discussed in the previously published literature (Thakur et al., 2015). Hence, the analysis is conducted as follows. First, the session will cover a descriptive analysis followed by the TCCM approach to literature reviews and thematic analysis.

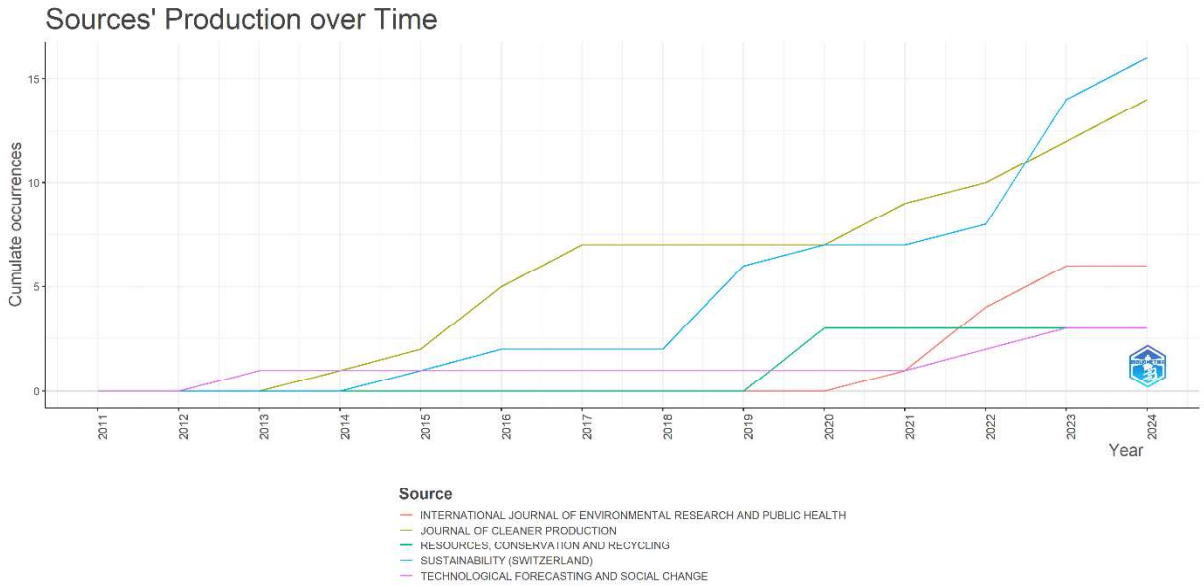
4.1 Descriptive Statistics

Descriptive statistics delineate the characteristics of the gathered data, including the number of publications per journal and per annum, as well as the methodologies addressed, among other factors (Dobrzykowski et al., 2014). The descriptives received through meticulous analysis of pertinent literature are presented as follows.

4.1.1 Articles publication per year

The number of publications about GH and sustainable healthcare published each year since 2011 is displayed in Figure 3. Between 2011 and 2016, not many studies were published, but since then, the trend has been upward except for 2018. Again, the upward trend continues till 2024, as the article extracts. The fact that nearly half of all articles were published in 2022 and 2023 indicates growing research traction supporting the GH domain. Since the extraction of articles was done in February 2024, it may be possible that further researches about GH in healthcare settings were released in the same year. Hence, there was a sudden decline that year, and the number of published articles does not accurately reflect this. The data trend indicates that scholars are paying attention to “Green and Sustainable healthcare” and advancing the study agenda.

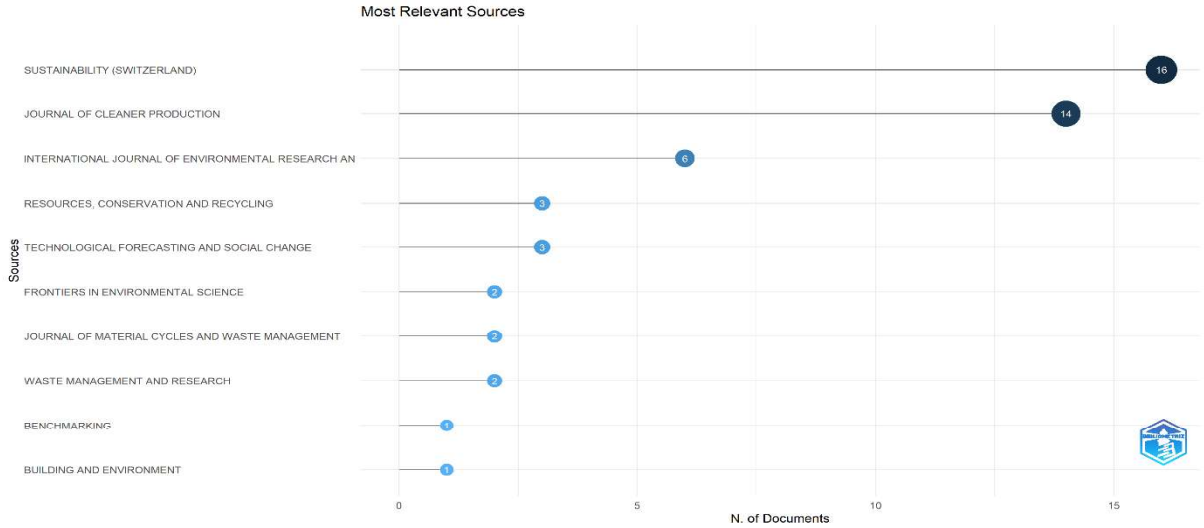
Figure 3: Sources' production over time



Source: Authors' own

On the other hand, the number of articles produced over time with the sources of journals is shown in Figure 4. The Sustainability (Switzerland) topped the list with 16 articles, followed by 14 articles from the Journal of Cleaner Production and six from the International Journal of Cleaner Production. Furthermore, journals like Resource, Conservation and Recycling & Technological Forecasting and Social Change are ranked in fourth and fifth places, with three articles each published over time. At least 1 article published from Benchmarking & Building and Environment Journals is ranked last.

