Green Supply Chain Management Practices and Sustainability of Pharmaceutical Firms: A Systematic Literature Review

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Abstract

The pharmaceutical industry plays a critical role in providing essential healthcare products to people globally. However, the industry's operations and supply chains have significant environmental impacts, including the consumption of resources, generation of waste, and emission of greenhouse gases. This study aimed to evaluate the impact of green supply chain management (GSCM) practices on the sustainability of pharmaceutical firms. This was a desk review. It followed a systematic approach, conducting a comprehensive search across academic databases such as Google Scholar, Research Gate, JSTOR, Emerald Insight and ProQuest, including journals and conference proceedings. The paper outlined the findings of past studies done on the relationship between GSCM practices and organizational sustainability especially in pharmaceutical firms. The researcher sourced studies online under the criteria that they focused on GSCM and organizational sustainability and were carried out from the year 2010 to 2023. The findings showed that GSCM has a positive impact on firm sustainability. Additionally, firms that embraced GSCM demonstrated a heightened commitment to employee welfare and community engagement further enhancing social sustainability. The research also highlighted the positive relationship between green procurement and firm performance, particularly in energy consumption reduction and waste management. Green manufacturing practices led to improved environmental performance, emphasizing optimized production processes and reduced hazardous substances. The conclusion was that the adoption of GSCM practices holds immense promise for enhancing the sustainability of pharmaceutical firms. The evidence suggests that proactive integration of GSCM practices leads to significant reductions in resource consumption, lower emissions, and heightened operational efficiency. It was concluded that pharmaceutical firms in Kenya should develop and implement holistic GSCM strategies that encompass eco-friendly sourcing, efficient transportation, waste reduction, and responsible disposal practices to minimize environmental impact. Pharmaceutical firms should also build strong partnerships with suppliers to encourage the adoption of sustainable practices throughout the supply chain, ensuring compliance with environmental standards and driving collective efforts towards sustainability goals.

Keywords: *Green Supply Chain Management, Sustainability, Pharmaceutical Firms*

Introduction

The pharmaceutical industry plays a critical role in providing essential healthcare products to people globally. However, the industry's operations and supply chains have significant environmental impacts, including the consumption of resources, generation of waste, and emission of greenhouse gases (Mangan, & Lalwani, 2016). Globally, there has been growing concern about environmental sustainability and the need for firms to integrate environmental practices into their operations, which has led to the emergence of the concept of GSCM (Khan & Qianli, 2017). GSCM refers to the integration of environmental considerations into supply chain management practices (Zimon, Tyan & Sroufe, 2020). It involves adopting sustainable practices throughout the entire supply chain, from sourcing raw materials to the manufacturing, distribution, and disposal of products. GSCM aims to minimize the environmental footprint of pharmaceutical firms by reducing resource consumption, waste generation, and pollution. It also focuses on enhancing the overall sustainability performance of the industry by promoting eco-friendly technologies, materials, and processes (Wang et al. 2020).

One of the critical environmental sustainability issues in Africa is the improper disposal and management of pharmaceutical waste, which poses a significant threat to both ecological and public health systems (Chisholm et al., 2021). As pharmaceutical firms continue to grow, particularly in rapidly industrializing regions in Africa, the inadequate robust waste management systems have led to the proliferation of expired, unused, or improperly disposed medications in the environment. This contributes to water pollution, soil degradation, and the disruption of natural ecosystems (Nyaga et al., 2020). The pharmaceutical compounds released into water bodies tend to harm aquatic life and create long-term ecological imbalances, exacerbating the already fragile environmental conditions in many African countries. This issue becomes even more pronounced in regions where access to safe drinking water is limited, making the consequences of pharmaceutical contamination particularly devastating (Karungamye et al., 2022).

