HARNESSING GREEN STRATEGY AND SOCIAL INNOVATION FOR COMPETITIVE EDGE: A SYSTEMATIC LITERATURE NETWORK ANALYSIS IN THE PHARMACEUTICAL INDUSTRY

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Abstract

This study investigates the strategic significance of integrating green strategies and social innovation within the pharmaceutical industry to achieve competitive advantage. Utilizing Systematic Literature Network Analysis (SLNA), the research elucidates critical linkages between green innovation, social innovation, and environmental sustainability. Findings reveal that the implementation of green accounting, life cycle assessments (LCA), and regulatory frameworks can significantly enhance a company's environmental performance, bolstering competitiveness. The study underscores the importance of multi-stakeholder collaboration in advancing green and social innovations, highlighting how cross-sector alliances enhance both social impact and profitability. Through sample case studies, the analysis illustrates the pharmaceutical sector's capacity for sustainable growth, positioning it as a leader in harmonizing profitability with environmental responsibility. This model offers valuable insights for other industries seeking sustainable innovation practices.

Keywords: Competitive advantage, Green innovation, Green strategy, Pharmacy, SLNA.

1. Introduction

The pharmaceutical industry has experienced rapid growth over recent decades, driven by high levels of innovation in research and development and the increasing demand for novel drugs to address emerging diseases [1]. However, along with this expansion, the sector faces substantial challenges related to environmental sustainability [2]. Implementing environmentally friendly operations remains costly due to the high expenses associated with green technologies and waste management [3]. Additionally, strict regulatory requirements complicate the adoption of sustainable practices, while limited stakeholder awareness and engagement further hinder environmentally responsible operations [4].

Pharmaceutical waste is a growing global concern, particularly due to active pharmaceutical ingredients (APIs) found polluting rivers worldwide [5]. These pollutants, including caffeine, paracetamol, antibiotics, and metformin, have been identified in river ecosystems across both developed and developing nations, contributing to issues such as bacterial resistance, feminization in fish, and hormonal disruptions among various species [6].

The presence of high concentrations of active pharmaceutical compounds in approximately 40% of the world's rivers [7] poses significant risks to environmental and public health, particularly for communities dependent on contaminated water sources. Rivers in countries such as Pakistan, Argentina, and Ethiopia exhibit pronounced levels of contamination, while locations like Iceland, Norway, and the Amazon rainforest show relatively lower levels, underscoring a global problem that demands a coordinated response from all stakeholders.

Previous studies highlight the urgent need for innovative approaches to mitigate the environmental and socio-economic impacts of pharmaceutical waste, advocating for more sustainable operational strategies across the industry 999. To address this gap, this study applies Systematic Literature Network Analysis (SLNA) to examine the role of green strategy and social innovation in fostering competitive advantage within the pharmaceutical sector. SLNA offers a dual approach, combining bibliometric analysis and systematic literature review, which enables a comprehensive understanding of research trends and key findings that can inform future policy directions. Through SLNA, this study identifies critical research questions related to green innovation and competitive advantage, focusing on aspects such as scientific production trends, co-occurrence analysis, and the geographical distribution of research contributions.

The objectives of this study are as follows: (1) to explore scientific production trends in green and social innovation within the pharmaceutical industry and their implications for competitive advantage; (2) to identify key publications and research themes through keyword co-occurrence analysis; (3) to analyse geographical contributions to the literature on green strategy and social innovation; (4) to investigate additional perspectives or trends within green pharmacy; and (5) to assess the correlation between green and social innovation in shaping competitive advantage, as identified through SLNA. By examining these elements, this study seeks to establish a nuanced understanding of green strategy and social innovation as strategic assets within the pharmaceutical industry, contributing insights that can serve as a replicable model for other sectors pursuing sustainable innovation.

2. Methods

SLNA is a research approach that performs an exhaustive examination of sustainable strategies and social innovation within the pharmaceutical industry [8]. It utilizes qualitative methods through literature reviews, enhancing understanding of the subject. Scopus, a leading database, offers comprehensive coverage of more than 15,000 titles, making it an indispensable resource for bibliometric research [9]. This study serves as a preliminary examination of the problems associated with competitive advantage in green pharmacy [10].