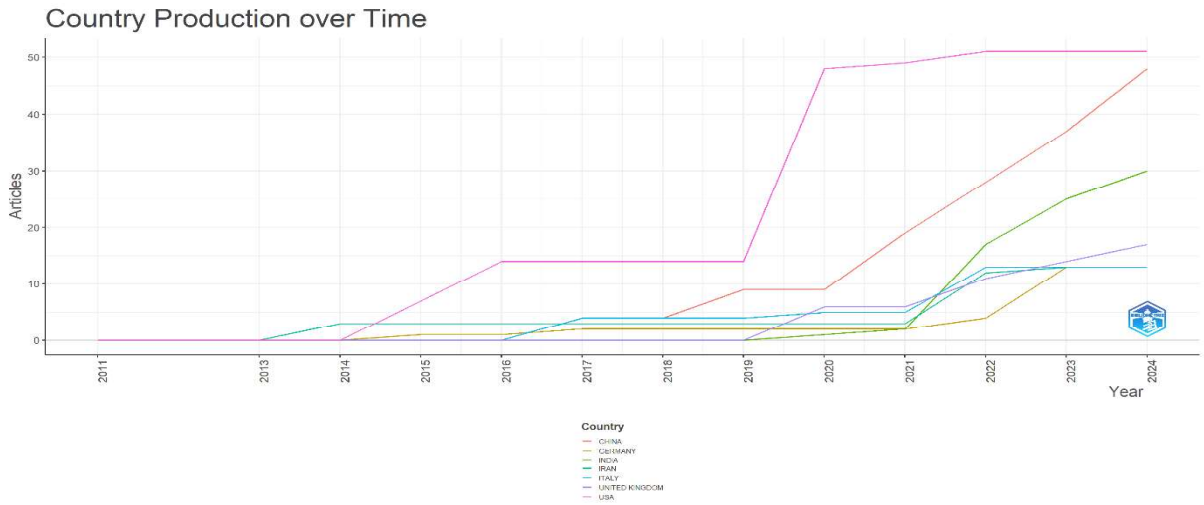
Figure 4: Most Relevance Sources



Source: Authors' own

4.1.2 Country/Region: The index of nations that contribute the most to this topic is one of the fundamental requirements for quantitative analysis. Figure 5 lists the top ten nations in the world as per the papers published in the GH and SH domains.

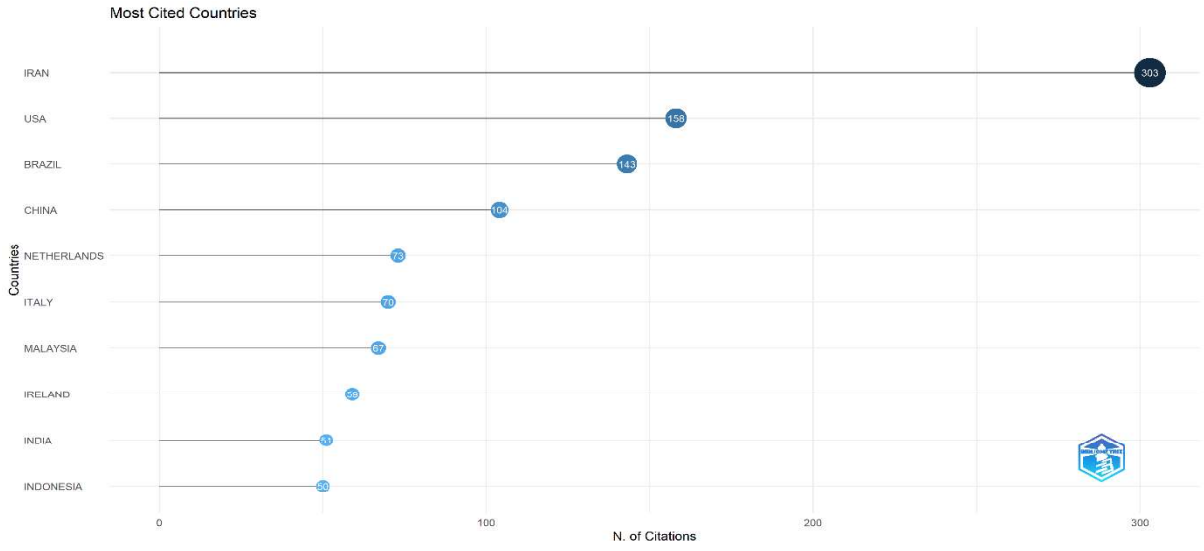
Figure 5: Country-wise production over time



Source: Authors' own

According to their nations, the corresponding author was the basis for selecting countries for multi-author publications. Researchers from China, India, Iran, and other Asian countries, including Saudi Arabia and Indonesia, were the most productive in the searched domain. The USA was the top nation from the American continent, followed by Brazil. Italy, the Netherlands, and the UK were the top publishing countries in Europe. Meanwhile, Iran, an Asian nation, led the list with the highest number of citations, followed by the USA, Brazil, and China. Indonesia and India are some of the countries with the lowest number of citations. [see Figure 6]

Figure 6: Most cited countries



Source: Authors' own

4.2 TCCM Approach

To analyze the kinds of literature previously published, we used the TCCM (Theory, characteristics, context, methodology) framework (Paul et al., 2019), as this framework provides a legitimate, transparent opinion and guarantees the robustness of SLR (Billore et al., 2021).

4.2.1 Theories used in the green healthcare domain

As per Walker et al. (2015), the "Operations and Supply Chain Management" research area needs a robust and unified theoretical foundation, typically relying on notions borrowed from different fields. Examining the theoretical foundations of the Green Healthcare field is thus intriguing. Out of the total number of publications, only 35 articles utilized theories to support their arguments, whereas 50 articles lacked any theoretical perspectives. The absence of a theoretical foundation can be attributed, at least in part, to the significant number of legal publications found throughout the search. Fuzzy set theory is the most commonly employed theory in the healthcare context. For example, it appears in eight articles (Thakur, V. 2021; Li, H. et al., 2021). Subsequently, the resource-based view theory is discussed in four articles viz. (Dixit et al., 2024; Akinwale et al., 2023). The theories of planned behavior and dynamic capability theory have been employed on three occasions, for example (Lu et al., 2024; Lee et al., 2023; Rahat et al., 2023; Issa et al., 2022, respectively). Followed stakeholder theory (Punnakitikasem et al., 2019; Pishvaee et al., 2014) and grounded theory (Priyadarshini et al., 2023; Dion et al., 2023) have each been featured in two papers. Additional theories mentioned once in the study include innovation theory, business model theory, complexity theory, health behavior theory, information theory, institution theory, supply chain theory, knowledge management theory, and technology acceptance theory.