A significant gap in the adoption of Green Supply Chain Management in African countries lies in the limited regulatory frameworks and inadequate infrastructure that support sustainable supply chain initiatives (Chisholm et al., 2021). Many African nations face challenges such as poor waste management systems, inadequate enforcement of environmental policies, and insufficient investment in green technologies, all of which hinder the implementation of GSCM (Singh et al., 2022). This is due to the scarcity of resources and expertise to integrate sustainability into existing supply chain structures, leaving many firms reliant on traditional, environmentally harmful practices. Consequently, there remains a pressing need for research and policy implementation that supports the adoption of GSCM in Africa, particularly within key industries such as pharmaceuticals, where sustainability is vital for both environmental and public health (Gwenzi et al., 2023).

According to Tseng et al. (2019), the adoption of GSCM practices enables firms to achieve a balance between environmental sustainability and economic development and overall organizational performance. Environmental sustainability and economic performance stems from ensuring a long-term buyer–supplier relationship, which results in adopting a green supply chain (Tumpa et al., 2019). Firms focus on identifying green suppliers while developing relationships and selecting suppliers because green suppliers ensure commitment to adopting GSCM practices. Besides, green suppliers emphasize reducing, recycling, and reusing materials and resources used for production through proper design. Green suppliers also ensure the reduction of toxic element

use and abide by environmental laws (Partanen et al. 2020). Therefore, trust and relationship with suppliers ensure environmental sustainability (Abdel-Baset, Chang, & Gamal 2019).

In the USA, the pharmaceutical industry is a major contributor to resource consumption, waste generation, and greenhouse gas emissions. This is because the production of pharmaceuticals involves the use of diverse raw materials, including chemicals and packaging materials. These materials often have significant environmental footprints, both in terms of their extraction and manufacturing processes. Additionally, pharmaceutical manufacturing processes consume substantial amounts of energy and water resources, further exacerbating the industry's environmental impact (Al-Sheyadi et al., 2019). The success of GSCM practices in the USA is because of their ability to enhance stakeholder engagement. Consumers, healthcare providers, and investors are increasingly demanding environmentally responsible products and practices. By embracing GSCM practices, pharmaceutical companies in the USA have aligned themselves with these expectations, enhancing their brand reputation and gaining a competitive edge, together with financial sustainability (Baliga et al., 2019).

In Japan, the second-largest pharmaceutical market in the world, GSCM practices have played a crucial role in reducing the environmental impact of pharmaceutical operations. Pharmaceutical companies in Japan have adopted sustainable sourcing strategies, ensuring that raw materials come from suppliers who follow environmentally responsible practices. This includes sourcing from suppliers who prioritize sustainable extraction methods, promote ethical labor practices, and comply with biodiversity conservation regulations (Gupta, Kumar & Sivarajah, 2021). By incorporating these practices, the sector has minimized its ecological footprint and contributed to environmental conservation. Additionally, GSCM practices have improved resource efficiency within the pharmaceutical sector in India. Pharmaceutical companies have implemented energy-saving technologies, optimized manufacturing processes, and adopted waste management systems to minimize resource consumption and waste during the manufacturing of drugs. These practices have not only reduced the sector's energy consumption and waste production but also lowered operational costs and increased the overall efficiency of the industry (Khan et al., 2023).

In China, pharmaceutical companies have increasingly shifted towards procuring raw materials and active pharmaceutical ingredients (APIs) from suppliers who adhere to environmentally friendly practices. For instance, many firms have forged partnerships with certified organic farms and manufacturers who employ eco-friendly production techniques. This not only reduces the environmental impact of sourcing but also ensures a more secure and transparent supply chain, aligning with global sustainability goals (Wong, Wong, & Boon-itt, 2020). Most of Chinese pharmaceutical firms have invested in advanced technologies and processes that optimize energy consumption in the drug manufacturing facilities. For example, the majority have implemented energy-efficient production lines and closed-loop manufacturing systems that have significantly lowered greenhouse gas emissions, demonstrating a commitment to sustainable operations that benefit both the environment and the industry's long-term viability (Yu et al., 2019).

In African countries, a prominent environmental sustainability challenge faced by pharmaceutical companies in Africa is the insufficient waste management infrastructure (Agyemang et al., 2020). Many regions lack proper facilities and protocols for the disposal of hazardous waste, including expired or unused pharmaceutical products. This deficiency poses a severe environmental risk, as this improper disposal leads to contamination of soil, water sources, and ecosystems. The absence

of robust waste management practices not only endangers the environment but also undermines the industry's commitment to responsible operations (Namagembe et al., 2019).