2.1. Systematic literature network analysis (SLNA)

SLNA integrates both quantitative and qualitative analysis to capture the evolution and impact of green strategy and social innovation. This method involves two stages: (1) bibliometric analysis to map research output, key themes, and influential contributions, and (2) a systematic literature review to analyse the content and implications of these studies. Bibliometric analysis followed by a Systematic Literature Review (SLR). SLNA process and PRISMA technique in this research can be seen in Figs. 1 and 2.
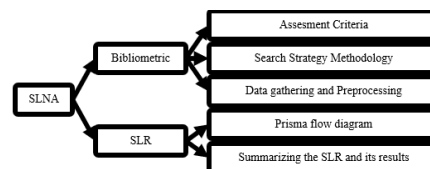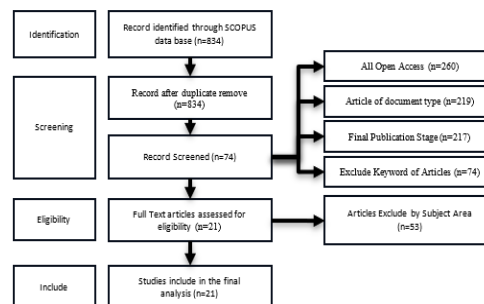

Fig. 1. SLNA process.

Fig. 2. PRISMA technique.

2.2. Bibliometrics analysis

The bibliometric analysis phase sourced data from the Scopus database using targeted keywords such as "green strategy," "competitive advantage," and "social innovation." An initial set of 834 documents was refined to 74 relevant articles through inclusion and exclusion criteria. Using VOS Viewer, we conducted a co-occurrence analysis that identified four main research clusters: pharmaceutical innovation, green chemistry, animal testing and gene expression, and sustainability through life cycle assessments (LCA). This clustering revealed the primary themes and interactions within green and social innovation research in the pharmaceutical sector.

2.3. Systematic literature review (SLR)

In the SLR phase, we applied the PRISMA guidelines to systematically evaluate the selected articles, narrowing the final set to 21 studies. The SLR highlighted how regulatory frameworks, stakeholder collaboration, green accounting, and LCA contribute to competitive advantage in the industry. The findings emphasized the essential role of collaborative and regulatory support in advancing green and social innovations, which not only enhance environmental outcomes but also foster business competitiveness. By integrating bibliometric mapping with an in-depth literature review, SLNA provides a robust understanding of the strategic implications of green and social innovations in the pharmaceutical industry. The combined insights from this methodology offer valuable guidance for other sectors seeking to embed sustainability within their competitive frameworks.

3. Results and Discussion

This results and findings section will analyse the coverage of keywords related to the impact of green strategy on competitive advantage, based on a bibliometric analysis of the occurrence and distribution of publications. Furthermore, a systematic literature review (SLR) of the analysed papers will be conducted. The description will be linked to the research questions. This section consists of four components. The first part will examine the publication distribution of the effect of green strategy on competitive advantage, using the Scopus database due to its prominence as one of the largest research databases. The second section deals with co-occurrence studies, where keyword correlations are described to identify prevailing research patterns. The last section highlights the importance of green strategies in achieving competitive advantage through a qualitative analysis of the systematic literature review, using the findings from the reviewed articles to draw new conclusions. The final section examines the analytical results of the systematic literature review, highlighting views and trends regarding the impact of GS on competitive advantage through GI and SI.

3.1. The trend analysis of scientific production

After setting the inclusion and exclusion criteria, the selection of article sources resulted in 834 documents to be analysed, documents generated 125 documents in 2024, and Ganjali, M.R. is one of the authors who produced the most documents, totalling 38 documents.