4.2.2 Industry of the research

The categories of Health Care Science and Services, Environmental Sciences, Environmental Studies, Green Sustainable Technologies, Social Sciences, Operations Research Management, and Sciences were the ones that were most frequently mentioned in the publications on green and sustainable healthcare (e.g., Zahoor et al., 2020). Professional healthcare fields like bio-medicals are big fans of sustainable and green papers as they are directly involved in the environmental ecosystem. Given that everything begins with attitude, knowledge, and abilities, including themes related to GHI in educational institutions might be interpreted as a positive indicator.

4.2.3 Characteristics

The majority of the literature emphasizes waste management (Yang et al., 2024; Kokkinos et al., 2024; Zarrinpoor et al., 2022; Khosla et al., 2022; Lattanzio et al., 2022; Lee & Lee, 2022; Mmereki et al., 2015), sustainable development (Li et al., 2021; Karamat et al., 2019; Zadeh et al., 2016; Campion et al., 2015; Weisz et al., 2011), and the environmental dimensions of sustainability within the hospital sector, driven by globalization and global climate change challenges. Other literature emphasizes the adaptability of sustainable practices in the healthcare sector, including organizational commitment and leadership behavior (Yusuf et al., 2024), telemedicine adoption (Lu et al., 2024; Altalbe et al., 2023; Naseer et al., 2023), technological innovation and healthcare performance (Akinwale et al., 2023), additive manufacturing (Priyadarshini et al., 2023), artificial intelligence (Vishwakarma et al., 2023), blockchain-based technologies (Bamakan et al., 2022), and green intellectual capital (Issa et al., 2023).

4.2.4 Methods used by researchers

Due to modernization and digitalization in the global era, the healthcare sectors need to reform various methods needed to evolve healthcare. With this context there are various methods has been proposed by researchers viz. environmental lifecycle assessment and analysis (Dihan et al., 2023; Shabani et al., 2023; Aini et al., 2023; Campion et al., 2015); IF-DEMATEL, IF-

MCDM and TOPSIS, CORPAS methodologies (Li, et al., 2021; Kokkinos et al., 2023; Dixit et al., 2024); smart PLS, CFA and PLS-SEM (Lu, et al., 2024; Issa et al., 2022; Lee et al., 2023); Delphi methods (Tushar et al., 2023: Kanokphanvanich et al., 2023; Alhaij et al., 2023); DEA and big data analytics (Azadi et al., 2023; Watrobski et al., 2023; Ghoushchi et al., 2022; Leksono et al., 2019); DRL and MICMAC analysis (Naseer et al., 2023; Verma et al., 2023; Thakur, 2021); AHP (Watrobski et al., 2023; Zarrinpoor, N. 2022; Hossain et al., 2021); sensitivity analyses (Negarandeh et al., 2021; Alotaibi et al., Thakur, 2021); cost-benefit analysis (Dion et al., 2023; Pereno et al., 2020); simulation analysis (Zhan et al., 2022; Kumar et al., 2014) methods. Moreover, various bibliometric, narrative, scoping, and systematic literature reviews in the healthcare domain have been used for meta-analysis (Lattanzio et al., 2022), thematic and content analysis (Sallwa, 2023; Sijm-Eeken et al., 2023; Priyadarshini et al., 2023; Ertz et al., 2020); use of PRISMA and SPAR-4 protocol (Rahat et al., 2023; Punnakitikasem et al., 2019; Duque-Uribe et al., 2019); and bibliometric analyses (Bamakan et al., 2022).

4.3 Thematic Analysis

Given the present circumstances, with climate change and viruses like COVID-19 threatening the environment and public health, the healthcare industry must invest more in programs that safeguard the environment. This can be achieved by adopting GH practices to minimize waste generation. Hence, based on the notion of GH and an in-depth review of existing literature, a conceptual framework of GHI (Figure 7) in the healthcare industry is developed using an inductive approach from themes presented in (Table 1) and the use of current trends and practices in the field of GH. The healthcare organization is divided into three tiers: primary operations of healthcare, auxiliary services of healthcare, and the healthcare environment according to their respective functions in a healthcare setting. The themes were elaborate as follows. The first tier represents the primary operations themes of the healthcare sector, including medical services and e-healthcare. The second tier, i.e., auxiliary services and management themes, encompasses the services and systems that facilitate the operations and maintenance of facilities, serving as a fundamental component of the primary healthcare operations. The third and final tier embodying healthcare environment themes pertains to the practices that function as a collection of forces surrounding strategic human factors, which impact the execution of primary and auxiliary healthcare services hierarchically. The thematic analysis helped us identify relevant issues and interpret the findings, which are expounded on in the following subsections.

Table 1: The subthemes encompassing the GHI

Themes/Sub-themes	No. of Articles	Exemplary researches
Primary Operations:		
Green medical care	3	Tushar et al. (2023); Hamed et al. (2017)
Environmentally friendly products	6	Lu et al. (2024); Hossain et al. (2021)
Eco-friendly medical devices	8	Priyadarshini et al. (2023); Altalbe et al. (2023)
e-healthcare	11	Chauhan et al. (2022); Wu, Q. (2021)
Auxiliary services & management:		
Green, flexible healthcare building	9	Zhan et al. (2022)
Resource conservation (water & energy)	6	Dion et al. (2023); Haeusser et al. (2023)
Green Technology and Innovation	18	Akinwale et al. (2023); Dion et al. (2023); De Oliveira et al. (2021)
Sustainable waste management	18	Lattanzio et al. (2022); Lee & Lee (2022)

Healthcare Environment:		
Sustainable/Green supply chain management	12	Hossain et al. (2021); Pishvaee et al. (2014)
Stakeholder's behavior and awareness	12	Yusuf et al. (2024); Vishwakarma et al. (2022)
Green Intellectual Capital	4	Issa et al. (2022); Cavicchi et al. (2017)
Green Healthcare Strategies	27	AlDulijand et al. (2023); Li, Y. et al. (2021)
Healthcare information systems (organizational, environmental)	18	Wu, Q. (2021); Zahid et al. (2921); Karamat et al. (2019)