In Kenya, the main challenge faced by pharmaceutical firms is limited access to reliable energy sources, resulting in increased reliance on fossil fuels for power generation. This not only contributes to greenhouse gas emissions but also poses operational risks due to frequent power outages and high-energy costs (Mugabe, 2017; Onyango, 2018; Srimarut & Mekhum, 2020). Additionally, inadequate waste management infrastructure and practices present challenges in the proper disposal of pharmaceutical waste, leading to environmental pollution and public health concerns. Muthoni and Mose (2020) reported that the lack of comprehensive regulatory frameworks and enforcement mechanisms for environmental standards hinders the adoption of sustainable practices within the pharmaceutical sector in Kenya. Addressing these sustainability challenges requires collaborative efforts between pharmaceutical companies, governments, and international organizations to improve energy access, strengthen waste management systems, enhance regulatory frameworks, and provide support for sustainable initiatives. Therefore, the purpose of this review study was to find out the impact of GSCM Practices on the Sustainability of Pharmaceutical Firms and to make recommendations for improvement.

Methodology

This desk review followed a systematic approach, conducting a comprehensive search across academic databases such as Google Scholar, Research Gate, JSTOR, Science Direct, IEEE Xplore, Emerald Insight and ProQuest, including journals and conference proceedings. It involved screening titles, abstracts, and topics, and applying keywords depending. Search terms included g*reen supply chain, supply chain management, sustainable supply chain, environmentally viable supply chain, GSCM practices and pharmaceutical industry*. Studies addressing green supply chain practices in the pharmaceutical were eligible for inclusion in the review. Studies excluded either focused on other industries, not written in English, or where the report was inadequate, to thoroughly evaluate the methods and results. In addition, we chose to limit the review to only studies published from the year 2010 to 2024.