3.2. The most used keywords in studies

In the next stage of this research, a content investigation was conducted by examining the distribution of keywords. After conducting an in-depth co-occurrence mapping using VOS Viewer, covering 4 major keyword clusters found in Green Strategy-related publications, a visualization of keyword density and a timeline view of keywords is presented, described in Fig. 3(a). Co-occurrence keywords are an important tool in scientific research as they highlight research clusters in specific fields of study, namely Unclassified Drugs (208), Human (195), Nonhuman (147) and Life Cycle Assessment (91). Additional support for scientific research is using linkage keywords.

The cluster visualization delineates four primary themes in pharmaceutical industry research: unclassified drugs, chemistry, animal experimentation, and green chemistry. The red cluster examines unclassified drugs and chemical processes, whereas the blue cluster explores animal experimentation, gene expression, and metabolism. The clusters underscore the significance of green chemistry, waste management, and animal experimentation in promoting sustainable pharmaceutical production techniques. The yellow cluster emphasizes human-related topics, focusing on clinical trials and treatment outcomes, while the green cluster highlights sustainability and life cycle assessment in the pharmaceutical industry. This study examines life cycle assessment and the environmental impacts of pharmaceutical products, emphasizing progress in ecological conservation and waste management strategies.

3.3. Countries' contribution of green strategy in pharma

Thirty-seven countries contribute to scientific papers in this pharmaceutical green strategy study. Countries in Asia are the predominant contributors, but others are distributed across America, Europe, Australia, and Africa. China, a leading contributor to research in this domain, accounted for 221 out of 834 articles, representing 26.5% of the global total, followed by the United States (96) and Iran (80) (See Fig. 3(b)). This study analyses Green Strategy (GS) through GI and SI, examining its impact on a firm's sustainable competitive advantage. It draws from 21 selected research papers from 15 Scopus journals across green innovation, social responsibility, environment, social innovation, and competitive advantage, highlighting its diverse nature.
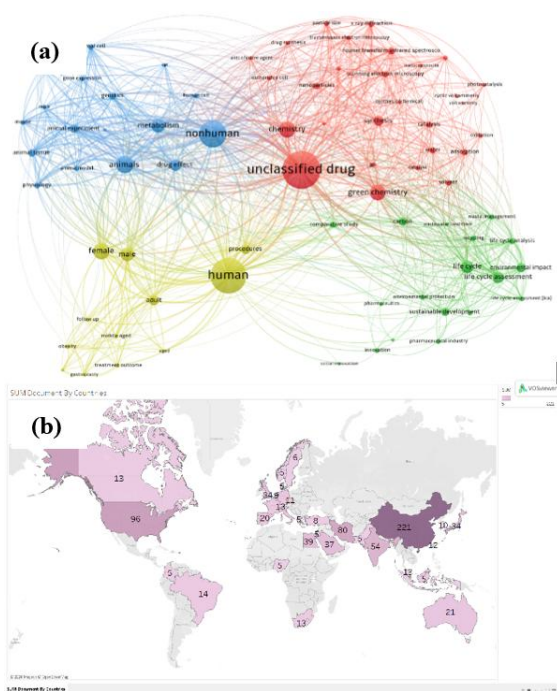

Fig. 3(a). Network visualization by all keywords,
(b) Document analysis by countries.

Table 1 summarizes the final compilation of articles categorized by authors, year of publication, study nature, and journal titles. Table 1 indicates that 13 reputable journals indexed by Scopus published 21 papers on green strategy, green innovation, and social innovation influencing competitive advantage. Of the 21 works, 20 are empirical investigations, 1 is a theoretical and/or qualitative study, and another employs a mixed-methods approach. The investigations were published between 2012 and 2024.

Table 1. Summary of the final papers collection.