Source: Author's own

4.3.1 Themes Derived from Primary Operations Aspect

4.3.1.1 Green Medical Care/Services

Healthcare service operations encompass many processes and functions designed to ensure efficient and effective delivery of medical care to patients. From an ecological perspective, healthcare can be considered an economic production influenced by the environment (Engelseth et al., 2021). As per the notion of the triple bottom line, health sectors should use sustainable service management practices that involve reducing the cost of treatment while improving the effectiveness of the system, ensuring fairer treatment for patients, and minimizing the adverse environmental effects of healthcare operations (Tushar et al., 2023). Patients meticulously seek comprehensive information regarding their expectations before choosing a healthcare service provider. To meet these expectations and ensure patient well-being, healthcare service providers should have a deeper understanding of the significance of sustainable medical care (Hamed et al., 2017). Hence, green medical care can achieve sustainable development of healthcare industries.

4.3.1.2 Environmentally Friendly Products

Research on environmentally friendly products typically focuses on pharmaceuticals, uniforms, and customized packaging. The life cycle assessment method, a crucial technique for assessing medicinal products and their environmental sustainability, can be used to evaluate the carbon and greenhouse gas emissions in pharmaceutical items (Dihan et al.; Shabani et al.; Aini et al., 2023; Campion et al., 2015). Environmental operations management (EOM), proposed by Gupta and Sharma (1996), can be considered a strategic aspect of operations management as it emphasizes the design of both products and processes. Telemedicine effectively lowers carbon emissions in the health sector by minimizing the necessity for travel (Lu W. et al., 2024). Sustainability in products or services is attained by practicing eco-efficiency, which involves effectively managing resources (Hossain et al., 2021).

4.3.1.3 Eco-friendly Medical Devices

Additive manufacturing (AM), a technology associated with Industry 4.0, is consistently transforming the healthcare sector for the betterment of society. Using this technology, the reduction in lead times, waste, and the cost involved in the production of medical devices can be possible (Priyadarshini et al., 2023). Additionally, using AM, the manufacture of intricate and customized eco-friendly medical equipment can be attainable, which was previously unattainable using conventional techniques, leading to enhanced patient results. Eco-friendly medical devices such as an Internet of Things (IoT)-enabled telepresence robot is highly desirable in various healthcare and industrial sectors where direct contact with patients is not feasible. It offers many advantages, including sustainability, improved welfare, cost-effectiveness, ease of use, and adaptability (Altalbe et al., 2023). Telemedicine is such an example that has significantly contributed to the goal of GH by minimizing patient travel distances (Qiao et al., 2023).

4.3.1.4 e-Healthcare

e-Healthcare services employ ICT platforms (Information and Communication Technology platforms) and electric tools to assist healthcare personnel (Chauhan et al., 2022). As a result, it decreases unnecessary patient trips to hospitals, dramatically reducing physical contact and the time patients spend in person with doctors and other healthcare personnel. AI is being used to positively impact the healthcare sector in unprecedented ways. Integrating medical equipment management and IoT technology can enhance hospital equipment management's efficiency, ease, and intelligence (Wu, Q. 2021).

4.3.2 Themes Derived from Auxiliary Services & Management Aspect

4.3.2.1 Green & Flexible Healthcare Building

In light of the escalating ecological issues and energy crises, greening practices have become imperative for sustainable development. The construction industry must implement the green idea for sustainable development (Zhan et al., 2022). A green building aims to achieve higher levels of sustainability by actively decreasing energy use, minimizing carbon emissions, and enhancing internal comfort. As per Hamed et al. (2017), evidence-based design (EBD) is a widely accepted design approach for healthcare buildings that prioritizes favorable outcomes, satisfaction, and well-being of healthcare personnel and stakeholders. The LEED certification, a rating system explicitly designed for environmentally friendly buildings, makes healthcare buildings greener and more flexible (Golbazi et al., 2020). It enhances the healthier and sustainable approach to building construction, maintenance, and operations design. For evaluating the performance of buildings, BIM is a highly effective approach that connects project technology, integrating information and project management teams to facilitate secure, efficient methods of transferring and storing data (Zhan et al., 2022).

4.3.2.2 Resource Conservation (Energy & Water)

Population growth, economic expansion, and unsustainable consumption drive the increasing global focus on energy. Healthcare, in particular, consumes a significant amount of energy, leading to higher operational costs and negative environmental impacts while reducing competitiveness (Dion et al., 2023; De Oliveira et al., 2021). Hence, there is a need for the GH approach to healthcare delivery to increase energy efficiency and provide more sustainable healthcare facilities. Building facility management is crucial for enhancing energy efficiency in hospitals. This entails the process of creating, constructing, renovating, and upkeeping facilities, with a specific emphasis on optimizing energy efficiency. The primary emphasis is on incorporating sustainable practices and low or zero-carbon technology to decrease the need for artificial air conditioning and lighting (Dion et al., 2023; De Oliveira et al., 2021). Alotaibi et al. (2019) compared renewable and conventional energy and discovered that the most effective approach would reduce carbon emissions by approximately 84% and diesel consumption by around 81% (Alotaibi et al., 2019). Waste-to-energy is a crucial energy source that will effectively decrease future CO_2 emissions—utilizing biomass as an energy source offers significant socio-economic benefits by enabling the conversion of hospital waste into energy without any loss (Alotaibi et al., 2019).

In one way, medications are vital for human well-being. In contrast, in another way, they affect the aquatic and terrestrial environment when they are used by patients and released into wastewater through excretion. Moermond et al. (2022) proposed a GREENER approach to identify and address significant environmental factors. By using this technology, the impact of pharmaceuticals on the environment might be decreased. The chemicals include medicinal residues, disinfecting agents, viruses, and pathogenic substances in hospital wastewater (Haeusser et al., 2023). For these reasons, the urgency of managing hospital wastewater is vital

for safeguarding the environment and public health. Thus, by employing the on-site hospital treatment facility approach developed by Haeusser et al. (2023), the efficiency in managing the plant in eliminating pharmaceutical residues and bacterial indicator species can be demonstrated.