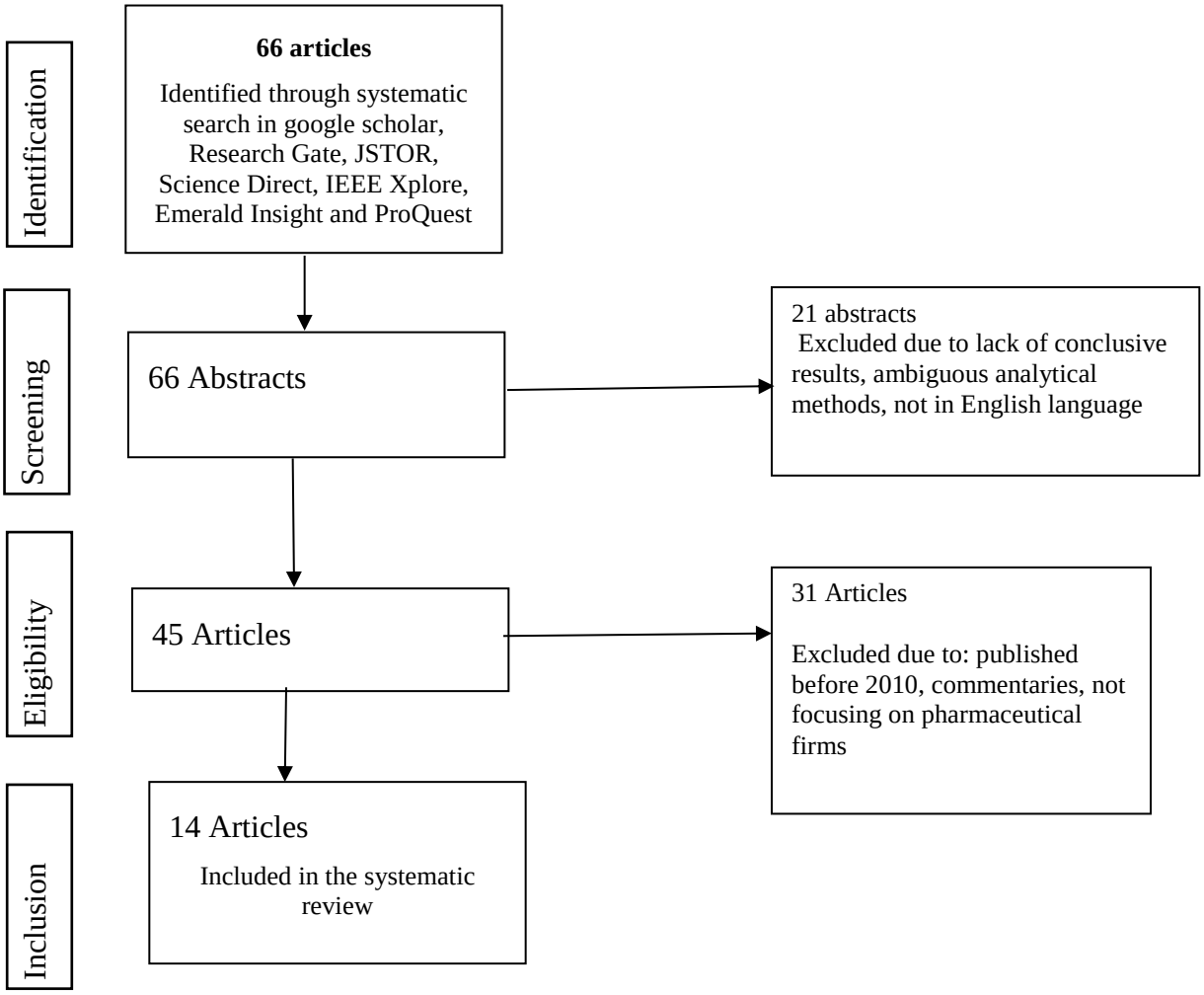

Figure 1: Flow chart for article identification and selection

Theoretical Framework

This study used the Institutional Theory postulated by DiMaggio and Powell (1983). According to the theory, broader institutional environment, which encompasses regulatory frameworks, cultural norms, and societal expectations profoundly influence organizations. It suggests that organizations conform to prevailing norms and practices to gain legitimacy and acceptance within their environment. This theory emphasizes the importance of adherence to regulatory frameworks and societal expectations, highlighting how organizations adopt structures and practices to align with established norms. Additionally, it recognizes that organizations may mimic the practices of industry leaders to gain legitimacy. The theory provides a framework for understanding how external institutional pressures shape organizational behavior and practices, influencing their strategies, policies, and overall sustainability efforts.

In the context of sustainability, there is an increasing societal norm that businesses, including pharmaceutical firms, should adopt environmentally responsible practices. This normative

pressure encourages pharmaceutical companies to integrate GSCM practices into their operations not only to meet societal expectations but also to gain legitimacy and enhance their reputation in the industry. Additionally, the theory recognizes that organizations can gain a competitive advantage by differentiating themselves from others in their field. By adopting GSCM practices, pharmaceutical firms distinguish themselves as environmentally responsible and committed to sustainability. This positive perception among consumers, investors, and stakeholders contributes to their legitimacy and long-term success.

The institutional theory offers a robust framework for comprehending how external institutional pressures and normative expectations shape the adoption of GSCM practices in the pharmaceutical industry. By adhering to these norms and aligning with regulatory frameworks, pharmaceutical firms enhance their legitimacy, reputation, and, ultimately, their sustainability performance. This theory, therefore, significantly informs the study by providing a structured approach to understanding how institutional factors influence the implementation of GSCM practices and, consequently, contribute to the overall sustainability of pharmaceutical firms.

Findings

A study by McCarthy and Giannakis (2016) investigated the adoption and impact of GSCM practices in the pharmaceutical industry in Ireland. It focused on its influence on organizational sustainability. This study employed a mixed-method approach, combining surveys and interviews with key industry stakeholders. The surveys covered pharmaceutical firms across Ireland to gather quantitative data on their GSCM practices and sustainability performance. Additionally, there were in-depth interviews to gain qualitative insights into the challenges and benefits of implementing GSCM practices. The study findings revealed a growing awareness and adoption of GSCM practices within the Irish pharmaceutical industry. Firms that actively implemented GSCM reported notable improvements in their environmental and economic sustainability, including reduced resource consumption, lower emissions, and enhanced operational efficiency. Additionally, the study identified collaboration with suppliers and regulatory compliance as crucial factors in successful GSCM adoption.