No.	Author	Empirical	Theoretical	Implementation phase	Journal	Quartile	H-index
1	Healy et al. [11]	✓		practice	Journal of Business Venturing Insights	Q1	37
2	Kleinhout-Vliek et al. [12]	✓		practice	Innovation: The European Journal of Social Science Research	Q2	44
3	Bade et al. [13]	✓		practice	Corporate Social Responsibility and Environmental Management	Q1	113
4	Adu et al. [14]	✓		practice	Journal of Environmental Management	Q1	243
5	Osorio-Tejada et al. [15]		✓	practice	Green Chemistry	Q1	272
6	Rahman and Islam [16]	✓		practice	Environmental Science and Pollution Research	Q2	179
7	Arfelis et al. [17]	✓		practice	Science of the Total Environment	Q1	353
8	Perez-Aleman and Ferretti [18]	✓		practice	Journal of International Business Policy	Q1	28
9	Agarwal et al. [19]	✓		practice	Journal of Risk and Financial Management	Q2	40
10	Rahman et al. [20]	✓		practice	Environmental Science and Pollution Research	Q1	179
11	Zhou et al. [21]	✓		experiment/ practice	Environmental Science and Pollution Research	Q1	179
12	Singh et al. [22]	✓		practice	Resources, Conservation and Recycling	Q1	196
13	Murphy et al. [23]	✓		practice	Science of the Total Environment	Q1	353
14	Osorio-Tejada et al. [24]	✓		practice	Green Chemistry	Q1	272
15	Tang [25]	✓		practice	Polish Journal of Environmental Studies	Q3	61
16	Beloin-Saint-Pierre and Hischier [26]	✓		practice	International Journal of Life Cycle Assessment	Q1	131
17	Bailey et al. [27]	✓		practice	Resources, Conservation and Recycling	Q1	196
18	Wang et al. [28]	✓		Evaluation	Science of the Total Environment	Q1	353
19	Salmoral and Yan [29]	✓		Practice	Resources, Conservation and Recycling	Q1	196
20	Nessi et al. [30]	✓		Evaluation	Science of the Total Environment	Q1	353
21	Edwards-Schachter et al. [31]	✓		Practice	Review of Policy Research	Q2	55

3.4. Discussion

In the pharmaceutical sector, Kleinhout-Vliek et al. [12] underscores the role of goal formulation in constructing the legitimacy of social innovation initiatives,

while Rahman and Islam [16] discuss how green accounting positively impacts both energy efficiency and environmental performance in Bangladeshi companies. Several studies also employ life cycle assessments (LCA) to evaluate the environmental impact of various technologies and processes, as seen in Osorio-Tejada et al. [24] study on carbon-to-carbon reactions and Arfelis et al. [17] investigation into calcium zincate production. In scaling social innovations, challenges persist, with studies like Adu et al. [14] focusing on overcoming barriers to green practices in SMEs, while others like Edwards-Schachter et al. [31] explore the use of living labs to identify the needs of specific populations, such as the elderly, and foster business opportunities through social innovation. This discussion highlights the interdisciplinary nature of social and green innovations, where sustainability, collaboration, and adaptability are key drivers for success across diverse sectors.

The Systematic Literature Network Analysis (SLNA) of the examined publications identifies several notable trends, including the correlation among GI, SI, and CA. Research by Healy et al. [11] and Perez-Aleman and Ferretti [18] highlights the complexity of scaling social innovation, emphasizing that collaboration and flexibility are essential for success. This is particularly vital in healthcare, where partnerships and efficient resource allocation promote substantial societal advancements. Rahman et al. [20] analyses the financial ramifications of green accounting, demonstrating that the adoption of sustainable practices enhances environmental performance and energy efficiency, thereby strengthening a company's competitive edge in the market. The analysis highlights the growing importance of life cycle assessments (LCA) in reducing environmental consequences, particularly in pharmaceutical manufacturing, as discussed by Osorio-Tejada et al. [15].

4. Conclusion

This study underscores the strategic role of green strategy and social innovation in enhancing competitive advantage within the pharmaceutical industry. Through systematic literature network analysis (SLNA), we identified critical connections between sustainable practices-such as green accounting, life cycle assessments, and regulatory support-and improved market positioning. The findings highlight the value of cross-sector collaboration in amplifying both social impact and profitability, suggesting that sustainable practices can effectively align business and environmental goals. Future research should investigate the economic effects of green innovation in various regions and industries, deepening our understanding of sustainability as a competitive asset. This study thus provides a foundation for continued exploration of sustainability as integral to strategic business success.

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