4.3.2.3 Green Technology and Innovations

Replacing energy-intensive equipment with more efficient alternatives significantly reduces energy consumption, mitigating adverse environmental impacts and reducing operational costs for the healthcare industry (De Oliveira et al., 2021). Green technology management encompasses obtaining, executing, and overseeing environmentally sustainable technologies. The technological advancements encompass various progressive modern technologies like blockchain, artificial intelligence, information and communication technology (ICT), machine learning, and autonomous robots (Akinwale et al., 2023). These technological innovations magnificently improve the effectiveness and efficiency of organizations, leading to improved productivity and performance.

4.3.2.4 Sustainable Waste Management

The demand for environmentally sustainable healthcare has been increasingly acknowledged due to the resource-intensive nature of hospitals, which consume significant amounts of public resources such as water, gas, energy, and food, as well as utilize various buildings to deliver medical services. Given the present circumstances, with global climate variations and viruses threatening humankind, the healthcare industry must increase its investment in environmental protection measures. Using green and sustainable methods can make the minimization of waste output attainable (Lee & Lee, 2022). Circular economy (CE), a new approach to healthcare waste management, can potentially optimize value and address various systemic issues in a country's society and economy, promoting sustainable development and mitigating irreversible environmental harm (Ghoushchi et al., 2022). Therefore, spreading the idea of GHI and acceptance among healthcare personnel plays a crucial role in comprehensively tackling the issues related to medical waste (Yang et al., 2024).

4.3.3 Themes Derived from Healthcare Environment Aspect

4.3.3.1 Green/Sustainable Supply Chain Management

This refers to the deliberate and transparent alignment of organizational objectives across the triple bottom line's people, planet, and profit dimensions. It involves the systematic coordination between organizations within a supply chain to enhance the overall long-term performance of the entire supply chain (Pishvaee et al., 2014). Meanwhile, organizational competitive advantages are maximized by establishing policies that promote a sustainable supply chain response strategy (Hossain et al., 2021). Environmentally friendly supply chain management aims to include environmental considerations in all supply-chain-network decision-making processes by incorporating an environmental aspect into SCM (Pishvaee et al., 2014). The effectiveness of the sustainable healthcare supply chain relies on implementing the performance assessment system. Here, performance refers to the ability of a company to decrease the consumption of resources like (energy or water) and to discover environmentally friendly remedies by enhancing the supply chain network (Leksono et al., 2019). Incorporating the sustainability idea into the healthcare supply chain (HSC) necessitates reducing the utilization of both renewable and non-renewable sources by identifying eco-friendly resolutions in supply chain enhancement (Hossain et al., 2021). Environmental sustainability is a vital component of the healthcare system in the HSC. Healthcare firms can mitigate their environmental effect and deliver high-quality patient care by adopting eco-friendly strategies such as GHI in their supply chain procedures.

4.3.3.2 Stakeholders' Behaviour and Awareness

The operation of healthcare institutions depends on collaboration with several stakeholders, including suppliers, the government, the general public, healthcare providers, patients, etc. (Hossain et al., 2021). GH involves an extra evaluation for healthcare professionals and institutions. Healthcare stakeholders possess the ability to develop plans to ensure the health sector's sustainability (Vishwakarma et al., 2022). Hence, community involvement is essential in developing sustainable healthcare (AlDulijand et al., 2023). As mentioned by Lattanzio et al. (2022). for greening healthcare facilities, it is necessary to focus on educating health personnel and management, implementing regulations from government bodies, and establishing an "environmental greening team," raising consciousness among healthcare personnel and legislators. To be sustainable, stakeholders must achieve the necessary system standards following the affordability index (Tushar et al., 2023). As environmental concerns gain greater attention, GH is becoming increasingly pertinent. Therefore, the commitment and behavior of healthcare workers towards their organization are essential for the smooth operation of the supply chain to promote environmentally sustainable healthcare practices (Yusuf et al., 2024). Therefore, spreading the idea of GHI among healthcare personnel can play a crucial role in comprehensively tackling the issues related to medical waste (Yang et al., 2024).

4.3.3.3 Green Intellectual Capital

Sustainable intellectual capital is the collective knowledge utilized to implement sustainable development initiatives inside healthcare organizations. Sustainable development encompasses these projects' social, economic, and environmental aspects (Cavicchi et al., 2017). Green intellectual capital (GIC) is a strategy that encompasses intangible knowledge related to environmental conservation. By leveraging the collective intelligence, organizational processes, and market connections available, GIC enables firms to effectively and efficiently abide by the rule of environmental sustainability while fulfilling the concerns of healthcare stakeholders (Issa et al., 2022). Intellectual capital enables a corporation to leverage its technological resources and networking skills to exchange knowledge between the firm and its stakeholders. As a crucial precursor to absorptive capacity, intellectual capital can guide insightful information with varying impacts on acquiring and utilizing knowledge, ultimately resulting in diverse performance outcomes. Hence, Issa et al. (2022) put up a framework to investigate the correlation among intellectual capital, absorptive ability, and a company's performance in the face of environmental change (turbulence).

4.3.3.4 Green Healthcare Strategies

As disasters continue to occur more frequently and with greater intensity worldwide, the strain upon the healthcare ecosystem has evolved. Although some disasters naturally affect the healthcare environment, healthcare institutions are bound to withstand and recover from them (AlDulijand et al., 2023). Sustainable disaster management can be considered a green healthcare strategy that ensures that hospitals are prepared and includes communities in sustainable health practices (AlDulijand et al., 2023). This encompasses the promotion of health literacy, the encouragement of environmental stewardship, and the strengthening of community resilience. An all-encompassing strategy ensures the long-term sustainability of the healthcare ecosystem, not just in terms of being prepared for disasters but also in its ability to promote a thriving and resilient community. Stakeholder engagement is a widely used approach in managing sustainable healthcare facilities, as it enables a methodical comprehension of the interconnected sustainability goals and operational procedures (Li Y. et al., 2021). Several sustainability models have been presented for the incorporation of GHI in the healthcare

industry, viz. sustainable development model by (Aini et al., 2023), the integrated model of GH undertaking, and TQM (total quality management) by (Lee & Lee, 2022); PESTEL components of a framework for sustainable healthcare waste management by (Thakur, 2021), a proposed framework for the proper acquisition of technology concerning healthcare waste management (Chen et al., 2022), etc. can be taken as healthcare strategies towards green healthcare. Sherman et al. (2020) and Ryan et al. (2016) considered green healthcare as an advanced strategy for environmental sustainability in healthcare institutions in their respective research. GH is a specialized field incorporating sustainable practices into healthcare institutions and organizations (Dion et al., 2023).