Pop and Axinte (2019) sought to assess the extent to which pharmaceutical companies in Romania had integrated GSCM practices into their operations and to analyze the effects of such practices on their sustainability. This research utilized a quantitative survey-based approach. Questionnaires distributed covered 128 multinational pharmaceutical firms in Romania, covering aspects related to the adoption of GSCM practices, environmental performance indicators, and sustainability outcomes. The study found that while there was a notable awareness of GSCM practices among Romanian pharmaceutical companies, the actual implementation was somewhat limited. Those firms that had actively integrated GSCM practices reported improved environmental performance, including reduced waste generation and energy consumption. However, challenges such as financial constraints and limited access to green technologies came out well as barriers to broader adoption.

Similarly, Oliveira and Domingues (2017) evaluated the relationship between the adoption of GSCM practices and performance of pharmaceutical companies in Portugal. This research employed a case study approach, analyzing multiple pharmaceutical firms in Portugal. The researcher collected data through semi-structured interviews, document analysis, and site visits. The study assessed the implementation of GSCM practices, measured environmental performance

indicators, and analyzed the overall sustainability outcomes. The study revealed a positive correlation between the adoption of GSCM practices and performance in Portuguese pharmaceutical firms. Those companies that actively embraced green practices reported reduced environmental impacts, such as lower emissions and waste generation. Additionally, the study highlighted the role of regulatory compliance and stakeholder engagement in driving successful GSCM implementation.

Sari and Putra (2020) explored the environmental impact of green procurement on the performance of PT Dexa Medica pharmaceutical firm in Indonesia. A case study approach employed, focused on 23 branches of the aforementioned firm. The results of the study showed a positive and significant relationship between green procurement and firm performance. ANOVA results showed that the pharmaceutical firms implementing green procurement practices demonstrated reduced energy consumption through energy-efficient production processes, as well as the use of renewable energy sources. Green procurement practices positively influenced waste management, thereby minimizing environmental pollution and resource depletion. Moreover, green procurement practices led to a reduction in the carbon footprint of pharmaceutical firms through measures such as improved transportation efficiency and the adoption of green packaging materials.

Hamed and Halil (2022) investigated the relationship between green manufacturing practices and the environmental performance of drug manufacturing firms in Egypt. A descriptive research design was used and 109 drug-manufacturing firms were included in the study. The findings depicted a positive and significant effect of green manufacturing practices and the environmental performance of the firms. Specifically, the study deduced that firms improved performance by optimizing production processes to minimize the use of raw materials and employing recycling and reclamation techniques to reduce waste output. In addition, the use of energy-efficient equipment, installation of renewable energy sources, and the implementation of energy-saving practices led to the environmental sustainability of the firms. The study further found that firms using green chemistry principles that are environmentally friendly lead to the reduction of hazardous substances in the environment.

Okonkwo et al., (2015) examined the relationship between green reverse logistics practices and cost management in selected pharmaceutical distributing firms in Lagos state, Nigeria. The study adopted a cross section survey design and 59 procurement managers participated in the study. t Firms in Nigeria actively embracing green reverse logistics practices reported significant cost savings. These firms optimized their logistics processes, leading to reduced transportation costs, improved inventory management, and minimized operational waste. The findings also indicated that companies with robust green reverse logistics practices experienced higher levels of customer satisfaction and loyalty. Efficient handling of returns and environmentally responsible disposal methods contributed to a positive customer experience, and customer retention.

Singh and Garg (2020) sought to assess the impact of GSCM practices on the environmental sustainability of pharmaceutical firms in India, with a specific focus on waste reduction and resource conservation. The study adopted a mixed-method approach, commencing with a comprehensive survey administered to 199 pharmaceutical companies across India. The survey encompassed inquiries regarding the adoption of GSCM practices, waste management strategies, and resource conservation initiatives. The research unveiled that pharmaceutical firms in India actively implementing GSCM practices reported significant reductions in waste generation. These

companies adopted innovative waste management techniques, such as recycling and reusing materials, thereby minimizing their environmental footprint. The study also demonstrated that the integration of GSCM practices led to notable enhancements in resource efficiency. Majority of the pharmaceutical firms invested in state-of-the-art technologies and processes, leading to optimized resource utilization. This, in turn, resulted in cost savings and bolstered their economic sustainability. The findings also indicated that companies with robust GSCM practices exhibited higher levels of compliance with environmental regulations and garnered a positive reputation in both industry circles and among consumers for their commitment to environmental stewardship.

Rahman and Uddin (2019) investigated the impact of GSCM practices on the social sustainability of pharmaceutical firms in Bangladesh, focusing on employee welfare and community engagement. This research adopted a mixed-method approach, commencing with a quantitative survey administered to employees within pharmaceutical companies in Bangladesh. The survey encompassed inquiries regarding working conditions, employee benefits, and community engagement initiatives. Additionally, the researcher conducted qualitative interviews with management and community stakeholders to gain deeper insights. The study revealed that pharmaceutical firms in Bangladesh that actively embraced GSCM practices demonstrated a heightened commitment to employee welfare. These companies provided improved working conditions, including safety measures and healthcare benefits, leading to higher levels of job satisfaction and employee retention. The research highlighted that firms with robust GSCM practices engaged more with the local community. The findings indicated that pharmaceutical firms with strong GSCM practices enjoyed positive perceptions among stakeholders, including employees, local communities, and regulatory bodies. This positive reputation further bolstered the firms' social sustainability performance.

Similarly, Moyo et al., (2020) examined the impact of lean manufacturing practices on the environmental sustainability of ABC Agrochemicals, a leading agrochemical factory in Zimbabwe. The study utilized both primary and secondary data. Findings indicated that the adoption of lean manufacturing practices resulted in a notable reduction in the environmental footprint of ABC Agrochemicals. Through initiatives like waste reduction, optimized resource utilization, and responsible chemical disposal, the factory reported a 37% decrease in greenhouse Gas Emissions 32% decrease in energy consumption. The findings also indicated that lean manufacturing practices led to significant cost savings for the firm. By optimizing raw materials and energy, the factory reported a 16% reduction in operational costs, which positively contributed to its economic sustainability.

Nyabote et al., (2014) assess the impact of green purchasing practices on the environmental sustainability of multinational agro-chemical processing firms in Isingiro district in Uganda. The study used a cross-sectional research design and stratified random sampling to select 41 firms. Regression results showed that green purchasing practices and environmental sustainability were positive and significantly related. Results also showed that 72% of the firms had actively adopted green purchasing practices that included sourcing environmentally friendly raw materials, prioritizing suppliers with eco-friendly certifications, and implementing waste reduction strategies in procurement processes. Firms that had embraced green purchasing practices reported better environmental sustainability performance compared to those that had not. The findings also indicated that firms practicing green procurement experienced cost-efficiency benefits and demonstrated higher levels of compliance with environmental regulations.

Kwame (2019) assessed the impact of green distribution practices on the financial and environmental sustainability of Tobinco Pharmaceuticals Ltd in Ghana. Quantitative data was collected through surveys distributed to employees and management at Tobinco Pharmaceuticals Ltd. Qualitative interviews were conducted with supply chain managers and environmental officers. The study depicted that the adoption of green distribution practices led to a notable improvement in Tobinco Pharmaceuticals Ltd's financial performance. Through initiatives such as route optimization, energy-efficient transportation, and reduced packaging waste, the company reported a 15% reduction in distribution costs and a 10% increase in net profit margins. Additionally, green distribution practices resulted in a significant reduction in environmental impact. Tobinco Pharmaceuticals Ltd achieved a 20% reduction in carbon emissions associated with distribution activities.