4.3.3.5 Healthcare Information Systems

Healthcare as an information system uses technology and data management practices to collect, store, manage, and analyze health information. The healthcare stakeholders cannot gain significant new knowledge due to the extensive information in the healthcare industry. Therefore, assessing, investing, scrutinizing, and distributing reliable and relevant information among healthcare ecosystems is vital (Karamat et al., 2019). One of the essential goals of SDG 3 is to create a thorough and proactive digital healthcare system that can precisely predict and notify early indicators of danger, assist in reducing risks, and offer assistance for handling health threats on a national and global scale. Zahid et al. (2021) state that integrating AI, ML, DL, IoT, and big data analytics technologies in the healthcare ecosystem can substantially contribute to attaining the SDG target by 2030. The information-based management system has significantly enhanced medical equipment by refining the old manual methods. Hence, the implementation of IoT is essential for users to effectively control hospital equipment, enhance efficiency, minimize manual intervention, and accomplish dynamic management objectives (Wu, 2021).

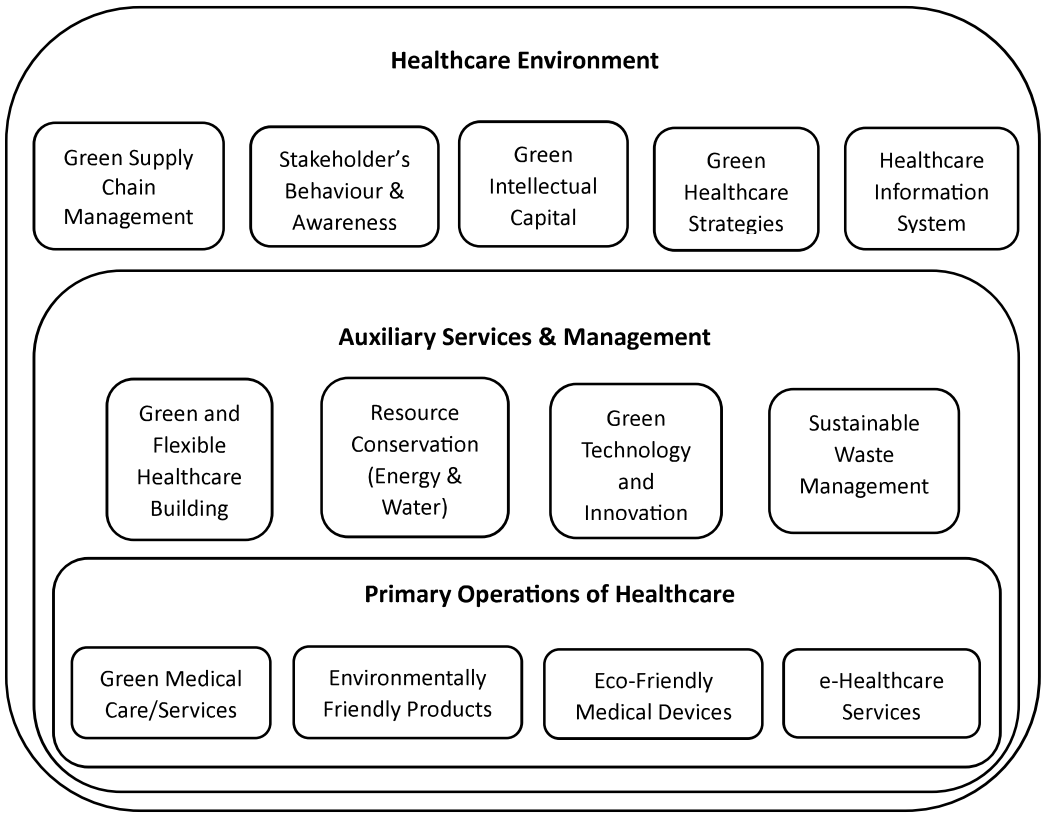
4.4 Recent Developments in GH practices and trends

Healthcare innovations may come from introducing new goods or services or leveraging new technologies to enhance already available goods and services (Akinwale et al., 2023). This technological development will help patients and healthcare facilities, improving health outcomes, superior care quality, and increased efficiency. Healthcare institutions have been striving to uphold exemplary levels of care, minimize the transmission of diseases, and optimize hospital operations. They have implemented several environmental management programs centered on GH practices to efficiently control energy consumption, dispose of waste, and create an eco-friendly environment for the surrounding community (Lee & Lee, 2022).

The healthcare industry is evolving due to various waste management techniques, viz. circular economy approach for healthcare waste reduction highlighted by (Dixit et al., 2024 Dihan et al., 2023; Ghoushchi et al., 2022); applicability of environmental management system by (Shabani et al., 2023); use of blockchain technology highlighted by (Bamakan et al., 2022); waste management using PESTEL analysis proposed by (Thakur, 2021); interval-valued fuzzy DEMATEL method used by (50). Stakeholders' behavior (Yang et al., 2024; Yusuf et al., 2024; Lu et al., 2024; Lee et al., 2023; Pereno et al., 2020) toward adaption of GHI in healthcare practices is an emerging trend currently going on. Green technologies and strategies like Green intellectual capital (Issa et al., 2022; Cavicchi et al., 2017), telemedicine and telepresence robots' adoption behavior (Lu et al., 2024; Altalbe et al., 2023; Naseer et al., et al., 2023; Qiao et al., 2023), industry 5.0 technologies i.e. ESG (environmental, social, governance) and AM (additive manufacturing) (Priyadarshini et al., 2023; Dion et al., 2023; Verma et al., 2023) are some of the significant developments have been recently going in in the field of healthcare.