Rarrah and Patel (2018) investigated the impact of lean manufacturing practices on the financial sustainability of Aspen Pharmacare Holdings Limited in South Africa. The research employed a mixed-method approach. Quantitative data was collected through surveys and financial reports from Aspen Pharmacare Holdings Limited. Qualitative interviews were conducted with key personnel in the company, including production managers and financial analysts. The findings outlined that lean manufacturing practices led to significant cost reductions through waste reduction, process optimization, and improved inventory management. The study also indicated that Aspen Pharmacare Holdings Limited's adoption of lean manufacturing practices positively influenced its competitiveness in the pharmaceutical industry. The company was able to offer products at more competitive prices, gaining a larger market share and increasing revenue.

Njoroge and Mwanangi (2015) did a comparative study on the impact of green production practices on the sustainability of chemical and allied firms in Kenya, with a specific focus on Panafrican Chemicals Ltd. and Osho Chemical Industries Ltd. From the findings, Panafrican Chemicals Ltd. demonstrated a strong commitment to green production practices. They had implemented pollution prevention strategies, adopted eco-friendly raw materials, and invested in waste reduction technologies. In contrast, Osho Chemical Industries Ltd. had not fully integrated green production principles into their operations. In addition, Panafrican Chemicals Ltd, which had embraced green production practices, exhibited significant improvements in environmental performance. They recorded a 35% reduction in greenhouse gas emissions and a 30% decrease in water consumption compared to baseline data. Osho Chemical Industries Ltd., without green production initiatives, did not show substantial improvements. The study revealed that Panafrican Chemicals Ltd experienced cost savings due to reduced resource consumption and waste generation. Additionally, the company reported improved market competitiveness, as they were able to promote their environmentally friendly products, attracting environmentally conscious customers.

Al-Awamleh et al (2022) sought to identify the impact of the green supply chain on sustainability of the Pharmaceutical Industry in Jordan, as they were formulating the company's strategies and determining its policies. A purposive sample consisting of 258 managers was selected. To gather the data needed for the analysis, a self-report questionnaire was used formulated electronically through Google Forms. AMOS software was used to examine the research hypotheses. The findings of the study indicate that the implementation of various Green Supply Chain Management (GSCM) dimensions—namely, Eco-Design, Green Distribution, Green Purchasing, Green Manufacturing, and Green Reverse Logistics—positively impacts sustainability. Eco-Design

practices, which involve designing products with environmental considerations, contributed to resource efficiency and waste reduction, ensuring products are more sustainable throughout their lifecycle. Green Distribution reduced carbon emissions through optimized logistics and transportation methods, while Green Purchasing emphasized sourcing environmentally friendly materials, enhancing the sustainability of supply inputs. Green Manufacturing focused on reducing waste, energy consumption, and pollution during the production process, leading to improved operational efficiency and environmental performance. Lastly, Green Reverse Logistics, which facilitates the recycling, reuse, and proper disposal of products, further promoted circular economy principles, minimizing environmental impact

The reviewed studies revealed a growing awareness and adoption of GSCM practices, resulting in notable improvements in environmental and economic sustainability for firms actively implementing these practices. While some regions face challenges like resource constraints and limited access to green technologies, others showed a positive correlation between GSCM adoption and performance, with regulatory compliance and stakeholder engagement playing crucial roles. Additionally, firms that have embraced GSCM have demonstrated a heightened commitment to community welfare, further enhancing social sustainability. The research also highlighted the positive relationship between green procurement and firm performance, particularly in energy consumption reduction and waste management. From the reviewed studies, a conceptual framework was proposed as shown in figure 2.