Other innovative technologies such as digital transformation (Akinwale et al., 2023), artificial intelligence (Wu, Q. 2021), deep learning (Azadi et al., 2023), blockchain (Bai et al., 2022; Bamakan et al., 2022), medical informatics (Sijm-Eeken et al., 2022; Zahid et al., 2021) in the field of healthcare supply chains and healthcare institutions lead to the evolution of GHI in the healthcare domain. Environmental life cycle (Alhaij et al., 2023; Campion et al., 2015) and circular economy (Dixit et al., 2024; Ghoushchi et al., 2022; Vishwakarma et al., 2022) integration in the healthcare industry is much needed-and critical-methods that have been emerged throughout the years. We have developed a sustainable and low-carbon healthcare model to address the rising demand for healthcare resources while minimizing climate change impacts.

Figure 7: A conceptual framework for GHI in healthcare settings



Source: Authors' own

5. Discussion

This study aimed to address two research inquiries that will be elaborated on below, followed by future research avenues in the field of GH domain based on these questions and themes discussed above.

5.1 What is our present understanding of GH?

The resource-intensive character of the healthcare sector contributes to its effects on both people and the environment. As they use many disposable products and produce much toxic waste that pollutes the environment, healthcare organizations represent energy-consuming institutions (Lee & Lee, 2022). In this context, the WHO (World Health Organization) introduced the concept of GH. GH is not new; instead, it is an approach that emphasizes

environmentally friendly procedures in healthcare settings intending to balance patient safety with environmental stewardship (Yang et al., 2024).

GH means simultaneously reducing adverse environmental effects and eliminating diseases by acknowledging the connection between people and environmental well-being through eco-friendly medical devices (Lee & Lee, 2022). Additionally, GH may increase the money value by reducing waste and operating expenses, raising consumer knowledge of sustainability's significance while increasing the economic value of healthcare facilities. GH is a healthcare approach incorporating environmental considerations into its high-quality services and prioritizes sustainable building design. It necessitates specific attributes, viz., a strategic plant location, energy efficiency, efficient water utilization, the use of high-quality materials, and reduction in air pollution (Lattanzio et al., 2022).

GH also acknowledges the correlation between environmental sustainability and public health, and it shows this awareness by incorporating these practices into its operations, strategy, and governance (De Oliveira et al., 2021). Here, environmental sustainability encompasses the capacity to safeguard ecosystems by responsibly utilizing and renewing the natural resources that sustain life on Earth. The definition of GH we put forward is as follows. GH is "the healthcare practices that prioritize environmental sustainability, resource conservation, and the use of eco-friendly technologies and products, aiming to minimize the environmental impact of healthcare operations while promoting public health."

5.2 What role could GHI play in the growth and development of the healthcare industry?
The growing apprehension regarding medical waste has prompted the investigation of different remedies, with the advocacy of GH emerging as a notably efficacious approach (Sijm-Eeken et al., 2022). GH is a concept that emphasizes the adoption of sustainable practices in the medical setting. It aims to combine patient safety with environmental stewardship (Tushar et al., 2023). Sijm-Eeken et al. (2021) demonstrated the green mission framework, a prime example. This innovative architecture combines environmental science with healthcare IT to reduce the climatic impact of healthcare practices. The focus is on three main areas: monitoring the environmental effects, increasing awareness, and implementing specific actions to minimize the impact of healthcare services. The success of the GH approach is closely linked to its awareness among stakeholders and adoption by the healthcare personnel through emotion-symbolic strategies and theories to increase awareness, as highlighted by (Yang et al., 2024).

According to the previously mentioned GHI framework, it is clear that GHI substantially impacts the progress and development of the healthcare sector through various methods. For example, implementing GHI can result in cost savings for healthcare institutions by using energy-efficient lighting. According to Nimlyat P.S. (2018), GHI continually prioritizes the promotion of healthier interior conditions for its stakeholders by encouraging the use of eco-friendly cleaning products, improving indoor air quality, and reducing exposure to dangerous substances. An improved work environment can enhance employee contentment, diminish absenteeism, and enhance patient results. Investing in GHI has the potential to stimulate advancements in medical technology and research. GHI enables healthcare facilities to engage with their communities and educate individuals about the connection between environmental sustainability and human well-being. Organizing educational activities, instituting recycling programs, and actively participating in neighborhood clean-up initiatives can cultivate positive sentiments and enhance community bonds (Lattanzio et al., 2022). Adopting GH practices is crucial for ensuring the long-term viability of the healthcare sector. Healthcare organizations

may help preserve the environment for future generations and maintain the availability and affordability of healthcare services by lowering energy usage, minimizing waste, and conserving resources.

6. Future Research Directions

6.1 From TCCM

6.1.1 Theory

Future research should more extensively employ theories such as the resource-based view, natural-resource-based view (NRBV), knowledge-based view, dynamic capabilities theory, and institutional theory to comprehensively illustrate the relationship between GHI and sustainable performances in the healthcare sector and attain competitive advantage. Future studies can investigate frameworks like the resource interaction method to capture interdependencies that extend across organizational boundaries in hospitals. Innovation systems and transition theory can be employed to develop operational strategies in healthcare. Integrating theory into survey-based research may assist in bridging the empirical gaps in the literature.

6.1.2 Context

Examining sustainability in healthcare through new samples from various nations might facilitate the analysis of cultural factors. To enhance applicability, researchers ought to examine healthcare sustainability in both developed and developing countries. Prioritize cross-cultural studies, especially those comparing industrialized and emerging nations, to discern global healthcare sustainability characteristics and underscore disparities. Healthcare policymakers must include patients' perspectives when executing sustainability initiatives.

6.1.3 Characteristics

Investigating the impact of leadership commitment to sustainability on the execution of green initiatives within healthcare systems and the methods to embed sustainability within healthcare culture, establishing it as a fundamental value rather than a peripheral initiative, could be employed in future research. Other research that could be explored in the future is creating comprehensive models to assess the financial returns on investment for sustainable healthcare initiatives, encompassing long-term savings and reductions in environmental impact. Investigating the ways in which partnerships among government entities, the private sector, and healthcare providers can advance and fund environmentally sustainable healthcare initiatives. Exploring innovative financial models, including green bonds and carbon credits, specifically intended to finance sustainable healthcare infrastructure.