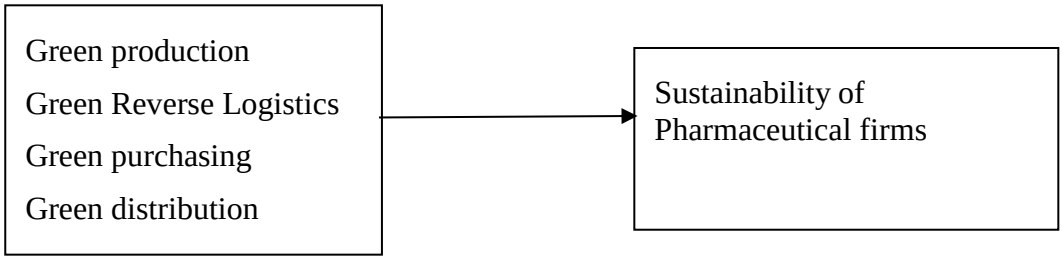

Figure 2: Proposed conceptual framework

Summary of Findings

Firms actively embracing green reverse logistics practices reported significant cost savings through optimized logistics processes and efficient handling of returns. Green distribution practices led to notable financial improvements, including reduced distribution costs and increased net profit margins. Lean manufacturing practices resulted in significant cost reductions and increased competitiveness in the pharmaceutical industry. In addition, lean practices led to substantial environmental footprint reduction and cost savings. The positive relationship between green purchasing practices and environmental sustainability was highlighted, leading to cost-efficiency benefits and higher compliance with environmental regulations. Finally, a comparative study highlighted the significant environmental performance improvements of one firm due to their commitment to green production practices, leading to cost savings and improved market

competitiveness, while another firm without such initiatives did not show substantial improvements. These studies collectively underscore the positive impact of implementing green practices within the pharmaceutical industry, ranging from improved environmental and economic sustainability to enhanced social engagement and regulatory compliance.

Conclusion

From the study findings, the conclusion was that the adoption of GSCM practices holds immense promise for enhancing the sustainability of pharmaceutical firms. The evidence suggests that proactive integration of GSCM practices leads to significant reductions in resource consumption, lower emissions, and heightened operational efficiency. This indicates that sustainability efforts are not only attainable but can also yield tangible benefits in terms of environmental conservation and economic viability within the pharmaceutical industry. Moreover, the studies highlight the pivotal role of collaboration with suppliers and adherence to regulatory frameworks in ensuring the success of GSCM initiatives. Despite persistent challenges, the overall trend towards increased awareness and implementation of GSCM practices within the pharmaceutical sector is a positive stride towards a more sustainable industry.

Additionally, the research stresses the broader societal advantages of GSCM practices. Firms that actively embrace these practices demonstrate an enhanced commitment to employee welfare, community engagement, and social sustainability. This signifies that sustainability endeavors in the pharmaceutical sector transcend operational improvements, positively affecting the well-being of employees and the communities in which these firms operate. Furthermore, the positive correlation between green procurement and firm performance, as well as the significant environmental footprint reductions resulting from lean manufacturing practices, accentuate the multifaceted advantages of adopting sustainable practices. These findings collectively offer invaluable guidance on how pharmaceutical companies can strategically align their operations with sustainability objectives, not only bolstering their financial standing but also contributing to a more environmentally conscious and socially responsible industry.

Recommendations

The conclusions made based on the study findings included the following:

1. Pharmaceutical firms should develop and implement holistic GSCM strategies that encompass eco-friendly sourcing, efficient transportation, waste reduction, and responsible disposal practices to minimize environmental impact.
2. Pharmaceutical firms should build strong partnerships with suppliers to encourage the adoption of sustainable practices throughout the supply chain, ensuring compliance with environmental standards and driving collective efforts towards sustainability goals.
3. Pharmaceutical firms should embrace cutting-edge technologies such as IoT, data analytics, and blockchain to enhance supply chain visibility, optimize operations, and reduce resource consumption, thereby advancing sustainability efforts.
4. Pharmaceutical firms should establish efficient reverse logistics systems to recover, refurbish, or safely dispose of products, minimizing waste generation and contributing to a circular economy model.
5. Pharmaceutical firms should also provide ongoing training on sustainable practices and engage employees in sustainability initiatives to foster a culture of environmental

responsibility within the organization, driving continuous improvement in supply chain sustainability.

6. Manufacturing pharmaceutical firms should adopt renewable energy sources, energy-efficient manufacturing processes, and green packaging materials, to reduce carbon footprints.
7. Pharmaceutical firms should also Establish key performance indicators (KPIs) for supply chain sustainability and conduct regular assessments to track progress.

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