6.1.4 Methods

Future researchers may undertake additional quantitative investigations, prioritizing experimental designs. They could advantageously utilize mixed-method research methodologies. They may also benefit from the application of longitudinal research designs by researchers. Future studies ought to encompass individuals from other sources, including healthcare practitioners and consumers. Moreover, future research can focus on the effects of environmentally friendly healthcare methods on society and the planet over the long run, particularly how they affect pollution and carbon emissions. Investigating the potential future impact of sustainability-minded training on the next generation of healthcare workers to influence green healthcare practices could be explored.

6.2 From Themes

6.2.1 Eco-friendly Technological Innovations

As per Akinwale et al. (2023), technological advancements, viz. AI, ML, DL, and Blockchain are highly significant in green healthcare and are recognized as competitive advantages. Hence, upcoming researchers can critically examine and integrate these technologies into healthcare. Also, Industry 5.0 technology, i.e., ESG-based management implementation in the healthcare sectors for more sustainable and greener healthcare, has an emerging scope for future research.

6.2.2 Healthcare Environment and GHI

Even though a few scholars have recommended a GH strategy for healthcare delivery, there has been a dearth of studies on its application, specifically in environmental sustainability. For organizations to function effectively in the long term, they need to sustain their interactions with their environments over an extended period (Weisz et al., 2011). In this context, future studies might be on how GH facilities contribute to improved indoor air quality, patient well-being, and faster recovery time.

6.2.3 Stakeholders Awareness and Healthcare Promotion

Healthcare's primary focus, i.e., medical care, including related support services and the newly emerging service of health promotion, are the central components of the triangle in the field of healthcare (Weisz et al., 2011). Thus, stakeholders' awareness and healthcare promotion can be valuable sources of healthcare research that might investigated in the following days. For example, they investigate the potential health benefits associated with GH practices and explore strategies to promote sustainable behavior among healthcare staff, patients, and visitors. How can awareness and education programs be designed to encourage energy and resource conservation in healthcare settings?

6.2.4 Methodological Advancements

It is recommended that data collection and methodology be enhanced by employing mixed method approaches, improved survey technologies, remote sensing Technogym, and on-site observations to acquire a more comprehensive understanding of GH activities in the healthcare setting. Advanced performance evaluation methodologies, such as DEA, could be used to analyze future research.

6.2.5 Green and Sustainable Supply Chain Models

The use of advanced performance evaluation methodologies, such as DEA, in healthcare supply chains to improve performance has garnered significant attention in the past twenty years (Azadi et al., 2023). Using such methods while investigating the environmental impact of healthcare supply chains, including pharmaceuticals, medical devices, and consumables, might give an advantage for further research.

6.2.6 Intervention in Policy and Governance

Future studies should focus on how policy interventions and support mechanisms might improve the growth and resilience of GHI. For example, analyzing the efficiency of existing GH laws and regulations in separate countries offers numerous opportunities for improvement. Also, without the interference of politics and governance, the healthcare manufacturing process can be significantly improved; e.g., the industry's consistent deployment of sustainable production practices that need fewer resources and energy (carbon footprints) illustrates success without official laws (Moermond et al., 2022).

6.2.7 Green Waste Management

Green waste management is not a new area of research, but there is still room for improvement in biomedical and liquid waste. Exploring holistic waste management systems for healthcare institutions that cover biomedical waste, e-waste, and other liquid hazardous materials may be considered a new area of research, as academics currently focus solely on solid waste management in the healthcare industry.

6.2.8 Renewable Energy Integration

Examining strategies for integrating renewable energy sources (solar, wind, biomass, etc.) into healthcare facilities to reduce carbon footprint and enhance energy security while considering the intermittency of renewable sources and their cost-effectiveness is an ongoing emerging trend in GH domain that can be explored for the betterment of healthcare environment. For example, they evaluate the impact of sustainable materials, passive cooling strategies, and indoor air quality management on patient outcomes and energy consumption.

7. Conclusion

The service sector is a crucial sector, and the healthcare industry has seen substantial transformations due to heightened consciousness and the advent of digital technologies (Azadi et al., 2023). Building and operating healthcare facilities now prioritize sustainable development due to their significant influence on the environment and society. Contemporary healthcare institutions must promptly adjust to the challenges of an aging population, rapid technological progress, and the increasing demand for top-notch healthcare (Li. Y. et al., 2021). Therefore, we undertook this SLR with the intention of constructing a conceptual framework for GHI in the healthcare context. This framework aims to elucidate its role in fostering the expansion and advancement of healthcare operations. Over the past decade, cutting-edge technologies like automation, AI, and cloud computing have greatly enhanced healthcare operations (Azadi et al., 2023). The study analysis revealed that integrating and improving these technologies in healthcare systems might create several lucrative commercial opportunities and develop new business models to optimize performance and accomplish desired results. For instance, implementing our framework, GHI, could potentially mitigate the environmental impact of the healthcare business, thereby enhancing the overall quality of public health. The research also revealed that integrating theories such as the resource-based view, natural-resource-based view (NRBV), and knowledge-based view, along with the influence of leadership commitment to sustainability, is essential for implementing green initiatives in healthcare systems and for embedding sustainability into the healthcare culture, thereby establishing it as a core value rather than a marginal initiative within GHI, which is vital for the progression and expansion of the healthcare sector using TCCM approach. There are various constraints to our research. The study is secondary data-based research, which means it does not contribute empirical data to the scientific community. The analysis examines articles in English from only two databases, Scopus and WoS, from 2011 onwards. While SLRs are generally regarded as rigorous, this study focuses on these criteria. From an operations management perspective, we conducted the SLR on the function of GHI in the healthcare business. The selection process we utilized, including the search terms and criteria for inclusion and exclusion, may have been excessively stringent, potentially resulting in the exclusion of pertinent papers.

Finally, given the current context, marked by the threats posed by viruses and climate change to individuals and the environment, the healthcare sector must invest more in environmental protection measures. The sustainability of our environment is vital for our continued existence on Earth, as society and government are inherently connected to the well-being of the environment, both directly and indirectly.

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